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UNITED STATES  
 DEPARTMENT OF THE INTERIOR  
 BUREAU OF MINES  
 HELIUM ACTIVITY  
 HELIUM RESEARCH CENTER  
 INTERNAL REPORT

VISCOSITY OF THE HELIUM-NITROGEN SYSTEM FROM 133° TO

740° K FOR PRESSURES BETWEEN 1 AND 240 ATMOSPHERES

BY

Robert E. Wood

W. J. Boone, Jr.

BRANCH Branch of Applied Research

PROJECT NO. 7016

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VISCOSITY OF THE HELIUM-NITROGEN SYSTEM FROM 133° TO  
740° K FOR PRESSURES BETWEEN 1 AND 240 ATMOSPHERES

by

Robert E. Wood<sup>1/</sup> and W. J. Boone, Jr.<sup>2/</sup>

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ABSTRACT

The temperature dependency of the low-density viscosity coefficients,  $\eta_T^\circ$ , of helium and of nitrogen, 100° to 1,000° K, is correlated with empirical equations, and the temperature and composition dependencies of the low-density viscosity coefficients,  $\eta_T^\circ$ , of helium-nitrogen mixtures are correlated with the Chapman-Enskog expressions by using the Lennard-Jones (6:12) potential function. The residual viscosity,  $\eta_{T,P} - \eta_T^\circ$  (the difference between the viscosity of a compressed gas and the dilute-gas at a given temperature), was found to be a function of the thermal pressure coefficient,  $(\partial P/\partial T)_V$ , and two parameters,  $\alpha$  and  $\beta$ , which are characteristic of gas composition.

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The equation  $\eta_{T,P} = \eta_T^\circ + \alpha [(\partial P/\partial T)_V]^\beta$  represented 1,340 higher pressure experimental viscosity values with a mean absolute deviation of 0.86 percent, and this equation was used to compute viscosities of the gaseous helium-nitrogen system for a range of temperatures and pressures including those encountered in Bureau of Mines helium purification processes and in a crude-helium conservation gas reservoir. Tabular viscosities for helium, nitrogen, and 13 helium-nitrogen mixtures are presented for 110 temperatures, 133° to 740° K, and 49 pressures in the range 1 to 240 atmospheres.

The accuracy of the tabulated viscosities varies because correlation parameters were obtained from experimental data of unequal reliability. It is estimated that uncertainties in the computed viscosity values are:  $\pm 5$  percent for the region 325° to 740° K,  $\pm 2$  percent for the region 183° to 325° K, and  $\pm 5$  percent for temperatures below 183° K. The latter uncertainty may rise to  $\pm 10$  percent as critical conditions are approached.

## INTRODUCTION

An accurate knowledge of the shear viscosity behavior of the helium-nitrogen system, over a broad range of pressures and temperatures, is required in the design of equipment to carry out the various unit operations which are assembled into an integrated helium purification plant. The effects of pressure, temperature, and gas composition on the viscosity of helium-nitrogen mixtures are also of special importance to the Bureau of Mines in the prediction of the movement of crude helium being injected into a



natural gas reservoir at the rate of 3.6 billion cubic feet per year. In addition to providing useful information for various direct engineering applications, the viscosity behavior of helium-nitrogen mixtures is of interest to the scientific community in the verification of hypotheses regarding intermolecular collisions and the intermolecular potential function, and in the applicability of statistical theories correlating microscopic properties with measurements.

This report presents a method for the prediction of the viscosities of gaseous helium, nitrogen, and helium-nitrogen mixtures over the practical range of pressures, temperatures, and gas compositions encountered in Bureau of Mines helium purification processes and in the gas reservoir where crude helium is being stored for future use. The temperature dependency of the low-density viscosity coefficients of helium and of nitrogen is correlated with empirical equations, and the temperature and composition dependencies of the low-density viscosity coefficients of mixtures are correlated with the Chapman-Enskog kinetic theory expressions (5, 27)<sup>3/</sup> by the Lennard-Jones (6:12) potential function (27).

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3/ Underlined numbers in parentheses refer to items in the list of references at the end of this report.

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The Chapman-Enskog expressions are applicable only when the gas is dilute, that is, only when binary collisions are of consequence. Hence the results of the theory are not applicable at densities





sufficiently high that three-body collisions become important. There is no reliable or satisfactory theory for the prediction of the viscosities of real gases at higher pressures, and dense-gas momentum transport must be represented for the most part by empirical methods. In this report, the effect of pressure on the viscosity behavior of the helium-nitrogen system is correlated by the Golubev (20) relationship where the residual viscosity of a gas,  $\eta_{T,P} - \eta_T^\circ$ , is a function of the thermal pressure coefficient,  $(\partial P/\partial T)_V$ , and two parameters  $\alpha$  and  $\beta$  which are characteristic of the gas composition. The residual viscosity is defined as the difference between the viscosity of a gas at a given temperature and high pressure,  $\eta_{T,P}$ , and the viscosity of the gas at the same temperature,  $\eta_T^\circ$ , but at a pressure sufficiently low for the Chapman-Enskog kinetic theory to be applicable.

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### DILUTE-GAS TRANSPORT

The viscosity of dilute gases can be calculated from the Chapman-Enskog theory. However, there is no precise distinction between what is meant by a dilute or a dense gas. This theory is not applicable at densities sufficiently high that three-body collisions become important. An incomplete knowledge of the nature of such collisions limits to some degree the applicability of results from the Chapman-Enskog expressions to practical problems. According to this theory, the viscosity is independent of pressure. At sufficiently low temperatures, the use of classical mechanics must be excluded because of quantum effects, and the theory can be used only when the spatial dimensions of a container confining the gas are large compared to the molecular mean free path. The theory cannot be used when the mean free path is comparable to the diameter of the vessel (slip flow regime) or is much greater than the vessel diameter, when the gas exhibits properties of a discontinuous medium, Knudsen flow (free molecular flow regime). Therefore some criteria must be set by which the expressions derived from the Chapman-Enskog theory are applicable.

Childs and Hanley (6) have attempted to define a pressure range for several gases for which the kinetic theory viscosity expression,

$$\eta^{\circ} = \frac{5}{16} \left( \frac{(\pi m k T)^{\frac{1}{2}}}{\pi \sigma^2 \Omega (2,2)^*} \right), \quad (1)$$

where

$\eta^{\circ}$  = viscosity of a dilute gas,



$m$  = mass of a molecule,

$k$  = Boltzmann's constant,

$\sigma$  = collision diameter,

$T$  = absolute temperature,

and  $\Omega^{(2,2)*}$  = molecular collision integrals--a

dimensionless function of temperature

and molecular potential field,

may be applied to experimental low-pressure viscosity data by correlating  $\eta$  as a function of the mean free path,  $L$ . The mean free path is density,  $\rho$ , dependent in the elementary equation

$$L = \frac{3\eta^\circ}{\rho} \left( \frac{\pi m}{8kT} \right)^{\frac{1}{2}} \quad (2)$$

They select an upper pressure limit of dilution associated with the density, at a given temperature, where experimental data depart from equation 1 by more than the uncertainty in the experimental data, and a lower pressure boundary, rarefied conditions, by using a factor  $a/L \leq 10$ , as a limit, where  $a$  is the radius of an apparatus used to determine the viscosity coefficient. The semiquantitative results of Childs and Hanley indicate that the viscosity data for nitrogen at 1 atmosphere would be applicable in equation 1 over the temperature range  $133^\circ$  to  $740^\circ$  K, considered in this report. However, it should be pointed out that in the more rigorous theory for real gases the mean free path does not appear explicitly in the derivation of the transport properties (27). In this report, it is assumed that the Chapman-Enskog expressions, in the first approximation, describe



completely the viscosity behavior of the helium-nitrogen system at pressures near 1 atmosphere for the temperature range 133° to 740° K.

According to the Chapman-Enskog theory (27), the first approximation to the viscosity of a pure gas is given by the equation

$$\eta^{\circ} \times 10^7 = \frac{266.93 \sqrt{MT}}{\sigma^2 \Omega^{(2,2)*}}, \quad (3)$$

where

$\eta^{\circ}$  = viscosity, g/cm sec,

T = temperature, °K,

M = molecular weight,

$\sigma$  = collision diameter, Å,

and  $\Omega^{(2,2)*}$  = collision integral values, reduced by rigid-sphere

values, which are functions of the intermolecular potential and of

the reduced temperature,  $T^* = k T/\epsilon$ . The correct functional form

of the potential energy of molecular interaction is not known, and

it is customary to use empirical potential energy functions. Three

commonly used empirical potential functions are:

The Lennard-Jones (6:12) potential, which has two adjustable parameters, force constants, which are evaluated from experimental data, is given by

$$\varphi(r) = 4\epsilon \left[ \left(\frac{\sigma}{r}\right)^{12} - \left(\frac{\sigma}{r}\right)^6 \right], \quad (4)$$

where  $\varphi(r)$  is the interaction potential of two molecules separated

by distance  $r$ , and  $\epsilon$  is the maximum energy of attraction. At  $r = \sigma$





the potential energy is zero,  $\varphi = 0$ .

The modified Buckingham (Exp-6) potential has three adjustable parameters. This potential is given by (27)

$$\varphi(r) = \frac{\epsilon}{1 - \frac{6}{\alpha''}} \left[ \frac{6}{\alpha''} e^{\alpha''} \left( 1 - \frac{r}{r_m} \right) - \left( \frac{r_m}{r} \right)^6 \right] \quad (5)$$

where  $r_m$  is the value of  $r$  at the energy minimum and  $\alpha''$  is a parameter which is a measure of the steepness of the repulsive part of the function.

The Kihara potential is given by (7)

$$\varphi(r) = 4\epsilon \left[ \left( \frac{\sigma - \gamma}{r - \gamma} \right)^{12} - \left( \frac{\sigma - \gamma}{r - \gamma} \right)^6 \right], \quad r > \gamma, \quad (6)$$

where  $\varphi(r) = \infty$ , for  $r \leq \gamma$ ,

and the finite size of the molecules is taken into account by a core diameter  $\gamma$ . If the core parameter  $\gamma$  is zero, this function reduces to the Lennard-Jones (6:12) potential function.

#### Low-Density Viscosity of Helium

Tables of collision integrals for the Lennard-Jones (6:12) potential as a function of  $T^*$  and force constants for helium and nitrogen are given by Hirschfelder, Curtiss, and Bird (27). The force constants given were derived principally from the viscosity data of Johnston and Grilly (31) and Johnston and McCloskey (33) for helium and nitrogen, respectively. Errors in viscosity data limit the accuracy of derived potential parameters, and Kestin has



found fault with the work of Johnston and coworkers because they did not account for edge effects in the oscillating disk viscometer they used to obtain viscosity coefficients. Kestin's comments can be found in the "Discussion" section of a paper by Bonilla, Wang, and Weiner (2). Viscosity values of helium predicted from the L-J (6:12) potential are not always considered in satisfactory agreement with experimental results. Theoretical considerations indicate that helium atoms are less rigid than given by the inverse twelfth-power energy of repulsion term of this potential (57, 71). Shih and Ibele (71) have used the Lennard-Jones (6:9) potential, and Mason and Rice (57) have used the "Exp-6" potential for predicting the low-density viscosity behavior of helium for the temperature ranges 200° to 3,000° K and 200° to 1,090° K, respectively. Shih and Ibele obtained force constants for the L-J (6:9) potential from the experimental data of a number of investigators (31, 42, 64, 78), and Mason and Rice obtained force constants for the "Exp-6" by using an assigned value of  $\alpha'' = 12.4$  from the experimental data contained in (31, 75-78, 80). The viscosity data of Trautz and coworkers (75-78) and of Wobser and Müller (80) were determined relative to air at a time when values for the viscosity of air were not known to  $\pm 1.5$  percent. Mason corrected their values by using  $\eta_{\text{air}}^{\circ} = 183.3 \mu\text{p}$  at 23° C and by following the procedures of Johnston and McCloskey (33). The Kihara potential is not generally used for the prediction of the physical properties of helium because for  $\gamma = 0$  this potential reduces to the L-J (6:12). Keesom (37) showed that the experimental low-density



viscosity data of gaseous helium, available in 1941, in the temperature range  $4^{\circ}$  to  $1,100^{\circ}$  K could be represented within about  $\pm 1$  percent by the empirical expression

$$\eta_{\text{He}}^{\circ} = 5.023 T^{0.647}, \mu\text{p.} \quad (7)$$

The simple form of this equation is much more attractive for engineering use than an empirical intermolecular potential to represent the dilute-gas behavior of helium because tables of collision integrals and an interpolation routine are not needed in a computer program. The low-density viscosity data for helium within the temperature range  $100^{\circ}$  to  $1,090^{\circ}$  K of a number of investigators (4, 12, 17, 21, 28, 30, 31, 34, 39-43, 45-46, 55, 65, 72, 75-78, 80) were fitted to the above equation form by a nonlinear least squares procedure with the result

$$\eta_{\text{He}}^{\circ} = 4.2605563 T^{0.67362904}. \quad (8)$$

For the 108 data points in foregoing references, one standard error of estimate from values predicted from equation 8 is  $1.53 \mu\text{p}$ . The standard error of estimate is defined as the square root of the quotient obtained from the sum of the squares of the residuals divided by the number of observations less the number of equation constants. Three data points (21, 46, 75) were not used in evaluating the constants in equation 8. Two points from (46, 75) contribute 27 percent of the sum of the squares of the residuals. The point from (21) not used was inadvertently omitted in the data set.

Data from these sources were also compared with values computed from equation 3 by using the L-J (6:12), the L-J (6:9), and the "Exp-6"



potentials with force constants for helium recommended for these potentials (27, 57, 71). No attempt was made to supply quantum corrections to the lower temperature data. Values of the viscosity coefficients used from sources (75-78, 80) contained corrections made by Mason (57). In all cases, equation 8 appeared to be superior to any one of the potentials.

Guevara and Wageman (23) measured what they considered Poiseuille flow of helium through a hole about 0.040 centimeters in diameter drilled through the wall of a tube with a wall thickness of 0.25 centimeters. Measurements were made at 24 temperatures ranging from 283° to 2,344° K. They considered the various sources of error in their measurements and applied corrections to their data, but they were unable to formulate a precise theory for the operability of their instrument. Results were presented as 23 viscosity ratios relative to their measurements at 283° K. Guevara and Wageman's data were fitted to the equation form of equation 8 by using  $\eta_{\text{He}}^{\circ} = 191.01 \mu\text{p}$  at 283° K, obtained from equation 8, to convert viscosity ratios to viscosity. Very poor results were obtained; the standard error of estimate in the viscosity was 5.61  $\mu\text{p}$  for 23 points, and no single point showed a large deviation. Viscosities of helium computed from the equation used to represent Guevara's data are from 5.17 to 0.8 percent larger than viscosities computed from equation 8 in the temperature range 280° to 1,000° K. The data of Guevara and Wageman (23) were not used in obtaining the coefficients of equation 8 because they considered their results inconclusive due to their inability to account in full for corrections relevant to their measurements.





The tabulated viscosity data of Tsederberg, Popov, and Morozova (79) for the temperature range  $0^{\circ}$  to  $1,000^{\circ}$  C were also fitted to the same equation form with a standard error of estimate of  $1.37 \mu\text{p}$  for 101 points. Viscosities of helium computed from the equation used to represent Tsederberg's results are from 1.19 to 0.0 percent smaller than viscosities computed for equation 8 in the temperature range  $270^{\circ}$  to  $980^{\circ}$  K. The viscosities tabulated by Tsederberg and coworkers (79) have as a base some of the experimental data used to evaluate the coefficients of equation 8. To avoid giving undue weights to the data of certain investigators, the viscosity values they present were not considered in evaluating the coefficients of equation 8.

Viscosities computed from Keesom's equation (37, p. 107) are larger than those obtained from our equation 8 in the temperature region  $100^{\circ}$  to  $480^{\circ}$  K (4.28 to 0.02 percent larger). At  $1,000^{\circ}$  K, Keesom's equation gives a viscosity value 1.91 percent smaller than that predicted by equation 8.

At ambient temperature viscosity coefficients of helium obtained from capillary and oscillating disk viscometers are in satisfactory agreement. However, at high temperatures viscosity coefficients determined by these two methods are discordant, with those obtained by the oscillating disk method being higher than those obtained by the capillary method. The results from each type of instrument appear to be mutually consistent. DiPippo and Kestin (11) published atmospheric pressure viscosity data for helium ( $297.16^{\circ}$  -  $672.88^{\circ}$  K) and



nitrogen (294.90° - 773.73° K) after the constants for equation 8 were obtained. Their measurements, made with an oscillating disk viscometer, are in excellent agreement with the work of Kestin and Whitelaw (46), who used a similar type viscometer. Figure 1 summarizes

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Figure 1. - Low-Density Viscosity Deviation Plot for Helium.

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the deviations in the low-density viscosity for helium when values obtained from equation 8 are compared with experimental values.

Deviation, percent, in figure 1 is represented by

$$\text{Deviation, percent} = [(\text{Exp.} - \text{Calc.})/\text{Calc.}] \times 100, \quad (9)$$

where

Exp. = the experimental value reported by an investigator,  
and Calc. = the value computed in this work.

All percent deviation calculations in subsequent sections of this report are defined in this manner. Because of the superposition of points, only part of the data used to obtain equation 8 is plotted on figure 1. Selected points from the work of DiPippo and Kestin (11) are presented in figure 1 to show the marked disagreement between viscosity values obtained from their oscillating disk measurements and those from the capillary-flow viscometer measurements of Trautz and coworkers (75-76, 78) in the temperature range 500° to 700° K. Hanley and Childs (24) have presented evidence that new unpublished viscosity coefficients for several gases (1,100° to 2,200° K) determined by Guevara, McInteer, and Wageman at the Los Alamos Scientific Laboratory are more consistent with the trend of the



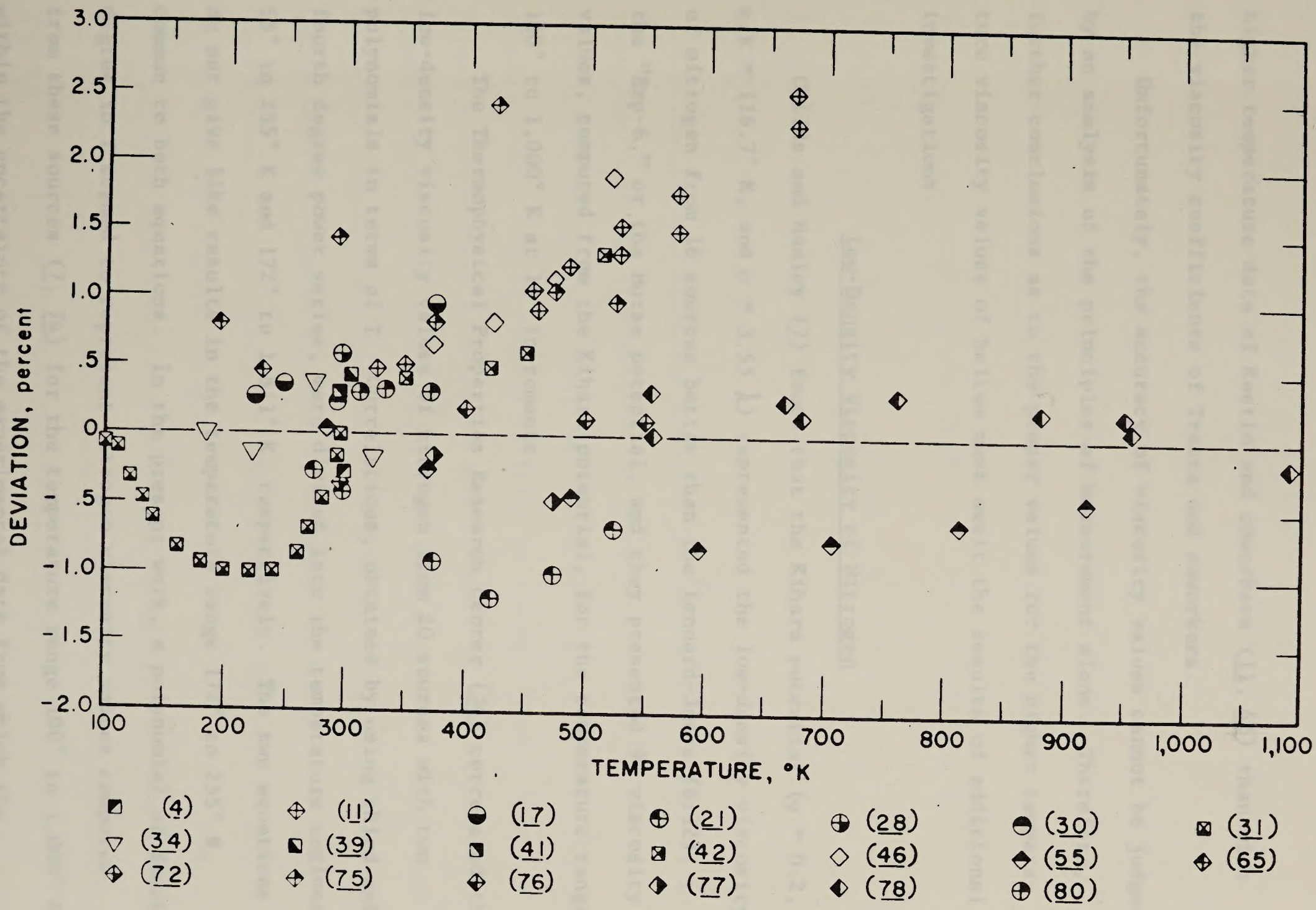


FIGURE 1. - Low-Density Viscosity Deviation Plot for Helium.



higher temperature data of Kestin and coworkers (11, 46) than with the viscosity coefficients of Trautz and coworkers.

Unfortunately, the accuracy of viscosity values cannot be judged by an analysis of the principles of measurement alone. Therefore, further conclusions as to the proper values for the higher temperature viscosity values of helium must await the results of additional investigations.

#### Low-Density Viscosity of Nitrogen

Childs and Hanley (7) found that the Kihara potential ( $\gamma = 0.2$ ,  $\epsilon/k = 116.7^\circ \text{K}$ , and  $\sigma = 3.55 \text{ \AA}$ ) represented the low-density viscosity of nitrogen from 16 sources better than the Lennard-Jones (6:12), the "Exp-6," or the Morse potential, and they presented 91 viscosity values, computed from the Kihara potential, for the temperature range  $100^\circ$  to  $1,000^\circ \text{K}$  at  $10^\circ$  increments.

The Thermophysical Properties Research Center (74) correlated the low-density viscosity values of nitrogen from 20 sources with two polynomials in terms of  $T$ . Correlations, obtained by using third and fourth degree power series, were divided into the temperature regions  $55^\circ$  to  $255^\circ \text{K}$  and  $172^\circ$  to  $1,811^\circ \text{K}$ , respectively. The two equations do not give like results in the temperature range  $172^\circ$  to  $255^\circ \text{K}$ , common to both equations. In the present work, a polynomial of fourth degree in  $T$  seemed to represent nitrogen viscosity values computed from these sources (7, 74) for the temperature range  $100^\circ$  to  $1,000^\circ \text{K}$ , within the uncertainty of the experimental data from which the empirical equations were derived.





Data from sources (13, 34, 39-40, 46, 55-56), inaccessible or not considered in these previous correlations (7, 74), and the 91 tabulated viscosity values of Childs and Hanley (7) were fitted to a fourth degree polynomial to represent the temperature dependency of the viscosity of dilute nitrogen. The equation recommended is

$$\eta_{N_2}^{\circ} = -8.9188690 \times 10^{-1} + 7.7622418 \times 10^{-1} T - 7.2970066 \times 10^{-4} T^2 + 4.9473812 \times 10^{-7} T^3 - 1.3971248 \times 10^{-10} T^4, \quad (10)$$

where  $T$  = temperature, °K,

and  $\eta_{N_2}^{\circ}$  = viscosity,  $\mu\text{P}$ .

Deviations of Childs and Hanley's (7) tabulated viscosity values from those computed from equation 10 range from -0.88 (100° K) to + 0.27 (990° K) percent. Their deviation plot (7, p. 13) for nitrogen viscosity data from 16 sources relative to values computed from the Kihara function shows a deviation band of about  $\pm 1$  percent. One standard error of estimate for their 91 tabulated points with respect to values computed from equation 10 is 0.94  $\mu\text{P}$ . The standard error of estimate relevant to equation 10 increases to 1.8  $\mu\text{P}$  when data from sources (13, 34, 39-40, 46, 55-56) are combined with Childs and Hanley's 91 computed points.

Figure 2 shows deviations of various investigators' experimental

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Figure 2. - Low-Density Viscosity Deviation Plot for Nitrogen.

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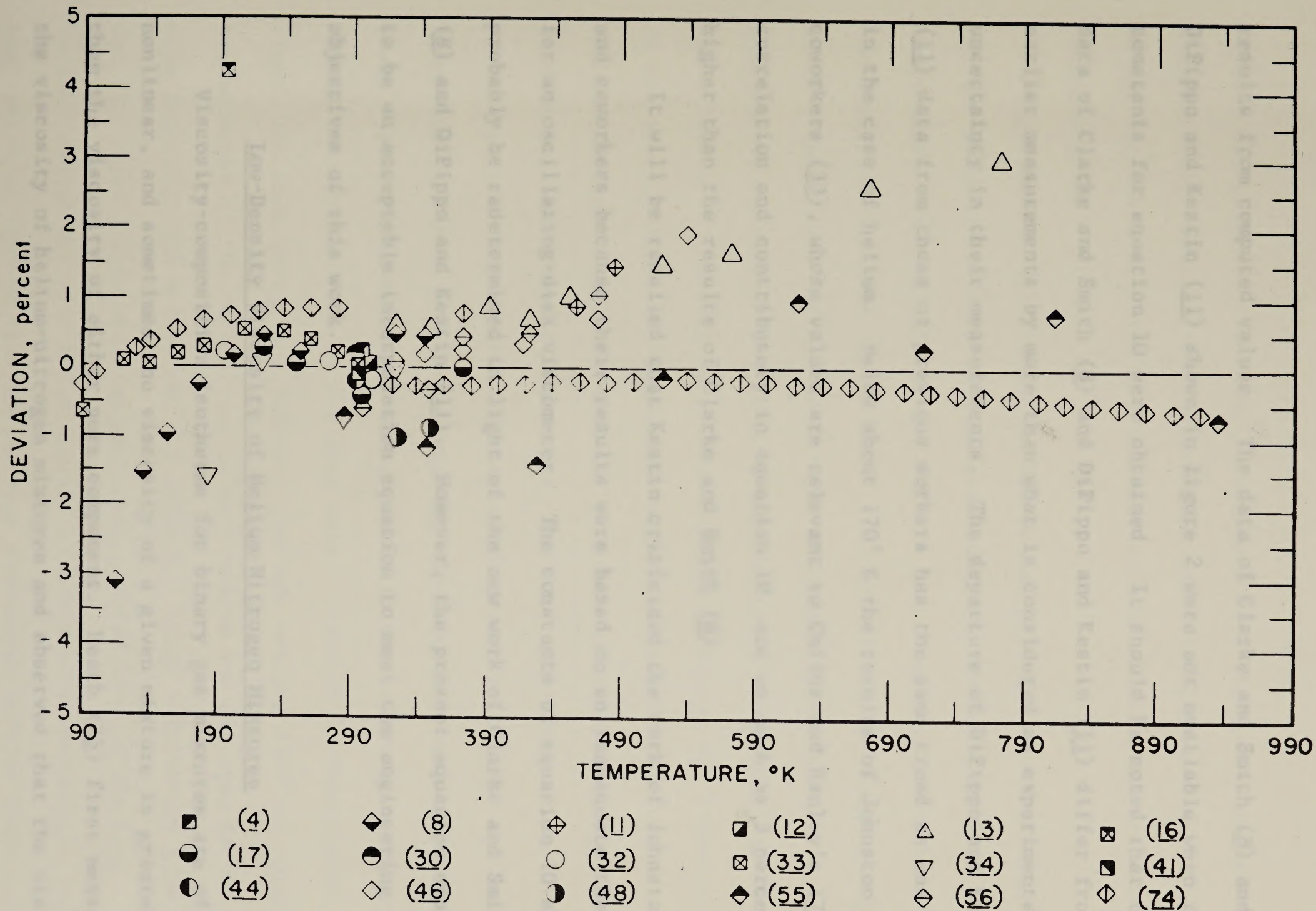


FIGURE 2. - Low-Density Viscosity Deviation Plot for Nitrogen.



results from computed values. The data of Clarke and Smith (8) and of DiPippo and Kestin (11) shown in figure 2 were not available when the constants for equation 10 were obtained. It should be noted that the data of Clarke and Smith (8) and DiPippo and Kestin (11) differ from earlier measurements by more than what is considered as experimental uncertainty in their measurements. The departure of DiPippo and Kestin's (11) data from those of previous workers has the same trend as was noted in the case of helium. Below about 170° K the results of Johnston and coworkers (33), whose values are relevant to Childs and Hanley's (7) correlation and contributory in equation 10, are as much as 3 percent higher than the results of Clarke and Smith (8).

It will be recalled that Kestin criticized the work of Johnston and coworkers because their results were based on an inadequate theory for an oscillating-disk viscometer. The constants of equation 10 should probably be redetermined in light of the new work of Clarke and Smith (8) and DiPippo and Kestin (11). However, the present equation appears to be an acceptable interpolation equation to meet the engineering objectives of this work.

#### Low-Density Viscosity of Helium-Nitrogen Mixtures

Viscosity-composition isotherms for binary gas mixtures are often nonlinear, and sometimes the viscosity of a given mixture is greater than the viscosity of either pure component. Heath (25) first measured the viscosity of helium-nitrogen mixtures and observed that the viscosities of given mixtures exceeded the viscosity of either of the pure components. His measurements at 18° C and 70 centimeters of



mercury pressure are presented in the form of a viscosity-composition diagram which suffers from scale-factor limitations, and viscosity values for the pure gases and nine mixtures cannot be read precisely from the graph.

Experimental viscosity data for helium-nitrogen mixtures (34, 39, 54) are scarce, and data of high precision are available only in the temperature range  $183.15^{\circ}$  to  $323.15^{\circ}$  K. The viscosity isotherms of Kao (34),  $183.15^{\circ}$ ,  $223.15^{\circ}$ ,  $273.15^{\circ}$ , and  $323.15^{\circ}$  K, terminate generally at 10 atmospheres, and the dilute-gas viscosity values he gives were obtained by extrapolation. Dilute-gas viscosity values derived from Kao's  $183.15^{\circ}$  K isotherm by a least squares technique are compared, in the section Dense-Gas Transport, with his extrapolated results. Kao and Kobayashi (35) estimate the probable error in Kao's (34) data as 0.14 percent. Kestin, Kobayashi, and Wood (39) estimate an accuracy of  $\pm 0.1$  percent for their viscosity measurements at  $293.15^{\circ}$  and  $303.15^{\circ}$  K. Makavetskias, Popov, and Tsederberg (54) estimated the maximum error in their viscosity measurements for mixtures in the temperature region  $284.65^{\circ}$  to  $952.55^{\circ}$  K to be not more than 4.5 percent. Makavetskias, Popov, and Tsederberg (55) indicate that the maximum error in their measurements of the viscosities of pure helium and nitrogen in the same apparatus did not exceed 3.5 percent. Large temperature gradients for the higher temperature measurements existed between the ring-balance manometer, used for differential-pressure measurements, and the capillary tube of the Rankine-type viscometer used by these investigators to measure mixture viscosities, and gas-phase separations





by thermal diffusion could result in marked differences in gas compositions in various parts of their apparatus. Gas-phase separations may have resulted in a 10 to 12 percent change in gas compositions between the cold and hot parts of their apparatus.

In the literature, the simplest viscosity mixture rule which permits a maximum to exist for a viscosity-composition isotherm is the empirical equation of Buddenberg and Wilke (4),

$$\eta_{\text{mix}}^{\circ} = \frac{\eta_1^{\circ}}{1 + \left(\frac{x_2}{x_1}\right)\left(\frac{1.385}{D_{12}}\right)\left(\frac{\eta_1^{\circ}}{\rho_1}\right)} + \frac{\eta_2^{\circ}}{1 + \left(\frac{x_1}{x_2}\right)\left(\frac{1.385}{D_{12}}\right)\left(\frac{\eta_2^{\circ}}{\rho_2}\right)}, \quad (11)$$

where

$\eta_1^{\circ}$  and  $\eta_2^{\circ}$  = viscosities of pure components 1 and 2  
at the temperature of the mixture,

$\rho_1$  and  $\rho_2$  = densities of components 1 and 2 at the  
temperature and total pressure of the  
mixture,

$x_1$  and  $x_2$  = mole fractions of components 1 and 2  
in the mixture,

and  $D_{12}$  = the coefficient of binary diffusion.

This equation is useful only when binary diffusion coefficients are available. Low-pressure binary diffusion coefficients for helium-nitrogen are available in the literature for the temperature range 244.27° to over 1,000° K. The uncertainty in these coefficients very often exceeds 6 percent because of experimental



difficulties, and the scattering of data and the lack of reproducibility of experimental points indicate that mixture-viscosity values computed from these results are questionable. The quantity  $(1.385/D_{12})$  in equation 11 is equal to a constant for a gas pair at a given temperature and pressure, and values of this constant can be obtained from viscosity data by trial and error (4). However, there are no experimental data on mixtures in the temperature range 133° to 183° K for such an evaluation. Makavetskas, Popov, and Tseiderberg (54) and Makaveckas (53) substituted the Chapman-Enskog expressions for the coefficients of binary and self-diffusion into Buddenberg and Wilke's (4) equation and used the empirical combining laws (27)

$$\sigma_{12} = 1/2 (\sigma_1 + \sigma_2), \quad (12)$$

and

$$\epsilon_{12} = (\epsilon_1 \epsilon_2)^{1/2}, \quad (13)$$

in conjunction with the Lennard-Jones (6:12) potential, to estimate the viscosity of helium-nitrogen mixtures for the temperature range 0° to 1,000° C. Viscosities computed were within 2.5 percent of experimental results (54).

An equation for computing the low-density viscosity of a binary gas mixture must take into account differences in the molecular diameter of the molecules, differences in the masses, and the interaction forces between molecules. Although Buddenberg and Wilke's equation has been widely used, it cannot satisfy all of these requirements. A more appropriate equation for computing the mixture



viscosities is the Chapman-Enskog equation, wherein the viscosity of a mixture to the first approximation is given by

$$\frac{1}{\eta_m^\circ} = \frac{X_\eta + Y_\eta}{1 + Z_\eta}, \quad (14)$$

with

$$X_\eta = \frac{x_1^2}{\eta_1^\circ} + \frac{2x_1x_2}{\eta_{12}^\circ} + \frac{x_2^2}{\eta_2^\circ},$$

$$Y_\eta = \frac{3}{5} A_{12}^\star \left\{ \frac{x_1^2}{\eta_1^\circ} \left( \frac{M_1}{M_2} \right) + \frac{2x_1x_2}{\eta_{12}^\circ} \left( \frac{(M_1 + M_2)^2}{4M_1M_2} \right) \left( \frac{\eta_{12}^2}{\eta_1^\circ\eta_2^\circ} \right) + \frac{x_2^2}{\eta_2^\circ} \left( \frac{M_2}{M_1} \right) \right\},$$

$$Z_\eta = \frac{3}{5} A_{12}^\star \left\{ x_1^2 \left( \frac{M_1}{M_2} \right) + 2x_1x_2 \left[ \left( \frac{(M_1 + M_2)^2}{4M_1M_2} \right) \left( \frac{\eta_{12}^\circ}{\eta_1^\circ} + \frac{\eta_{12}^\circ}{\eta_2^\circ} \right) - 1 \right] + x_2^2 \left( \frac{M_2}{M_1} \right) \right\},$$

$x_1$  and  $x_2$  = mole fractions of components 1 and 2,

$M_1$  and  $M_2$  = molecular weights of components 1 and 2,

$$A_{12}^\star = \Omega^{(2,2)\star} / \Omega^{(1,1)\star},$$

$$\eta_{12}^\circ \times 10^7 = \frac{266.93 \sqrt{2M_1M_2T/(M_1 + M_2)}}{\sigma_{12}^2 \Omega_{12}^{(2,2)\star}},$$

$T$  = temperature, °K,

$\eta_{12}^\circ$  = viscosity interaction parameter, g/cm sec,

$\sigma_{12}$  = parameter characteristic of 1-2 interaction, Å,

and  $\Omega^{(1,1)\star}$  and  $\Omega^{(2,2)\star}$  = reduced collision integral values which

are functions of the potential model and reduced temperature,

$$T_{12}^\star = k T / \epsilon_{12}.$$



Equation 14 is not strictly applicable to a gas mixture containing a diatomic gas because the theory from which this equation was derived is for molecules with symmetrical force fields and with no internal degrees of freedom. However, the viscosity, unlike thermal conductivity, is not appreciably affected by the presence of internal degrees of freedom, and equation 14 appears to give a good account of the viscosities of a gas mixture, provided molecules in the mixture are not too nonspherical.

For equation 14, Kestin, Kobayashi, and Wood (39) determined values of  $\sigma_{12} = 3.1198 \text{ \AA}$  and  $\epsilon_{12}/k = 36.18^\circ \text{ K}$  for the Lennard-Jones (6:12) potential by using their viscosity data on helium-nitrogen mixtures. Makaveckas (53) and Makavetskas, Popov, and Tsederberg (54) used  $\sigma_{12} = 3.1625 \text{ \AA}$  and  $\epsilon_{12}/k = 28.56^\circ \text{ K}$  as force constants for the Lennard-Jones (6:12) potential to estimate helium-nitrogen mixture viscosities for the temperature region  $0^\circ$  to  $1,000^\circ \text{ C}$ . Kao (34) did not propose a mixing rule to represent his data. Force constants of helium and nitrogen for the Lennard-Jones (6:12) potential (27), based on the viscosity data of Johnston and coworkers (31, 33), and the mixing rules 12 and 13 yield values of  $\sigma_{12} = 3.1285 \text{ \AA}$  and  $\epsilon_{12}/k = 30.58^\circ \text{ K}$ .

Molecules of helium-nitrogen mixtures have a "soft" intermolecular force contribution, and the effective collision diameter of an unlike pair may not satisfy precisely the additivity rule,  $\sigma_{12} = 1/2 (\sigma_1 + \sigma_2)$ . However, the arithmetic mean for  $\sigma_{12}$  is assumed to be reasonably accurate, whereas it is known from the London theory





of dispersion forces that the geometric mean for  $\epsilon_{12}$  is only a limiting relationship.

Imposing the requirement that  $\eta_1^\circ$  and  $\eta_2^\circ$  in equation 14 have values obtained from empirical equations 8 and 10 and  $\sigma_{12} = 3.12 \text{ \AA}$ , a computer procedure was utilized to estimate the "best value" of  $\epsilon_{12}/k$  to represent the mixture data (34, 39, 54). The viscosity depends more strongly on the parameter  $\sigma_{12}$  than on the energy well parameter  $\epsilon_{12}$ , and other values of  $\epsilon_{12}/k$  in the vicinity of  $\sigma_{12} \approx 3.12$  were also tested. The "best results" obtained were close to the values of  $\sigma_{12}$  and  $\epsilon_{12}/k$  derived by Kestin and coworkers (39), and their values of the force constants were used to compute the low-density viscosity behavior of helium-nitrogen mixtures.

Collision integrals  $\Omega^{(1,1)*}$  and  $\Omega^{(2,2)*}$  for the Lennard-Jones (6:12) potential tabulated in (27) for the reduced temperature range 0.3 to 200 were fitted by a least squares technique to a multinomial of the form

$$\begin{aligned} \Omega^{(l,s)*} = & P_0 + P_1 T^* + P_2 (T^*)^2 + P_3 (T^*)^3 + P_4 (T^*)^4 \\ & + P_5 (T^*)^5 + P_6 (T^*)^6 + P_7 (1/T^*) + P_8 (1/T^*)^2 \\ & + P_9 (1/T^*)^3 + P_{10} (1/T^*)^4 + P_{11} (1/T^*)^5 \\ & + P_{12} (1/T^*)^6, \end{aligned} \quad (15)$$

where

$$T^* = k T/\epsilon,$$

and values for the constants are:



	$\Omega^{(1,1)\star}$	$\Omega^{(2,2)\star}$
$P_0$	+7.6070438 ( $10^{-1}$ )	+8.6881587 ( $10^{-1}$ )
$P_1$	-1.0254183 ( $10^{-2}$ )	-1.2672727 ( $10^{-2}$ )
$P_2$	+2.7105188 ( $10^{-4}$ )	+3.6256347 ( $10^{-4}$ )
$P_3$	-4.6775042 ( $10^{-6}$ )	-6.5768094 ( $10^{-6}$ )
$P_4$	+4.6185077 ( $10^{-8}$ )	+6.7033760 ( $10^{-8}$ )
$P_5$	-2.3278934 ( $10^{-10}$ )	-3.4490075 ( $10^{-10}$ )
$P_6$	+4.5196819 ( $10^{-13}$ )	+6.7846122 ( $10^{-13}$ )
$P_7$	+5.9761505 ( $10^{-1}$ )	+4.7185172 ( $10^{-1}$ )
$P_8$	+1.9897294 ( $10^{-1}$ )	+5.4259734 ( $10^{-1}$ )
$P_9$	-1.3561679 ( $10^{-1}$ )	-3.7823299 ( $10^{-1}$ )
$P_{10}$	+2.9639310 ( $10^{-2}$ )	+1.0882350 ( $10^{-1}$ )
$P_{11}$	-1.9903389 ( $10^{-3}$ )	-1.5367909 ( $10^{-2}$ )
$P_{12}$	-8.4408981 ( $10^{-5}$ )	+8.8652554 ( $10^{-4}$ )

A comparison of computed and tabulated integrals  $\Omega^{(l,s)\star}$  gave these results:

Maximum percent deviation for  $\Omega^{(1,1)\star} = -0.05933$  at  $T^* = 90$ .

Maximum percent deviation for  $\Omega^{(2,2)\star} = 0.1157$  at  $T^* = 20$ .

Average absolute percent deviation for 80 values of

$$\Omega^{(1,1)\star} = 0.0177.$$

Average absolute percent deviation for 80 values of

$$\Omega^{(2,2)\star} = 0.0239.$$

Terms in equation 14 for the viscosity of binary mixtures were evaluated by using the multinomials for  $\Omega^{(1,1)\star}$  and  $\Omega^{(2,2)\star}$ .



A comparison of the experimental viscosity data of Kao (34) and Kestin, Kobayashi, and Wood (39) with computed results is provided in figure 3. It will be seen that experimental values of  $\eta_{\text{mix}}^{\circ}$  and

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Figure 3. - Low-Density Viscosity of Helium-Nitrogen Mixtures  
From 183.15° to 323.15° K in Terms of Composition.

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values derived from equation 14 are in good agreement. The maximum difference between an experimental and computed value on figure 3 is 1.87 micropoises, and this occurs for Kao's nitrogen data at 183.15° K. The data of Makavetskas and coworkers (54) for mixtures scatter badly and were not plotted on a graph. The maximum deviation between an experimental and computed value was -4.27 percent for their mixture of 0.4350 mole fraction of helium at 952.55° K. The overall mean deviation from the results of Makavetskas and coworkers is about 1.66 percent, which is slightly better than the 2.5 percent they obtained by using Buddenberg and Wilke's (4) equation and equations 12 and 13 for  $\sigma_{12}$  and  $\epsilon_{12}$  in conjunction with the Lennard-Jones (6:12) potential to represent their mixture viscosities.

#### DENSE-GAS TRANSPORT

No systematic approach to obtain transport coefficients of dense gases is known as yet, and there appears to be no accepted theory upon which to base estimation techniques. A number of empirical equations for correlation of viscosity values at higher pressures are given in the literature. A number of estimation methods commonly



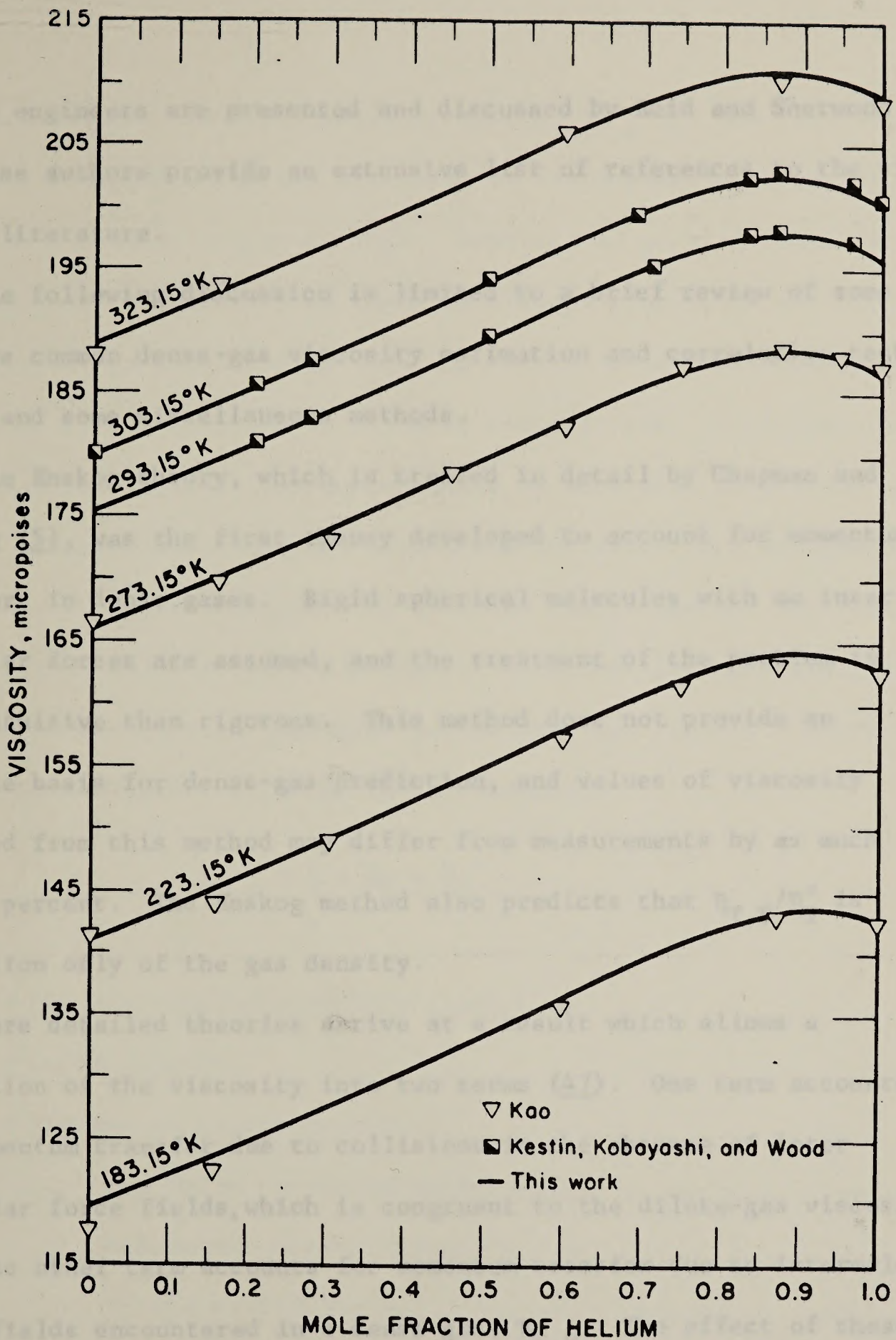


FIGURE 3. - Low-Density Viscosity of Helium - Nitrogen Mixtures From 183.15° to 323.15° K in Terms of Composition.





used by engineers are presented and discussed by Reid and Sherwood (62), and these authors provide an extensive list of references to the viscosity literature.

The following discussion is limited to a brief review of some of the more common dense-gas viscosity estimation and correlation techniques and some miscellaneous methods.

The Enskog theory, which is treated in detail by Chapman and Cowling (5), was the first theory developed to account for momentum transport in dense gases. Rigid spherical molecules with no intermolecular forces are assumed, and the treatment of the problem is more intuitive than rigorous. This method does not provide an accurate basis for dense-gas prediction, and values of viscosity computed from this method may differ from measurements by as much as 100 percent. The Enskog method also predicts that  $\eta_{T,P}/\eta_T^\circ$  is a function only of the gas density.

More detailed theories arrive at a result which allows a separation of the viscosity into two terms (47). One term accounts for momentum transfer due to collisions in the absence of intermolecular force fields, which is congruent to the dilute-gas viscosity,  $\eta_T^\circ$ . The other term accounts for momentum transfer due to intermolecular force fields encountered in a dense gas,  $\eta_{T,P}$ . The effect of these two contributions, kinetic and potential, suggests that the residual viscosity,  $\eta_{T,P} - \eta_T^\circ$ , is a monotonic function of density,  $\rho$ . Rogers and Brickwedde (66) have shown that nitrogen and several other gases do not obey this simple relationship, and that isometric viscosity values are temperature dependent.



Correlations based on viscosity ratios,  $\eta_{T,P}/\eta_T^\circ$ , and residual viscosity concepts using the principle of corresponding states have been widely used by engineers (62). However, no general scheme for defining reduced viscosity in terms of reduced properties or in terms of dimensionless functional groups has emerged from this principle. Because of the general nature of these correlations, predicted viscosities often deviate from measurements by more than 20 percent at ambient temperatures, and predicted viscosity values are particularly unreliable at low temperatures as critical conditions are approached.

A formal solution of the transport equations for moderately dense gases of molecules with repulsive forces only has yielded a viscosity expression analogous to the PV virial expansion

$$\eta_{T,P} = \tilde{A} + \tilde{B}\rho + \tilde{C}\rho^2 + \dots, \quad (16)$$

where

$\tilde{A}$  = the low-density viscosity limit  $\eta_T^\circ$ ,

$\rho$  = molar density,

$\tilde{B}$  = the second viscosity virial,

and  $\tilde{C} + \dots$  = the third viscosity virial and

subsequent higher viscosity

virial coefficients.

The coefficients in this expansion have not been evaluated because the solutions of the equations of motion for three, four, etc., particles are required. The  $i$ -th virial coefficient involves dynamical events of  $(i + 1)$  particles. Kim and Ross (47) have presented a calculation of the contribution of triple collisions



to the coefficient  $\tilde{B}$ , but more rigorous calculations are required to verify the results. Kim and Ross's account of repulsive interaction is inadequate. The  $\tilde{A}$  term in this density power series is generally assumed to be equivalent to the dilute-gas viscosity predicted by the Chapman-Enskog theory.

Kawasaki and Oppenheim (36) have concluded from the work of other investigators, cited in their paper, that the phase-space volume is not finite for dynamical events involving four or more particles and have suggested that the density expansion of viscosity should take the form

$$\eta_{T,P} = \tilde{A} + \tilde{B}_\rho + \tilde{C}_\rho^2 \ln \rho + \tilde{D}_\rho^2 \dots \quad (17)$$

for a classical or quantum gas. Fujita (18) has examined the results of Kawasaki and Oppenheim and has reached the conclusion that the divergence term,  $\ln \rho$ , does not exist, and their results are due to the erroneous use of a real number in computations whereas a complex number is called for in analysis. At the present time, the accuracy of experimental viscosity data is not sufficient to give evidence to verify the existence of the divergence term in the density expansion of transport properties.

Hydrostatic pressure may be interpreted as the average rate of change of momentum due to the impact of molecules on a unit area of a wall containing a gas, and temperature may be correlated with the average kinetic energy of translation of molecules. Hydrostatic pressure can be regarded as the net effect of a kinetic



pressure and a cohesive pressure or internal pressure which is due to the mutual attractions of molecules. Boyd (3) used the similarity between kinetic pressure and viscosity as a method for predicting the viscosity of a dense gas. His method is based on evaluating the kinetic pressure of a real gas from an equation of state. The temperature-dependent terms of the equation of state are used as a measure of the kinetic pressure. The ratio of the kinetic pressure of the real gas to that of an ideal gas, at a given temperature, is assumed to be equal to the ratio of the viscosity of a dense gas to that of the viscosity of the dilute gas at the given temperature; that is,

$$\frac{P_k}{P_i} = \frac{\eta_{T,P}}{\eta_T^{\circ}}, \quad (18)$$

where

$P_k$  = kinetic pressure of the real gas,

$P_i$  = kinetic pressure of a perfect gas,

$\eta_{T,P}$  = viscosity of the dense gas,

and  $\eta_T^{\circ}$  = viscosity of dilute gas.

Thus, if low-density viscosity data and a suitable equation of state are available for a gas, its viscosity at a high pressure can be estimated. Boyd used the Beattie-Bridgeman equation in conjunction with his low-precision viscosity data for nitrogen, hydrogen, and a mixture of these gases to test this theory. Boyd's method for computing the viscosities of gases at high pressures is not well substantiated from his results for nitrogen. The inability of the Beattie-Bridgeman equation of state to represent the properties of nitrogen at high





pressures and the fact that his individual viscosity measurements differed from his mean viscosity values by as much as 7 percent undoubtedly contributed to his unsatisfactory results.

Irreversible thermodynamics, the description of kinetic systems by using thermodynamic variables, is one way to linearize equations of transport (27). The fundamental theorem of irreversible processes is due to Onsager (59-60). Unfortunately, the thermodynamic approach alone cannot lead to expressions for transport coefficients, irreversible thermodynamics provides few useful theorems, and its phenomenological formulation makes no claims to physical understanding. Some of the postulates of irreversible thermodynamics are that thermodynamic functions of state exist for each element of the system in which irreversible processes are taking place, that thermodynamic quantities for a non-equilibrium system are the same functions for local state variables as the corresponding equilibrium quantities, and that theorems are applicable for situations which are not removed too far from equilibrium. The last statement is vague because the question of how far from equilibrium these results will permit one to go cannot be answered. In an equilibrium situation, there is absolutely no ambiguity as to what is meant by the thermodynamic or hydrostatic pressure. Pressure is exerted equally in all directions at a particular point and is a scalar quantity. In a non-equilibrium state, this is not the case; the hydrodynamic equations of change derived from the Boltzmann equation show the pressure is a second-rank tensor, and the forces exerted across three mutually perpendicular planes at some



point within the field are neither equal in magnitude nor, in general, normal to the planes. Therefore, there is a degree of arbitrariness with regard to what is meant by thermodynamic pressure in a non-equilibrium situation. Irreversible thermodynamics does not seem to provide any straightforward way for predicting momentum transport in dense gas. To the knowledge of the authors, this approach has not been used to correlate the viscosity of dense gases.

The thermodynamic equation

$$\left(\frac{\partial E}{\partial V}\right)_T = T \left(\frac{\partial P}{\partial T}\right)_V - P, \quad (19)$$

where

$E$  = internal energy,

$P$  = hydrostatic pressure,

$T$  = absolute temperature,

and  $V$  = molar volume,

has been used in predicting the viscosity behavior of dense gases.

In the theory of liquids and regular solutions, Hildebrand and Scott (26) have defined  $(\partial E/\partial V)_T$ ,  $T (\partial P/\partial T)_V$ , and  $P$  as the internal pressure, thermal pressure, and external pressure, respectively; this terminology is also used by Hirschfelder, Curtiss, and Bird (27) in their discussions of the transport properties of dense gases and liquids. The internal pressure,  $(\partial E/\partial V)_T$ , represents the change in internal energy due to intermolecular forces, and it is supposed that in the interior of a dense gas there is a balance between attractive and repulsive forces which gives rise to this term in the thermodynamic equation of



state. If there were no intermolecular attractions and repulsions,  $E$  would be independent of volume and pressure and would depend only on temperature, as in the simple kinetic theory of gases. Enskog, in formulating his theory of transport coefficients of a dense gas supposed that a real gas is equivalent to a rigid sphere gas in which the external pressure has been replaced by the thermal pressure (27).

Golubev (20) in his book has shown through semitheoretical arguments that the residual viscosity,  $\eta_{T,P} - \eta_T^\circ$ , should be a unique function of the thermal pressure-temperature ratio or thermal pressure coefficient,  $(\partial P/\partial T)_V$ . Golubev plotted  $(\eta_{T,P} - \eta_T^\circ)$  versus  $(\partial P/\partial T)_V$  on log-log coordinates for a number of substances, and obtained linear plots.

From the relationship

$$\eta_{T,P} - \eta_T^\circ = \alpha [(\partial P/\partial T)_V]^\beta, \quad (20)$$

Golubev obtained values of  $\beta$  from the dense-gas viscosity behavior of hydrogen, nitrogen, carbon dioxide, ammonia, methane, ethane, propane, and ethylene which ranged from 1.10 to 1.12. The mean value of  $\beta$  derived from his results is 1.115. Values of  $\alpha$  are characteristic of the substance.

Lennert and Thodos (50) used thermal pressure coefficients in a corresponding states approach to predict the dense-gas viscosity behavior of argon, krypton, xenon, nitrogen, oxygen, and carbon dioxide. Their dimensional analysis approach produced the relationship



$$\left(\eta_{T,P} - \eta_T^{\circ}\right) \xi = \frac{\alpha'}{R^{1/6}} Z_c^m \left(\frac{\partial P_r}{\partial T_r}\right)_{\rho_r}, \quad (21)$$

where

$$\xi = \text{viscosity parameter} = T_c^{1/6} / M^{1/2} P_c^{2/3},$$

M = molecular weight,

$\alpha'$  = constant,

Z = compressibility factor,

R = gas constant,

$\rho$  = density,

T = absolute temperature,

P = pressure,

and the subscripts r and c refer to properties reduced by critical parameters of the substances and to the critical constant of a substance, respectively. Their log-log plots of  $\left(\eta_{T,P} - \eta_T^{\circ}\right) \xi$  versus  $\left(\frac{\partial P_r}{\partial T_r}\right)_{\rho_r}$  for argon, krypton, and xenon were essentially linear and identical in analytical detail, and they combined their results into a single expression,

$$\left(\eta_{T,P} - \eta_T^{\circ}\right) \xi = 6.195 \times 10^{-5} \left(\frac{\partial P_r}{\partial T_r}\right)_{\rho_r}^{1.075}. \quad (22)$$

Lo, Carroll, and Stiel (51) used the Golubev relationship to correlate the viscosity of gaseous air at moderate and high pressures. The results of their work will be discussed later in the report.

Lefrancois (49) used Boyd's (3) concept for computing the viscosity of a gas at high pressure but used the thermal pressure,





$T \left( \frac{\partial P}{\partial T} \right)_V$ , as being representative of kinetic pressure rather than eliminating non-temperature dependent terms of an equation of state, such as the Beattie-Bridgeman, to evaluate the kinetic pressure. He correlated the high-pressure viscosity behavior of six gases in terms of reduced properties; his results are poor in comparison with those obtained from other correlation methods. For example, his correlation of the nitrogen viscosity data of Michels and Gibson (58) gives an average deviation of 4.5 percent, whereas results obtained in this work give an average percent deviation of less than 0.3 for the same ranges of temperature and pressure.

Kestin (38) has summarized other empirical relations for the prediction of the viscosity behavior of dense gases and commented on the performance of the various equation forms as predictive tools.

It is well known that empirical models differing greatly in detail can reproduce experimental data with acceptable accuracy for many engineering calculations, provided their parameters are determined from a given set of experimental data. However, the less theoretical the input to a predictive model is, the more likely the occurrence of unreliable extrapolations. On the other hand, a purely theoretical approach without regard to what is known from experiment is of little or no value. The high-pressure viscosity data for helium, nitrogen, and helium-nitrogen mixtures are of modest precision, the range of pressures covered is unimpressive, and the intensity of coverage is particularly poor at low temperatures. The virial expansion for describing the viscosity behavior



of dense gases does not conflict in any essential way with general theoretical results, and efforts were made in this investigation to fit Kao's (34) data to this type of expansion. Experimental data cannot be fitted directly to a virial expansion and indirect methods for estimating virial coefficients must be used. A commonly used method consists of fitting polynomials to the experimental data by the method of least squares. The interdependence of the arbitrary constants in the least squares treatment of a finite set of data precludes representing the coefficient of terms including  $\rho$  as virials, where a number of such terms up to a higher degree in  $\rho$  are employed. There is no known relationship between the free parameters of least squares polynomials and virial coefficients. Therefore, it is not possible, in practice, to obtain virial coefficients unambiguously from experimental results. This difficulty in giving unambiguous values to coefficients does not mean that it is not useful to express the viscosity coefficients as polynomials in density to represent experimental data.

Kao required densities for the calculation of differential pressures and kinetic corrections relevant to his experimental measurements. He used the eight equations presented by Pfenning, Canfield, and Kobayashi (61) for representing the PVT behavior of helium, nitrogen, and six helium-nitrogen mixtures (87.68, 75.23, 60.41, 44.56, 30.06, and 15.78 percent helium) from  $240^{\circ}$  to  $560^{\circ}$  R, for pressures between 14.696 and 7,500 psia, to compute densities and presented density values with his measured viscosities. Kao's gas compositions did not



correspond exactly to those used by Pfenning and coworkers, and he had to make some interpolation of gas densities. The eight equations of Pfenning and coworkers are all of the same functional form, but combination rules for the constants of these equations in terms of gas composition have not been developed.

The Leiden form of the virial equation of state of Wood, Boone, Marshall, and Baer (82) for helium-nitrogen mixtures for temperatures from 133.15° to 748.15° K and for pressures to 300 atmospheres, relates pressure, volume, temperature, and gas composition by virials and interaction virials. Their equation is suitable for computing the PVTx properties of all possible helium-nitrogen mixtures in the pressure and temperature domain given for the equation of state. The equation of state of Wood and coworkers was used to check the density values Kao reported in conjunction with his viscosity data for pressures to 300 atmospheres, and a number of marked differences in density values were noted. Densities computed from Pfenning's eight equations and from the equation of state of Wood and coworkers, at PVTx conditions applicable to both works, are essentially in agreement, and density values tabulated by Kao were corrected to the results obtained from the equation of state of Wood and coworkers. The viscosity isotherms of Kao were then fitted by a least squares procedure to polynomials of the following form, by employing successively higher degree terms of  $\rho$  to the fourth degree:

$$\eta_{T,p} = \hat{A} + \hat{B}\rho + \hat{C}\rho^2 + \dots \quad (23)$$



The superscript  $\hat{\phantom{A}}$  is used to denote maximum likelihood estimators for the viscosity virial coefficients. Coefficients from those polynomials of the degree which exhibited minimum variance were plotted as functions of gas composition for given temperatures. Virial coefficients of pure gases and gaseous mixtures of fixed composition are rational functions of the absolute temperature only and independent of other state variables such as density and pressure. The same least squares procedure was employed in using the residual viscosity concept because  $\hat{A}$  values obtained from the least squares equations were not always in accord with  $\eta_T^\circ$  values used to represent the low-density gas behavior. The coefficient  $\hat{A}$  for different degree polynomials for Kao's 183.15° K viscosity isotherm, his limiting viscosity values which he obtained by extrapolations, and values  $\eta_T^\circ$  obtained in this work from equations 8, 10, and 14 are shown below.

Mole fraction of helium	Degree of polynomial			Kao's value	This work
	2nd	3rd	4th		
1.0000	142.34	142.55	142.91	142.5	142.48
.8717	142.94	142.88	143.06	143.0	143.39
.5972	135.46	135.56	136.25	135.7	136.57
.1588	122.43	121.88	122.34	122.4	123.62
.0000	117.60	116.91	114.47	117.8	119.67

Statistical-thermodynamic theory requires that the n-th virial coefficient of the complete expansion of the compressibility factor, Z, for a binary gas mixture be a polynomial of the n-th order in the mole fractions. If the viscosity virial expansion is analogous to the Z





expansion and by inference the maximum likelihood estimators ( $\hat{B}$ ,  $\hat{C}$ , etc.) are equivalent to virial coefficients (a doubtful postulate), then the rules for obtaining interaction virial coefficients in the Z expansion should be applicable to the viscosity expansion. Unfortunately, it was not possible to perceive satisfactory relationships with respect to gas composition and temperature from the free parameters obtained in the regression analysis. Also, there was no relationship between interaction virial coefficients of the equation of state, presented by Wood (81), and interaction viscosity virials.

Kestin, Kobayashi, and Wood (39) used the residual viscosity concept in representing their very precise low-pressure viscosity data for helium, nitrogen, and helium-nitrogen mixtures by second degree equations in terms of density and found that their  $\hat{B}$  and  $\hat{C}$  values were essentially independent of temperature for their measurements at 293.15° and 303.15° K. The density values they used are in excellent agreement with densities obtained from the equation of state of Wood and coworkers (82). Slight extrapolations of their equations using densities computed from the equation of state give inappropriate results. There are no high-pressure viscosity data for helium and helium-nitrogen mixtures in the temperature range 133.15° to 183.15° K, and one general shortcoming of the residual viscosity versus density correlation is that the correlation requires closely spaced viscosity data and highly accurate density data in order to interpolate the viscosities with accuracy. Therefore, this type of correlation did not appear to be very practical and the more empirical approach of



relating residual viscosity values to thermal pressure coefficients was investigated.

Thermal pressure coefficients,  $(\partial P/\partial T)_V$ , derived from the equation of state of Wood and coworkers (82) and residual viscosities,  $\Delta\eta = (\eta_{T,P} - \eta_T^\circ)$ , obtained from experimental data were plotted on log-log coordinates. If an investigator gave  $\eta_T^\circ$  values, these values were used in conjunction with his higher pressure data to obtain  $\Delta\eta$  values; otherwise, applicable  $\eta_T^\circ$  values computed from equations 8, 10, or 14 were used to compute residual viscosities. Large-scale graphs (constructed from 1 x 1 cycle logarithmic-coordinate sheets each with a grid of 9.85 x 9.85 inches) of  $(\eta_{T,P} - \eta_T^\circ)$  versus  $(\partial P/\partial T)_V$  showed that most of the data points for a gas of fixed composition clustered about a straight line. The concentration of points of an individual investigator about a line of regression of  $\Delta\eta$  on  $(\partial P/\partial T)_V$  for his points alone appeared to be within the experimental uncertainty claimed for his data. The envelope of all experimental points on the surface of a graph for a gas of fixed composition also indicated a linear relationship between  $\Delta\eta$  and  $(\partial P/\partial T)_V$  on log-log coordinates. However, on these graphs data points were more scattered and widely dispersed because of the marked discrepancies in experimental viscosity data of compressed helium and nitrogen obtained by various methods and investigators. Visual inspection of the graphs showed that the parameter  $\beta$  in the Golubev relationship, equation 20, increased in value as the helium concentration increased in the mixtures, and  $\beta$  for helium was about 1.6 times larger than  $\beta$  for nitrogen.



The equation of state (82) used to calculate thermal pressure coefficients,  $(\partial P/\partial T)_V$ , for helium, nitrogen, and binary mixtures of these gases is the virial power series in density truncated at the fifth virial coefficient:

$$Z = \frac{P}{\rho RT} = 1 + B\rho + C\rho^2 + D\rho^3 + E\rho^4 \quad (24)$$

where

$Z$  = compressibility factor,

$P$  = pressure,

$\rho$  = molal density, reciprocal of molal volume,

$R$  = gas constant,

$T$  = absolute temperature,

and  $B$ ,  $C$ ,  $D$ , and  $E$  = the second, third, fourth, and fifth virial coefficients, respectively.

The empirical equations used to represent the functional relationships of the virial coefficients with respect to temperature are (82):

$$B = a + b/T + c/T^2 + dT + eT^2, \quad (25)$$

$$C = f + g/T + h/T^2 + i/T^6, \quad (26)$$

$$D = j + k/T, \quad (27)$$

and

$$E = l + m/T. \quad (28)$$

The parameters  $a$  through  $m$  are related to the mole fraction of helium,  $x_1$ , where



$$a = [n_1 + n_2 x_1] \quad (29)$$

$$b = [n_3 + n_4 x_1 + n_5 x_1^2] \times 10^2, \quad (30)$$

$$c = [n_6 + n_7 x_1 + n_8 x_1^2] \times 10^4, \quad (31)$$

$$d = [n_9 + n_{10} x_1 + n_{11} x_1^2] \times 10^{-2}, \quad (32)$$

$$e = [n_{12} + n_{13} x_1 + n_{14} x_1^2] \times 10^{-6}, \quad (33)$$

$$f = [n_{15} + n_{16} x_1], \quad (34)$$

$$g = [n_{17} + n_{18} x_1 + n_{19} x_1^2 + n_{20} x_1^3] \times 10^2, \quad (35)$$

$$h = [n_{21} + n_{22} x_1 + n_{23} x_1^2 + n_{24} x_1^3] \times 10^4, \quad (36)$$

$$i = [n_{25} + n_{26} x_1 + n_{27} x_1^2] \times 10^8, \quad (37)$$

$$j = [n_{28} + n_{29} x_1 + n_{30} x_1^2 + n_{31} x_1^3] \times 10^4, \quad (38)$$

$$k = [n_{32} + n_{33} x_1 + n_{34} x_1^2] \times 10^6, \quad (39)$$

$$l = [n_{35} + n_{36} x_1 + n_{37} x_1^2 + n_{38} x_1^3] \times 10^6, \quad (40)$$

and

$$m = [n_{39} + n_{40} x_1 + n_{41} x_1^2 + n_{42} x_1^3] \times 10^8. \quad (41)$$

Numerical values for  $n_1$  through  $n_{42}$  are given in table 1.

The thermal pressure coefficient expressed in terms of the virial parameters of the equation of state 24 is

$$\begin{aligned} \left(\frac{\partial P}{\partial T}\right)_V = R \rho \left[ 1 + \rho \left( B + T \frac{dB}{dT} \right) + \rho^2 \left( C + T \frac{dC}{dT} \right) \right. \\ \left. + \rho^3 \left( D + T \frac{dD}{dT} \right) + \rho^4 \left( E + T \frac{dE}{dT} \right) \right]. \quad (42) \end{aligned}$$





TABLE 1. - Equation of state constants<sup>1/</sup>

(R = 82.0597 cm<sup>3</sup> atm/g mole °K)

	Value		Value		Value
n <sub>1</sub>	+43.55717061	n <sub>15</sub>	+653.4350	n <sub>29</sub>	-10.3168469978
n <sub>2</sub>	-26.44142402	n <sub>16</sub>	-593.8107	n <sub>30</sub>	+6.7544135362
n <sub>3</sub>	-113.93090540	n <sub>17</sub>	+943.0050	n <sub>31</sub>	-1.4213610130
n <sub>4</sub>	+197.33531750	n <sub>18</sub>	-2150.8043	n <sub>32</sub>	-12.43854709
n <sub>5</sub>	-87.91454650	n <sub>19</sub>	+1507.8055	n <sub>33</sub>	+28.45763019
n <sub>6</sub>	-89.28053030	n <sub>20</sub>	-173.3216	n <sub>34</sub>	-16.49176184
n <sub>7</sub>	+166.47036350	n <sub>21</sub>	+3291.2149	n <sub>35</sub>	+1.22067686
n <sub>8</sub>	-77.18061130	n <sub>22</sub>	-8040.7069	n <sub>36</sub>	-2.69220173
n <sub>9</sub>	+0.11947536	n <sub>23</sub>	+6270.9306	n <sub>37</sub>	+0.53500731
n <sub>10</sub>	-1.88880885	n <sub>24</sub>	-1462.0293	n <sub>38</sub>	+0.95326739
n <sub>11</sub>	+0.31910785	n <sub>25</sub>	+4834983.16	n <sub>39</sub>	+1.34284616
n <sub>12</sub>	-3.53781356	n <sub>26</sub>	-9702847.53	n <sub>40</sub>	-1.14608807
n <sub>13</sub>	+3.60178035	n <sub>27</sub>	+4867864.37	n <sub>41</sub>	-1.86210420
n <sub>14</sub>	+6.72930720	n <sub>28</sub>	+5.2624836522	n <sub>42</sub>	+1.69131096

1/ These coefficients require that the units for  $\rho = \text{g mole/cm}^3$ ,  
 $T = \text{°K}$ , and  $R = \text{cm}^3 \text{ atm/g mole °K}$ .



The empirical equations, 25-28, used to represent the functional relationships of virial coefficients with respect to temperature, yield the following expressions for the terms in equation 42:

$$\left( B + T \frac{dB}{dT} \right) = a - cT^{-2} + 2dT + 3eT^2, \quad (43)$$

$$\left( C + T \frac{dC}{dT} \right) = f - hT^{-2} - 5iT^{-6}, \quad (44)$$

$$\left( D + T \frac{dD}{dT} \right) = j, \quad (45)$$

and

$$\left( E + T \frac{dE}{dT} \right) = k. \quad (46)$$

The equation of state, equation 24, cannot be solved explicitly for the molar density,  $\rho$ , as a function of temperature and pressure. Therefore, it is necessary to use an iterative process to solve for density when pressure and temperature are the independent variables. The Newton-Raphson method of iteration was used to compute densities, and convergence was assumed when

$$|Z_{(k+1)} - Z_{(k)}| \leq 10^{-6}, \quad (47)$$

where

$Z_{(k)}$  = an approximation of the compressibility factor,

$Z = P/RT\rho$ , at a given pressure and temperature,

and

$Z_{(k+1)}$  = the next successive approximation of the compressibility factor at the same conditions of pressure and temperature.

For additional details regarding this method, the iteration process, and the recurrence relationship used, the reader is referred to Wood



and coworkers (82).

The nonlinear Golubev equation, equation 20, can be readily reduced to a linear form for least squares treatment by treating residuals,  $r$ , as

$$r = \log \alpha + \beta \log \left( \frac{\partial P}{\partial T} \right)_V - \log \left( \eta_{T,P} - \eta_T^\circ \right), \quad (48)$$

but this procedure of evaluating  $\alpha$  and  $\beta$  so that  $\Sigma r^2$  is minimum is inappropriate and would be correct only for a constant absolute error in  $\log \left( \eta_{T,P} - \eta_T^\circ \right)$ , that is for a constant percentage error in  $\left( \eta_{T,P} - \eta_T^\circ \right)$ , which is very unlikely. A general computer program for solving nonlinear regression problems written by Grout (22) was used to evaluate  $\alpha$  and  $\beta$  in the Golubev relationship from high-pressure viscosity data. In this computer program, weighting factors can be assigned to the dependent variables, and estimating parameters are improved by the Newton-Raphson or Gauss-Newton method of iteration. Twenty-two digit floating-point precision is used in program execution, and iterations are carried out for as long as the sum of the weighted squares of the residuals,  $\Sigma r^2$ , continues to get smaller or until the relative change in  $\Sigma r^2$  becomes insignificant. Estimating parameters  $\tilde{\alpha}$  and  $\tilde{\beta}$  for this computer program were obtained from equation 48. Convergence was assumed when  $\Sigma r^2$  values of successive approximations differed by  $10^{-16}$  or less in the nonlinear least squares program.

High-pressure viscosity isotherms for nitrogen from 24 sources (1, 3, 12, 14, 16-17, 19, 29-30, 34, 39-41, 45-46, 48, 55-56, 58, 63, 67-70) in the temperature region 131.15° to 933.46° K were



considered in computing  $\alpha$  and  $\beta$  values for the Golubev equation. The nonlinear least squares method of Grout (22) was used to compute  $\alpha$  and  $\beta$  values from individual viscosity isotherms to see if  $\alpha$  and  $\beta$  were temperature-dependent. No temperature dependency in either  $\alpha$  or  $\beta$  was noted. Two-hundred eight data points for nitrogen, consisting of averaged data where a series of measurements had been made for a given isotherm, and individual points were used to obtain the "best" overall values of  $\alpha$  and  $\beta$  for nitrogen. A standard error of estimate of 1.64  $\mu\text{p}$  in the residual viscosity was obtained from the 208 points used. The regression analyses yielded  $\alpha = 58.2659757$  and  $\beta = 1.1160332$  when the residual viscosity values,  $(\eta_{T,P} - \eta_T^\circ)$ , are in micropoises.

Lo, Carroll, and Stiel (51) presented a viscosity correlation for air for the temperature region  $-70^\circ$  to  $600^\circ$  C for pressures to 1,000 atmospheres, using the Golubev equation where  $(\partial P/\partial T)_V$  values for nitrogen were computed from the derived data of Deming and Shupe (9). If residual viscosity values are expressed in micropoises, the coefficients obtained by Lo and coworkers are  $\alpha = 57.6$  and  $\beta = 1.126$ . Golubev (20) obtained the relationship

$$(\eta_{T,P} - \eta_T^\circ) = 56.7 \left[ \left( \frac{\partial P}{\partial T} \right)_V \right]^{1.12} \quad (49)$$

for nitrogen from the data of Golubev and Petrov presented in (20); his  $(\partial P/\partial T)_V$  values were obtained from the work of Deming and Shupe (9).





Makavetskias, Popov, and Tsederberg (55) used the Golubev relationship to correlate their higher pressure viscosity data for helium and nitrogen. The  $(\partial P/\partial T)_V$  values they required for correlation were derived from helium data presented by Tsederberg, Popov, and Morozova (79) and nitrogen data presented principally by Din (10). The  $\alpha$  and  $\beta$  values they obtained for nitrogen and helium depart markedly from  $\alpha$  and  $\beta$  values obtained from either a linear or a nonlinear treatment of their viscosity data, when  $(\partial P/\partial T)_V$  values used in analysis were derived from the equation of state of Wood and coworkers, equation 24. Values of  $\alpha$  and  $\beta$  depend strongly on the values of the thermal pressure coefficient; it was assumed initially that the incongruous results obtained were due to marked variance in  $(\partial P/\partial T)_V$  values from different sources. Fortunately, Makavetskias and coworkers tabulated the  $(\partial P/\partial T)_V$  values they used. A comparison of  $(\partial P/\partial T)_V$  values for helium computed from equation 24 and those tabulated (55) show deviations of less than 0.8 percent, except for one pair at 918.52° K and 490.9 atmospheres, where the tabulated and the computed value differed by 1.11 percent. In a like comparison of  $(\partial P/\partial T)_V$  values for nitrogen, the agreement was not quite as good as that for helium; 6 out of 62 pairs of  $(\partial P/\partial T)_V$  values diverged by more than 1.4 percent.

The equation of state of Wood and coworkers, equation 24, was not designed for pressures above 300 atmospheres or temperatures higher than 748.15° K. One would expect deviations to increase with increasing pressure and for the two isotherms of Makavetskias, 813.08° and 933.46° K,



which were outside the range of the equation of state. The pattern in which the larger deviations, up to 5.26 percent, occurred was unexpected. Elimination of their higher pressure and temperature data from the regression analysis would not have resulted in agreement of the  $\alpha$  and  $\beta$  values of Makavetskias and coworkers with those obtained by the nonlinear least squares treatment of their data.

The  $\alpha$  values obtained from Makavetskias and coworkers' data for helium and nitrogen departed so greatly from  $\alpha$  values obtained from the viscosity isotherms of other investigators that their data for helium and nitrogen were not used in the regression analysis, wherein the data of a number of investigators were combined to obtain the "best" values of  $\alpha$  and  $\beta$ . The shear viscosity data of Boyd (3) and kinematic viscosity values of Filippova and Ishkin (14) for nitrogen were also not considered in obtaining  $\alpha$  and  $\beta$  values. Filippova and Ishkin's kinematic viscosity values were converted to dynamic values with densities taken from Strobridge (73); the results checked, in part, with densities obtained from equation 24. Boyd's data were rejected because his individual viscosity measurements, at a given temperature and pressure, often deviated from the arithmetical mean of these measurements by as much as 7 percent.

The reliability of Filippova and Ishkin's (14) data was considered doubtful because in several instances their results show a sharp rise or fall in isothermal viscosity values with increasing pressure. For example, on their 173.15° K isotherm, the viscosity increases 30.48  $\mu$ p for a pressure increase of only 1.3 atmospheres, 139.0 to 140.3; on their 223.15° K isotherm, the viscosity drops 11.52  $\mu$ p when the



pressure is increased from 127.6 to 138.5 atmospheres.

However, it would not be prudent to reject all their experimental data on the basis of a few discrepancies. Proofreading and correction of tabular material before publication is apparently not a virtue in the Russian literature. Filippova and Ishkin (15) claimed that the empirical formula

$$\eta_{T,P} = \eta_T^\circ + \left[ c\rho^{4/3}/(1 - b\rho) \right], \quad (50)$$

where

$c$  and  $b$  = constants,

and  $\rho$  = density,  $\text{g/cm}^3$ ,

gave a good description of their data when they used  $\eta_T^\circ$  values obtained from Golubev's (20) book. Viscosity values were computed from equation 50 by using densities computed from equation 24 and  $\eta_T^\circ$  values from equation 10. The computed viscosities were compared with the experimental data of Filippova and Ishkin (14), and deviations greater than 6 percent were encountered between the computed and experimental viscosity values. The magnitude of the differences encountered cannot be accounted for in terms of discrepancies between  $\eta_T^\circ$  values taken from Golubev's book and results obtained from equation 10 or because of uncertainty in the density of nitrogen. In general, the overall results indicated that Filippova and Ishkin's data are erratic and should not be considered in a correlation of the viscosity data of compressed nitrogen.

The 473.15° K viscosity isotherm of Reynes and Thodos (63) for nitrogen gave  $\alpha$  and  $\beta$  values which departed appreciably from their



other viscosity data, and three points out of eight higher pressure values on this isotherm were excluded from the regression analysis. Reynes and Thodos make no estimate of the accuracy of their viscosity data. The three points in question were not rejected from final computations because of a known lack of merit but were excluded because they were more than 3 standard error of estimate removed from the preliminary line of regression.

The validity of the viscosity data of Ross and Brown (67) for nitrogen is questionable because their values do not agree with the data of a number of investigators (17, 19, 30, 34, 41, 56, 58, 70). For this reason, Ross and Brown's data were not used in obtaining  $\alpha$  and  $\beta$  values for nitrogen.

It appears that Makavetskas and coworkers (54-55) assumed ab initio that  $\beta$  should have the value 1.12 for helium, nitrogen, and helium-nitrogen mixtures. Such a premise could explain, in part, the lack of agreement in  $\alpha$  and  $\beta$  values obtained by the nonlinear least squares treatment of their viscosity data, where both  $\alpha$  and  $\beta$  were treated as variables, and their final results. Also, in the case of nitrogen, the higher pressure viscosity values from their 284.55° K isotherm delimit the upper boundary of points on the  $\Delta \eta$  versus  $(\partial P/\partial T)_V$  graph when Boyd's (3) data are not considered.

The only viscosity data for helium and helium-nitrogen mixtures of sufficient accuracy and at pressures sufficiently high to yield meaningful values of  $\alpha$  and  $\beta$ , are those of Kao (34). Therefore, the  $\alpha$  and  $\beta$  values for helium and helium-nitrogen mixtures used in this report are based solely on results derived from Kao's viscosity isotherms.





For computing the properties of all binary mixtures, Golubev recommended the formula

$$\alpha_m = \alpha_1 x_1^2 + \frac{2}{3} (\alpha_1 + \alpha_2) x_1 x_2 + \alpha_2 x_2^2 \quad (51)$$

where

$\alpha_m$  = coefficient for a mixture of fixed composition,

$x_1$  and  $x_2$  = mole fractions of components 1 and 2 in the mixture,

and  $\alpha_1$  and  $\alpha_2$  = coefficients of the pure gas 1 and pure gas 2.

The  $\alpha_m$  constants we obtained from the nonlinear least squares procedure were not well represented by equation 51. It was found that a better representation of  $\alpha_m$  values could be obtained from the expression

$$\alpha_m = \alpha_1 x_1^2 + 2x_1 x_2 \alpha_{12} + \alpha_2 x_2^2. \quad (52)$$

The values for constants of equation 52 are:

$$\alpha_1 = 2.5254571$$

$$\alpha_{12} = 24.4447980$$

$$\alpha_2 = 58.2659757$$

The subscripts 1 and 2 reference helium and nitrogen, respectively; and  $\alpha_{12}$  is an artificial quantity characteristic of 1 - 2 interaction.

A comparison of  $\alpha_m$  values obtained from experimental data with  $\alpha_m$  values computed from equation 52 is provided in figure 4.

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Figure 4. - The Dense-Gas Viscosity Parameter  $\alpha_m$  as a Function of Composition.

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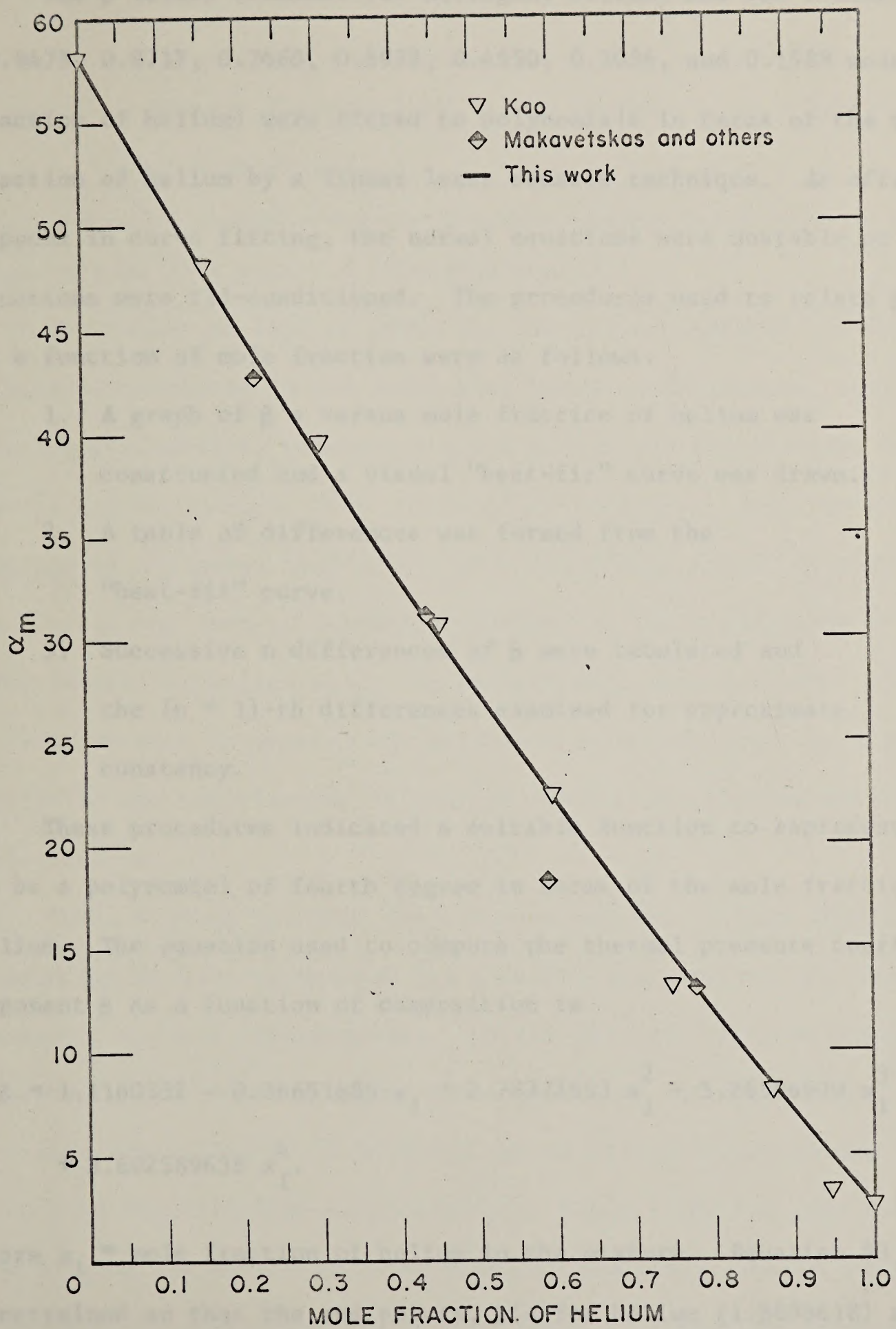


FIGURE 4. - The Dense-Gas Viscosity Parameter  $\alpha_m$  as a Function of Composition.



The  $\beta$  values obtained for nitrogen, helium, and Kao's mixtures (0.9475, 0.8717, 0.7460, 0.5972, 0.4550, 0.3036, and 0.1588 mole fraction of helium) were fitted to polynomials in terms of the mole fraction of helium by a linear least squares technique. As often happens in curve fitting, the normal equations were unstable or the equations were ill-conditioned. The procedures used to relate  $\beta$ 's as a function of mole fraction were as follows:

1. A graph of  $\beta$ 's versus mole fraction of helium was constructed and a visual "best-fit" curve was drawn.
2. A table of differences was formed from the "best-fit" curve.
3. Successive  $n$  differences of  $\beta$  were tabulated and the  $(n + 1)$ -th differences examined for approximate constancy.

These procedures indicated a suitable function to represent  $\beta$ 's to be a polynomial of fourth degree in terms of the mole fraction of helium. The equation used to compute the thermal pressure coefficient exponent  $\beta$  as a function of composition is

$$\beta = 1.1160332 - 0.36651685 x_1 + 2.78372553 x_1^2 - 5.26596970 x_1^3 + 3.602589636 x_1^4, \quad (53)$$

where  $x_1$  = mole fraction of helium in the mixture. Equation 53 was constrained so that the end points,  $\beta$ 's for helium (1.8698618) and nitrogen (1.1160332), corresponded to  $\beta$ 's obtained from the experimental data. The free parameters of the equation necessary to represent



given mixtures were obtained by successive approximations. Figure 5

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Figure 5. - Thermal Pressure Coefficient Exponent  $\beta$  as a Function of Composition.

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shows values of  $\beta$  computed from equation 53.

The number of figures given for the coefficients of the various equations presented do not imply that virial coefficients, low-density viscosities, parameters  $\alpha$  and  $\beta$ , and thermal pressure coefficients can be computed to 8- to 10-place accuracy. Just how many figures of any given coefficient are significant cannot be stated because of the lack of knowledge relevant to the reliability of the experimental data from which the coefficients were derived. However, it appears that in general the equations will give a better approximation of the experimental data if at least eight figures are used in calculations.

Table 2 shows the data distribution and the average absolute percentage deviations between the computed and experimental viscosity values of various investigators. In our opinion, in considering how representative the prediction equations are of the experimental data, the unreliable results of Boyd (3) and of Filippova and Ishkin (14) should be excluded from consideration. Table 2 has the inadequacy of not showing the spread or dispersion of quantities used to compute the mean absolute deviation. Therefore, table 3 is provided to show the maximum deviations between computed and experimental viscosities for nitrogen and helium. The value of  $\eta_T^0$  for nitrogen computed in this





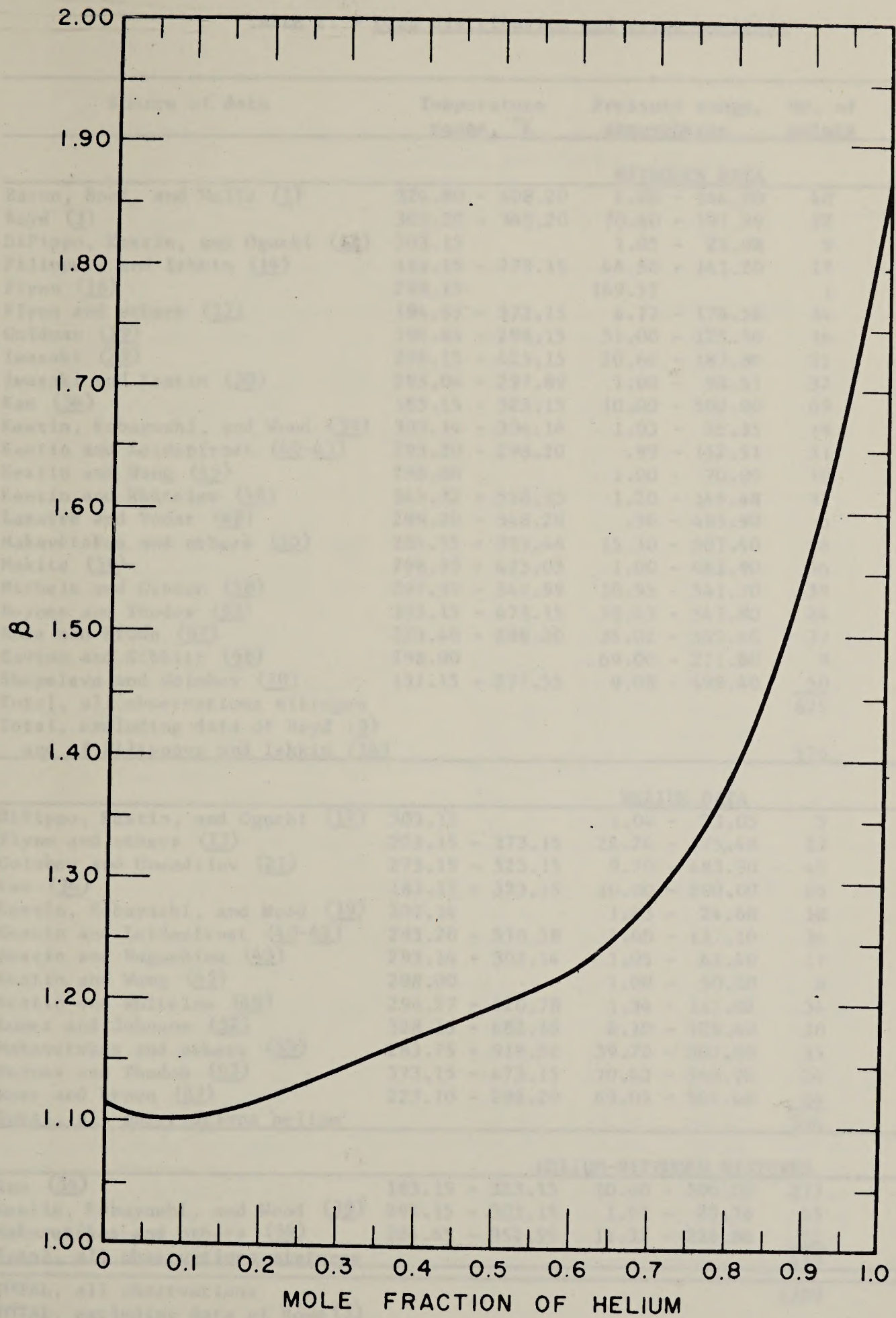


FIGURE 5. - Thermal Pressure Coefficient Exponent  $\beta$  as a Function of Composition.



TABLE 2. - Data distribution and error analysis

Source of data	Temperature range, °K	Pressure range, atmospheres	No. of points	$\frac{\Sigma}{N}$   Pct Dev   <sup>1/</sup>
NITROGEN DATA				
Baron, Roof, and Wells (1)	324.80 - 408.20	6.80 - 544.00	40	1.79
Boyd (3)	303.20 - 343.20	70.40 - 191.00	32	6.66
DiPippo, Kestin, and Oguchi (12)	303.15	1.05 - 23.08	5	.11
Filippova and Ishkin (14)	133.15 - 273.15	46.50 - 141.20	17	6.11
Flynn (16)	298.15	149.57	1	.36
Flynn and others (17)	194.65 - 373.15	6.77 - 176.58	34	.32
Goldman (19)	194.65 - 298.15	51.00 - 125.50	16	.75
Iwasaki (29)	298.15 - 423.15	20.60 - 187.80	25	.43
Iwasaki and Kestin (30)	293.04 - 297.89	1.00 - 98.51	32	.11
Kao (34)	183.15 - 323.15	10.00 - 500.00	69	.79
Kestin, Kobayashi, and Wood (39)	303.14 - 304.14	1.03 - 25.35	19	.06
Kestin and Leidenfrost (40-41)	293.20 - 298.20	.99 - 152.51	31	.16
Kestin and Wang (45)	298.00	1.00 - 70.00	10	.11
Kestin and Whitelaw (46)	345.32 - 538.33	1.20 - 146.48	37	1.32
Lazarre and Vodar (48)	298.20 - 348.20	.96 - 483.90	6	.94
Makavetskias and others (55)	284.55 - 933.46	15.10 - 507.40	56	2.58
Makita (56)	298.99 - 473.03	1.00 - 483.90	36	1.09
Michels and Gibson (58)	297.99 - 347.99	10.95 - 541.70	39	.28
Reynes and Thodos (63)	373.15 - 473.15	70.43 - 547.80	24	1.24
Ross and Brown (67)	223.40 - 298.20	35.02 - 545.40	37	2.44
Savino and Sibbitt (68)	298.00	69.00 - 271.80	9	1.14
Shepeleva and Golubev (70)	131.15 - 277.55	9.08 - 499.40	50	1.56
Total, all observations nitrogen			625	1.52
Total, excluding data of Boyd (3) and of Filippova and Ishkin (14)			576	1.09
HELIUM DATA				
DiPippo, Kestin, and Oguchi (12)	303.15	1.04 - 23.05	5	0.39
Flynn and others (17)	223.15 - 373.15	22.24 - 175.48	23	.23
Golubev and Gnezdilov (21)	273.15 - 523.15	9.70 - 483.90	45	.60
Kao (34)	183.15 - 323.15	10.00 - 500.00	65	.36
Kestin, Kobayashi, and Wood (39)	303.14	1.03 - 24.68	10	.32
Kestin and Leidenfrost (40-42)	293.20 - 510.58	1.00 - 137.10	34	.42
Kestin and Nagashima (43)	293.14 - 303.14	1.05 - 63.40	17	.28
Kestin and Wang (45)	298.00	1.00 - 50.00	8	.41
Kestin and Whitelaw (46)	296.27 - 520.78	1.34 - 117.02	34	.85
Luker and Johnson (52)	328.15 - 682.15	8.10 - 129.40	30	2.16
Makavetskias and others (55)	283.75 - 918.52	39.70 - 507.00	35	1.07
Reynes and Thodos (63)	373.15 - 473.15	70.43 - 546.70	24	1.59
Ross and Brown (67)	223.10 - 298.20	69.05 - 545.40	24	1.01
Total, all observations helium			354	.78
HELIUM-NITROGEN MIXTURES				
Kao (34)	183.15 - 323.15	10.00 - 500.00	273	0.48
Kestin, Kobayashi, and Wood (39)	293.15 - 303.15	1.01 - 25.76	65	.17
Makavetskias and others (54)	284.65 - 952.55	11.32 - 226.86	72	1.49
Total, all observations mixtures			410	.61
TOTAL, all observations			1389	1.06
TOTAL, excluding data of Boyd (3) and of Filippova and Ishkin (14)			1340	.86

<sup>1/</sup> Mean absolute percent deviation.



TABLE 3. - Maximum deviations between computed and experimental viscosities for nitrogen and helium

Source of data	T, °K	P, atm	$\eta_{\text{Exp.}}$ , $\mu\text{P}$	$\eta_{\text{Comp.}}$ , $\mu\text{P}$	Deviation, percent
NITROGEN DATA					
Baron, Roof, and Wells (1)	408.20	544.00	348.10	332.20	4.78
Boyd (3)	303.20	176.90	272.50	224.10	21.59
DiPippo, Kestin, and Oguchi (12)	303.15	15.05	182.34	182.08	.14
Filippova and Ishkin (14)	173.15	139.00	209.59	256.63	-18.33
Flynn, Hanks, Lemaire, and Ross (17)	194.65	90.83	169.90	172.85	-1.70
Goldman (19)	194.65	125.50	212.40	204.87	3.67
Iwasaki (29)	423.15	162.70	249.50	253.09	-1.42
Iwasaki and Kestin (30)	297.89	98.51	199.73	198.67	.52
Kao (34)	183.15	10.00	118.88	122.15	-2.68
Kestin, Kobayashi, and Wood (39)	304.14	5.00	181.23	181.01	.11
Kestin and Leidenfrost (40)	298.20	69.04	191.64	191.09	.28
Kestin and Leidenfrost (41)	293.20	144.02	212.70	211.14	.73
Kestin and Wang (45)	298.00	10.00	179.30	178.96	.18
Kestin and Whitelaw (46)	538.33	133.69	292.90	284.18	3.06
Lazarre and Vodar (48)	298.20	483.90	348.00	341.01	2.04
Makavetskas and others (55)	284.55	396.30	350.20	312.43	12.08
Makita (56)	473.03	483.90	303.00	322.73	-6.11
Michels and Gibson (58)	347.99	212.40	240.80	243.51	-1.11
Reynes and Thodos (63)	473.15	479.40	310.00	321.92	-3.70
Ross and Brown (67)	223.40	545.40	422.80	472.03	-10.43
Savino and Sibbitt (68)	298.00	271.80	250.50	257.72	-2.80
Shepeleva and Golubev (70)	132.15	248.92	665.00	618.03	7.59
HELIUM DATA					
DiPippo, Kestin, and Oguchi (12)	303.15	5.00	200.93	200.07	0.42
Flynn, Hanks, Lemaire, and Ross (17)	248.15	174.25	174.77	176.10	-.76
Golubev and Gnezdilov (21)	273.15	483.90	197.00	193.50	1.80
Kao (34)	323.15	500.00	212.27	214.26	-.93
Kestin, Kobayashi, and Wood (39)	303.14	7.50	200.77	200.06	.35
Kestin and Leidenfrost (40)	293.20	4.39	196.19	195.62	.28
Kestin and Leidenfrost (41)	293.20	41.86	196.40	195.68	.36
Kestin and Leidenfrost (42)	506.00	137.09	287.20	282.74	1.57
Kestin and Nagashima (43)	303.14	14.54	200.88	200.07	.40
Kestin and Wang (45)	298.00	50.00	199.20	197.86	.67
Kestin and Whitelaw (46)	520.78	22.91	293.52	288.06	1.89
Luker and Johnson (52)	517.15	127.00	300.00	286.88	4.57
Makavetskas and others (55)	594.73	292.90	329.70	315.66	4.44
Reynes and Thodos (63)	473.15	546.70	279.60	273.14	2.36
Ross and Brown (67)	298.20	545.40	210.30	205.23	2.46



work at  $183.15^{\circ}$  K is 1.58 percent higher than Kao's (34) limiting viscosity value. Discrepancies between computed and experimental higher pressure viscosity values on this isotherm are characteristic of the low-density result, except for the two measurements at 120 atmospheres which deviated from computed results by less than 0.3 percent. The very large deviations shown in table 3 are, in many cases, for viscosity values at pressures greater than 300 atmospheres. The accuracy of the thermal pressure coefficients derived from the equation of state for pressures greater than 300 atmospheres is probably not very good because it is known that the equation of state begins to depart from apparently reliable experimental compressibility factors at pressures greater than 300 atmospheres. However, the discrepancies between computed and experimental results at pressures greater than 300 atmospheres are not due solely to inadequacies in the prediction equation but in many cases result from lack of agreement between the experimental viscosity coefficients reported by investigators. The amount of variation between Kao's (34) experimental results and computed viscosity values for pressures greater than 300 atmospheres is not appreciably greater than the amount of variation for comparable lower pressure comparisons.

The  $284.55^{\circ}$  K viscosity isotherm of Makavetskas and coworkers (55) for nitrogen falls within the pressure and temperature domain of Kao's data but discrepancies between computed and experimental results increase sharply for pressures above 295 atmospheres. Table 2 shows the mean absolute percent deviation to be 2.58 for the 56 nitrogen points of Makavetskas and coworkers (55). However, the three highest pressure





points on their  $284.55^{\circ}$  K isotherm, 5 percent of their data, account for 23 percent of the overall discrepancy between computed and experimental values. The penultimate point of their  $284.55^{\circ}$  K isotherm is given in table 3. Their points adjacent to this point have deviations greater than 10 percent.

A situation similar to that of Makavetskas and coworkers' nitrogen data exists in the case of Ross and Brown's (67) nitrogen data. The three highest pressure points on their  $223.40^{\circ}$  K viscosity isotherm, 11 percent of their data, account for 34 percent of the overall discrepancy between computed and experimental results. If all of Ross and Brown's  $223.40^{\circ}$  K viscosity data for nitrogen, about 25 percent of the data, were excluded from consideration, the mean absolute percent deviation for the remainder of their nitrogen data, 28 points at higher temperatures, would be 1.28.

Unfortunately, the experimental data of Shepeleva and Golubev (70) for nitrogen are at extremely large pressure intervals, and there is a lack of closely spaced data in the vicinity of their viscosity point at  $132.15^{\circ}$  K and 248.92 atmospheres, shown in table 3, which differs from the computed value by 7.59 percent. Therefore, it is not known if this large deviation is part of a trend or the result of a large error in an isolated point. Shepeleva's tabulated data show the viscosity of nitrogen to be  $488.2 \mu\text{p}$  at  $133.65^{\circ}$  K and 98.99 atmospheres. This value appears to be a typographical error, and from figure 2 in his paper it is evident that the first significant figure should be a 3 rather than 4, and this change was made in using his data.



Figure 6 shows computed viscosities for nitrogen. A common

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Figure 6. - Viscosity of Nitrogen.

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characteristic of gases in the vicinity of the critical region is a sharp rise in the viscosity with increasing pressure. The computed results cannot be compared quantitatively for each isobar because of the lack of sufficient experimental data. However, the variation of viscosity along isobars conforms to this generalization and illustrates further the ability of the prediction equation to represent the behavior of a real gas.

The helium viscosity data of Flynn, Hanks, Lemaire, and Ross (17); Kao (34); Kestin, Kobayashi, and Wood (39); Kestin and Leidenfrost (40-41); Kestin and Nagashima (43); and Kestin and Wang (45) appear to be of very high precision. Data from three of these sources (17, 34, 41) indicate that the isothermal viscosity of helium decreases very slightly from the dilute-gas value with increasing pressure, passes through a very superficial minimum, and then increases with increasing pressure. The thermal pressure method for computing residual viscosities is incompatible with such phenomena because the thermal pressure coefficients of helium are positive and increase monotonically with increasing pressure. Data from sources (12, 21, 42-43, 45-46) probably have uncertainties of 1 percent or less. However, the data of Luker and Johnson (52) are not in good agreement with the data of other investigators. Data from this source may have uncertainties up to 4 percent. Luker and Johnson's results show that the isothermal viscosity of helium increases by about



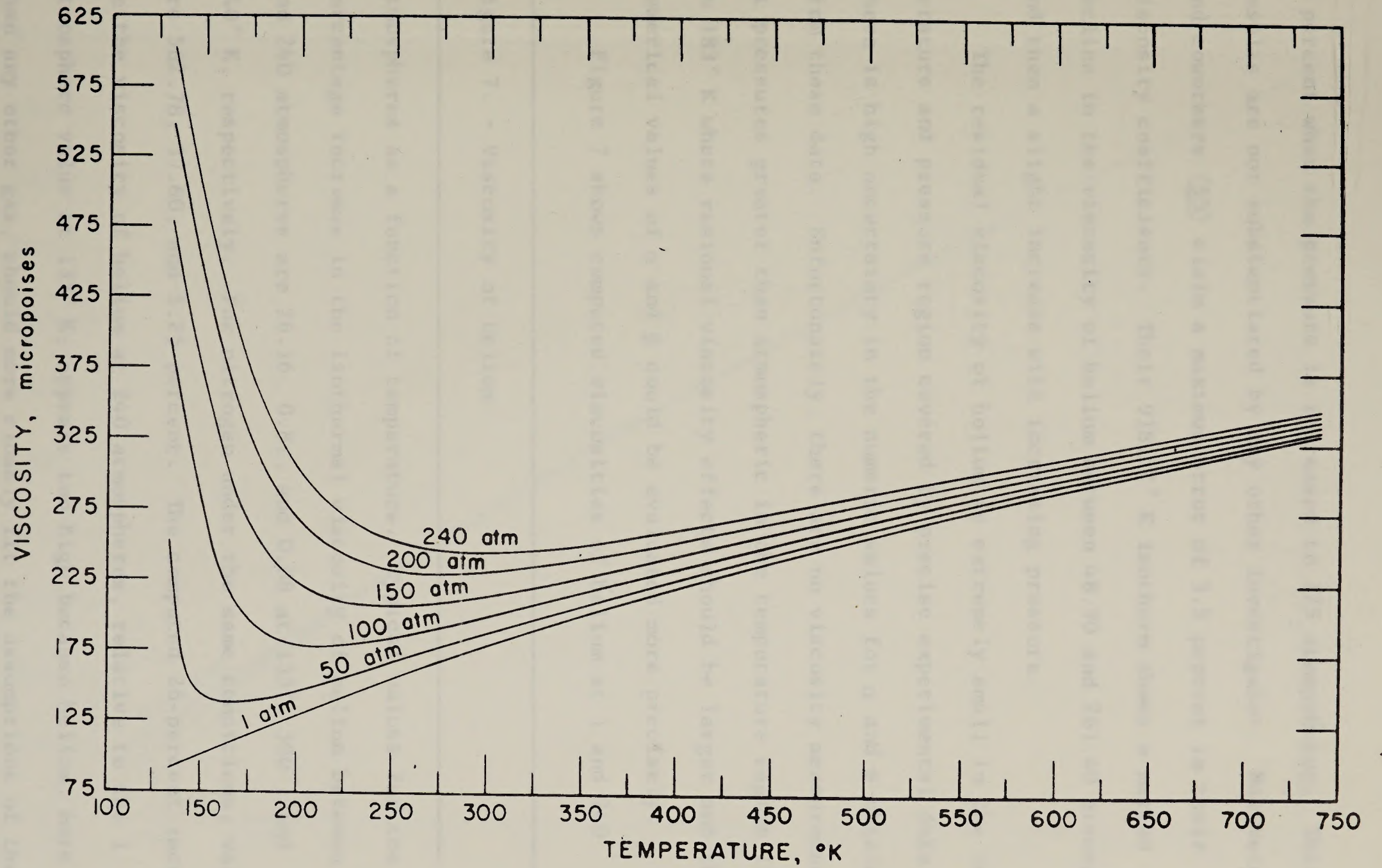


FIGURE 6. - Viscosity of Nitrogen.



4 percent when the pressure is increased to 125 atmospheres. Their results are not substantiated by any other investigator. Makavetskas and coworkers (55) claim a maximum error of 3.5 percent in their viscosity coefficients. Their 918.52° K isotherm shows a marked decline in the viscosity of helium between 48.90 and 261.40 atmospheres and then a slight increase with increasing pressure.

The residual viscosity of helium is extremely small in the temperature and pressure region covered by precise experimental data, and there is high uncertainty in the numeric values for  $\alpha$  and  $\beta$  obtained from these data. Unfortunately, there are no viscosity measurements at pressures greater than atmospheric in the temperature region 133° to 183° K where residual viscosity effects should be larger and the numerical values of  $\alpha$  and  $\beta$  could be evaluated more precisely.

Figure 7 shows computed viscosities of helium at 1 and 240

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Figure 7. - Viscosity of Helium.

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atmospheres as a function of temperature. Typical values for the percentage increase in the isothermal viscosity of helium between 1 and 240 atmospheres are 26.16, 0.81, and 0.08 at 133°, 300°, and 740° K, respectively. For nitrogen under the same conditions, values are 562.78, 37.60, and 5.25 percent. The computed 26-percent increase in the viscosity of helium at 240 atmospheres, relative to the 1 atmosphere value at 133° K, appears too high because helium, more than any other gas, should more closely fit the assumptions of the elementary kinetic theory. A 26-percent increase in the viscosity of





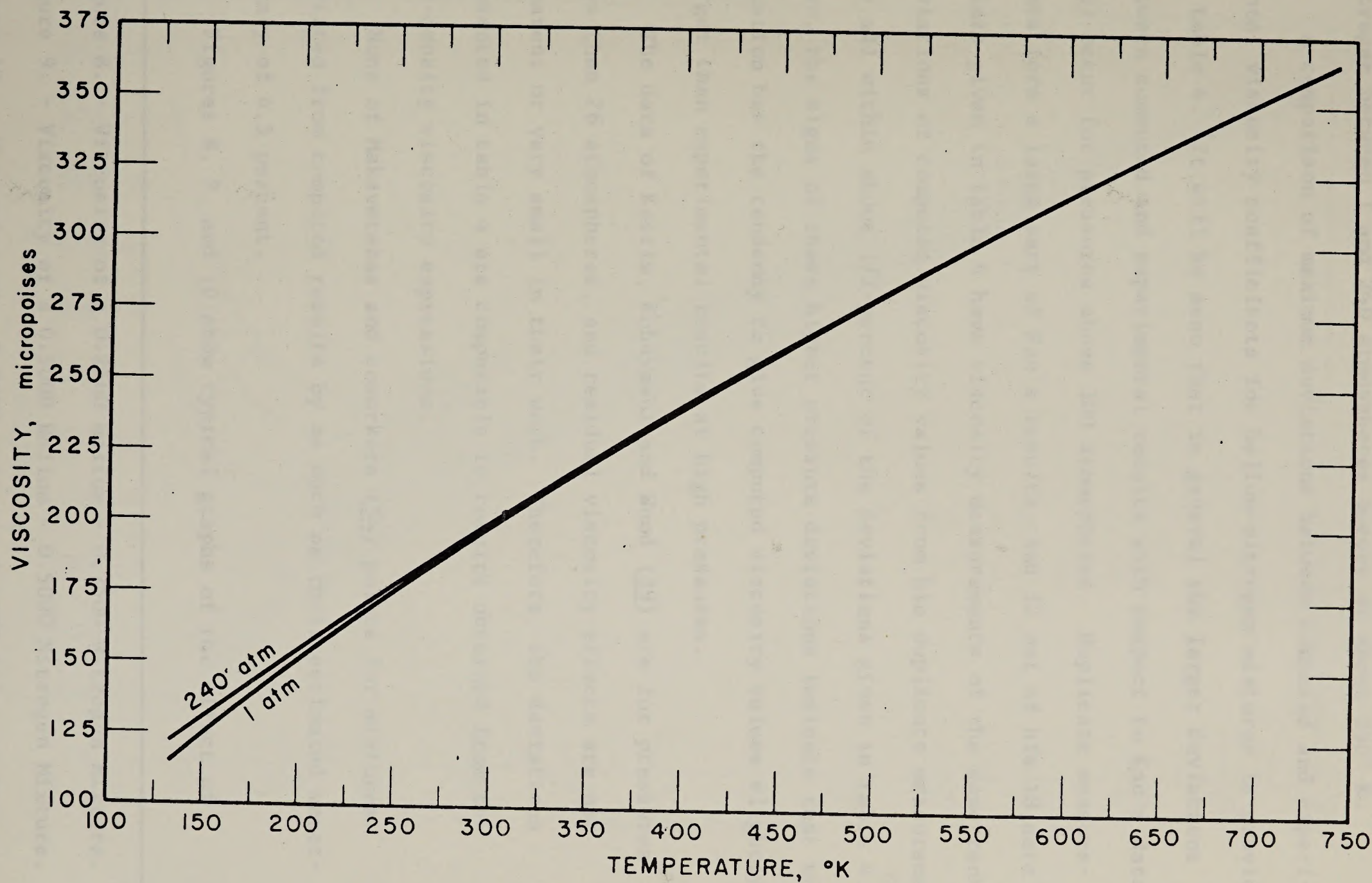


FIGURE 7. — Viscosity of Helium.



nitrogen between 1 and 240 atmospheres occurs at about 350° K.

A comparison of maximum deviations between computed and experimental viscosity coefficients for helium-nitrogen mixtures is provided in table 4. It will be seen that in general the larger deviations between computed and experimental results with respect to Kao's data (34) occur for pressures above 300 atmospheres. Duplicate measurements form a large part of Kao's results, and 12 out of his 18 data points given in table 4 have viscosity measurements of the same rank. Deviations of computed viscosity values from his duplicate measurements are all within about 1/2-percent of the deviations given in table 4. Also, the signs of these higher pressure deviations indicate that the equation has the tendency to give computed viscosity values slightly larger than experimental results at high pressures.

The data of Kestin, Kobayashi and Wood (39) are for pressures less than 26 atmospheres, and residual viscosity effects are not apparent or very small in their work. Therefore, the deviations presented in table 4 are comparable to results obtained from the low-density viscosity expressions.

None of Makavetskas and coworkers (54) points for mixtures deviated from computed results by as much as their estimated uncertainty of 4.5 percent.

Figures 8, 9, and 10 show typical graphs of the effect of

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Figure 8. - Viscosity of a 0.2500 Helium - 0.7500 Nitrogen Mixture.

Figure 9. - Viscosity of a 0.5000 Helium - 0.5000 Nitrogen Mixture.

Figure 10. - Viscosity of a 0.8000 Helium - 0.2000 Nitrogen Mixture.

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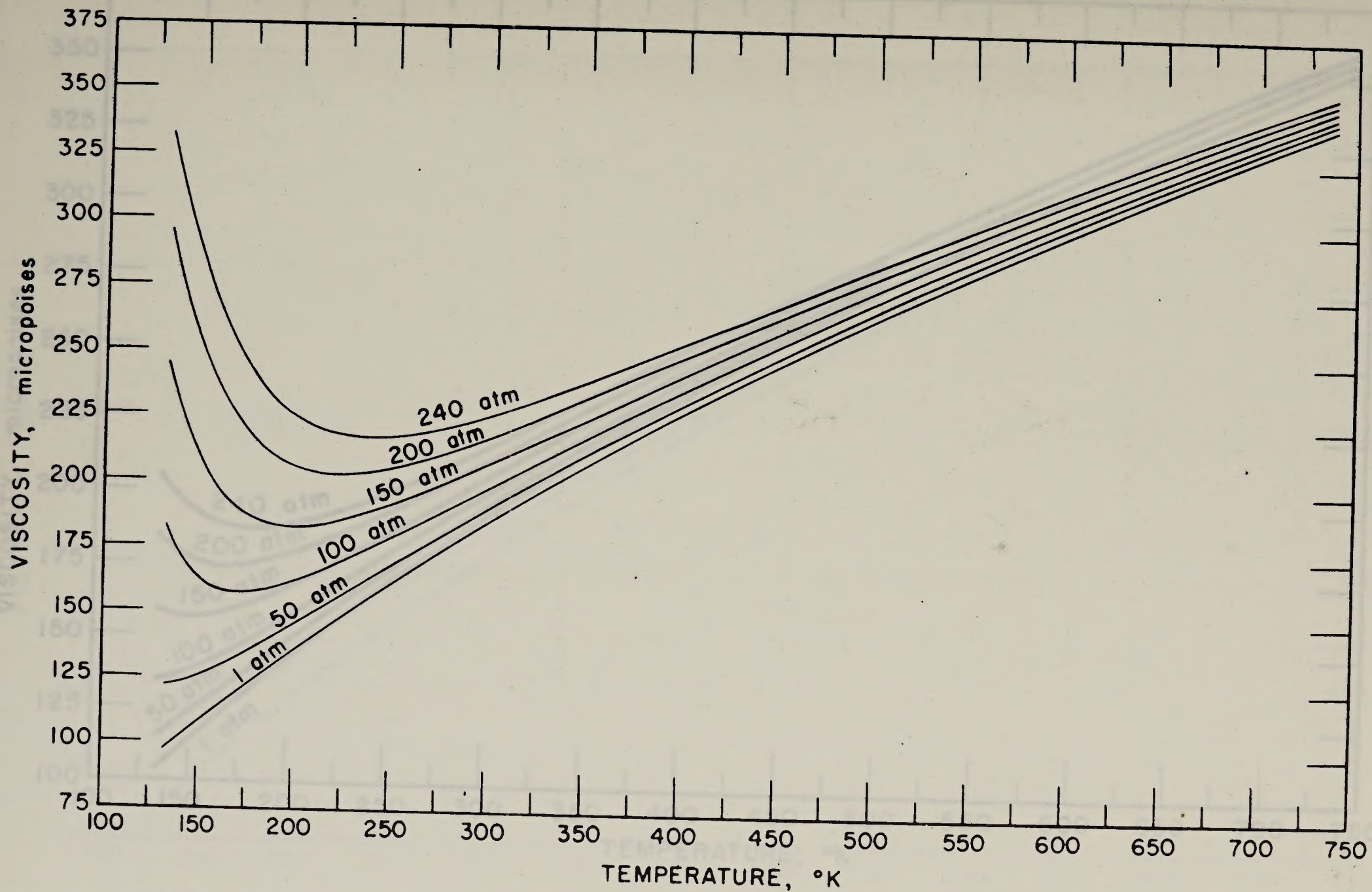


FIGURE 8. - Viscosity of a 0.2500 Helium - 0.7500 Nitrogen Mixture.



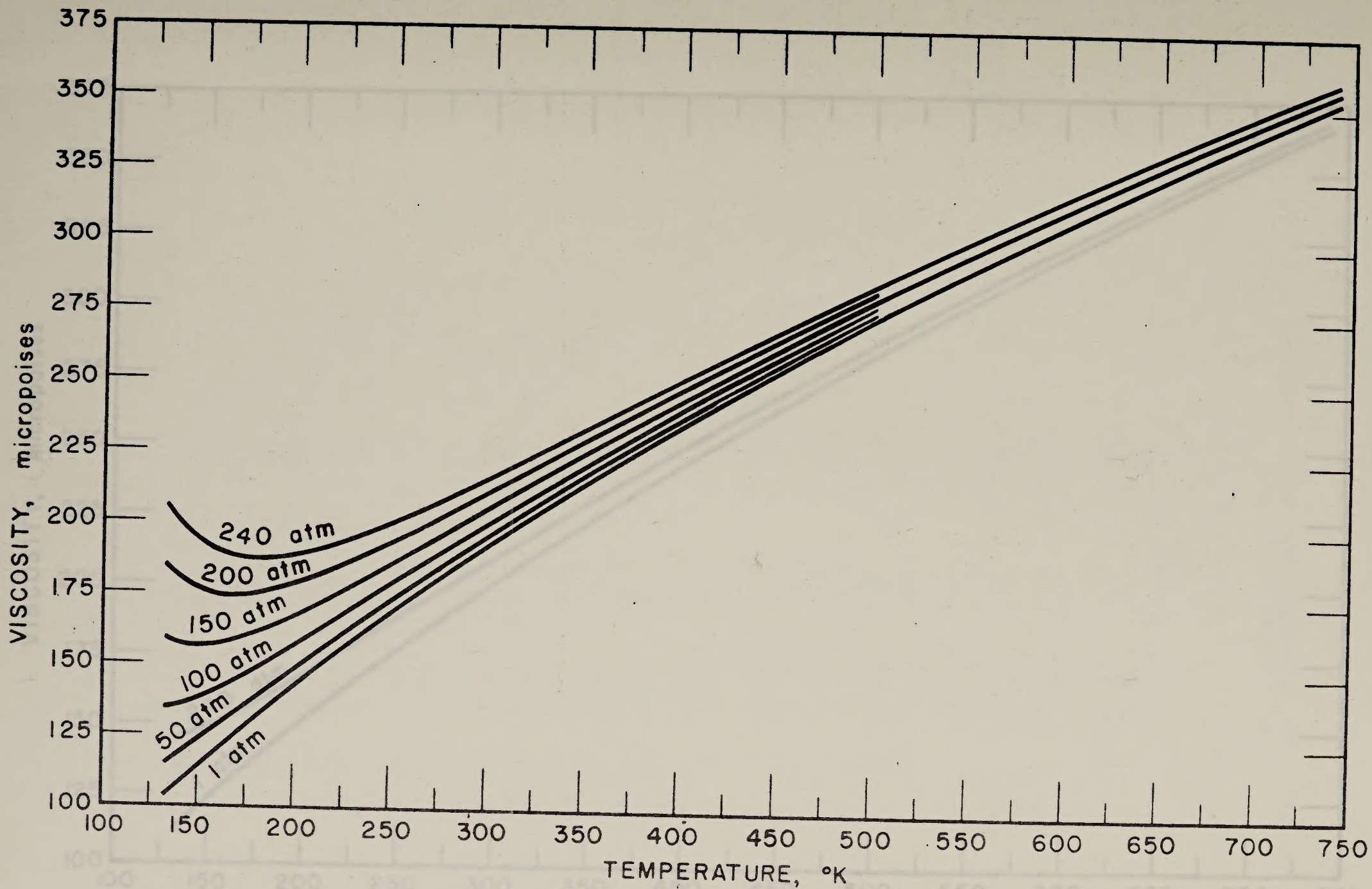


FIGURE 9. - Viscosity of a 0.5000 Helium - 0.5000 Nitrogen Mixture.

FIGURE 10. - Viscosity of a 0.9000 Helium - 0.2000 Nitrogen Mixture.





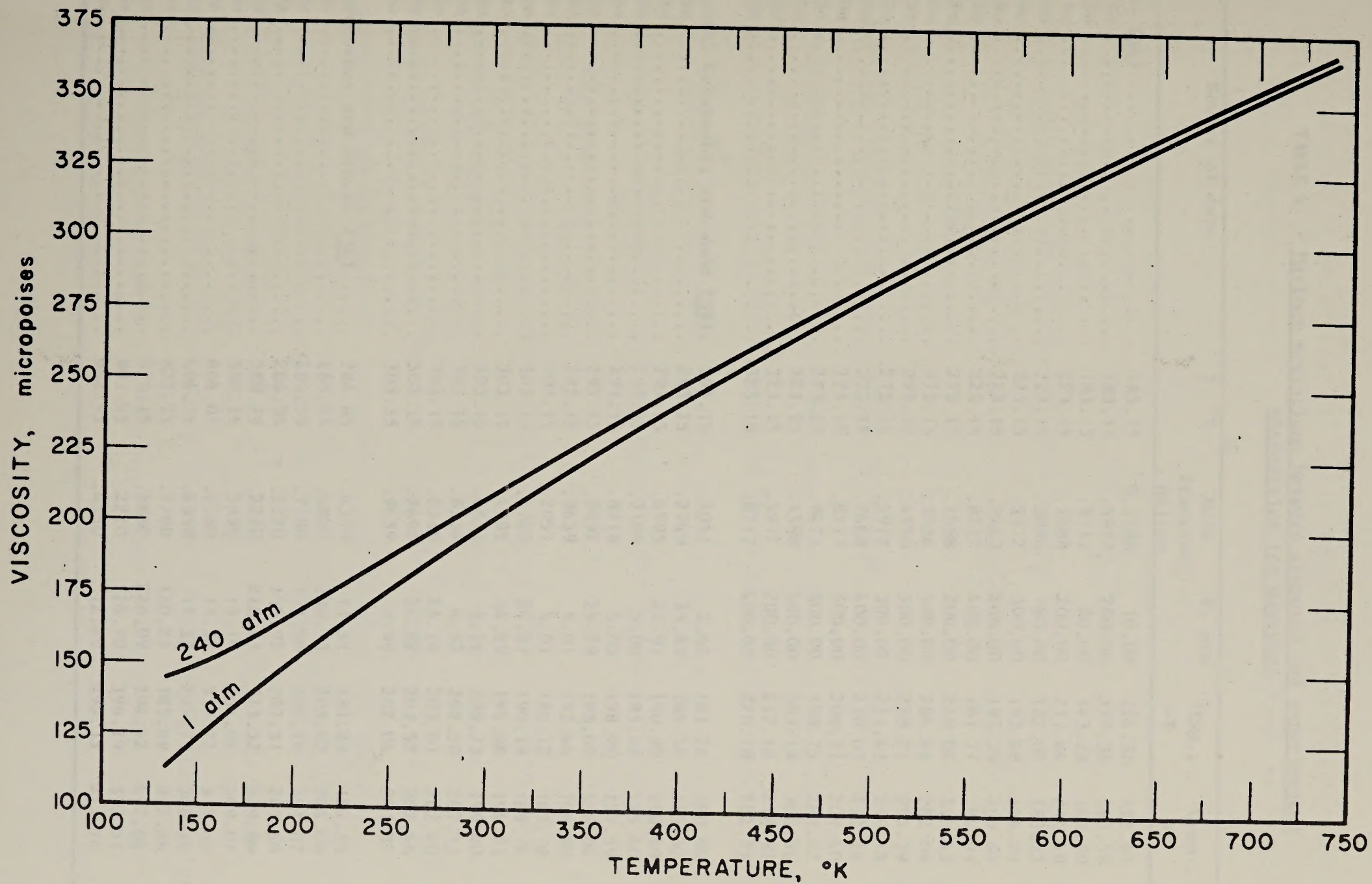


FIGURE 10. - Viscosity of a 0.8000 Helium - 0.2000 Nitrogen Mixture.



TABLE 4. - Maximum deviations between computed and experimental viscosities for mixtures

Source of data	T, °K	Mole fraction, helium	P, atm	$\eta_{Exp.}$ , $\mu P$	$\eta_{Comp.}$ , $\mu P$	Deviation, percent
Kao (34)	183.15	0.1588	10.00	124.30	125.65	-1.07
Do	183.15	.5972	200.00	170.36	167.58	1.65
Do	183.15	.8717	20.00	143.28	143.70	-.29
Do	223.15	.1588	200.00	211.64	214.49	-1.32
Do	223.15	.3036	80.00	162.05	163.72	-1.02
Do	223.15	.5972	300.00	193.68	196.21	-1.29
Do	223.15	.7460	400.00	193.79	196.66	-1.46
Do	223.15	.8717	400.00	181.71	184.95	-1.75
Do	273.15	.1588	200.00	219.04	216.43	1.20
Do	273.15	.3036	500.00	284.44	282.09	.83
Do	273.15	.4550	500.00	258.25	255.79	.96
Do	273.15	.5972	300.00	211.43	210.78	.30
Do	273.15	.7460	400.00	210.07	212.15	-.98
Do	273.15	.8717	500.00	206.31	209.40	-1.47
Do	273.15	.9475	500.00	198.75	201.22	-1.23
Do	323.15	.1588	500.00	303.19	300.56	.87
Do	323.15	.5972	200.00	217.18	218.92	-.79
Do	323.15	.8717	400.00	220.18	222.71	-1.13
Kestin, Kobayashi, and Wood (39)	293.15	.2051	2.44	181.20	180.94	.14
Do	293.15	.2749	25.49	185.56	185.32	.12
Do	293.15	.4995	22.91	190.90	190.69	.10
Do	293.15	.7100	5.00	195.62	195.40	.11
Do	293.15	.8318	5.03	198.00	197.59	.20
Do	293.15	.8692	25.29	198.60	198.04	.28
Do	293.15	.9639	5.01	197.44	196.88	.28
Do	303.15	.2051	5.01	186.12	185.78	.17
Do	303.15	.2749	24.87	190.19	189.74	.23
Do	303.15	.4995	14.69	195.08	194.71	.18
Do	303.15	.6871	4.16	199.73	199.40	.16
Do	303.15	.8314	4.52	202.50	202.13	.18
Do	303.15	.8318	25.16	203.01	202.40	.29
Do	303.15	.8692	24.82	203.52	202.56	.47
Do	303.15	.9639	4.99	202.06	201.37	.34
Makavetskas and others (54)	284.65	.4350	11.32	181.33	184.15	-1.53
Do	285.55	.5880	200.73	202.02	204.49	-1.20
Do	285.55	.7780	193.96	204.76	201.07	1.83
Do	286.95	.2220	155.92	207.31	205.60	.83
Do	588.75	.2220	218.93	313.32	309.86	1.11
Do	590.15	.5880	15.10	301.06	309.01	-2.57
Do	604.05	.7780	11.32	313.72	319.66	-1.86
Do	604.75	.4350	11.32	295.77	308.14	-4.01
Do	822.75	.7780	120.21	385.89	392.36	-1.65
Do	873.15	.5880	226.09	394.42	402.04	-1.89
Do	901.55	.2220	174.70	396.29	393.31	.75
Do	952.55	.4350	12.49	394.33	411.70	-4.21



temperature upon the isobaric viscosity coefficients of three mixtures.

The composition dependency of the viscosity of helium-nitrogen mixtures along isobars at  $133^{\circ}$ ,  $300^{\circ}$ , and  $740^{\circ}$  K is shown in figures 11, 12, and 13.

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Figure 11. - Viscosity of the Helium-Nitrogen System at  $133^{\circ}$  K.

Figure 12. - Viscosity of the Helium-Nitrogen System at  $300^{\circ}$  K.

Figure 13. - Viscosity of the Helium-Nitrogen System at  $740^{\circ}$  K.

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#### COMPUTER PROGRAM FOR CALCULATING VISCOSITY COEFFICIENT TABLES

Viscosity coefficients for helium, nitrogen, and 13 helium-nitrogen mixtures are presented in tables 5-19 for 110 temperatures in the region  $133^{\circ}$  to  $740^{\circ}$  K, and for 49 pressures from 1 to 240 atmospheres at increments of 5 atmospheres for pressures greater than 5 atmospheres.

Computing thermal pressure coefficients from the Leiden form of the virial equation of state is a laborious task because of the iteration methods required for solution. The computed viscosities are presented at temperature, pressure, and composition intervals in tables 5-19 to facilitate simple interpolation and should be adequate for most problems involving viscosity coefficients. However, for extensive heat transfer or pressure drop calculations, it is not always profitable to look up values from tables; it may be more expedient to solve certain problems with a digital computer.



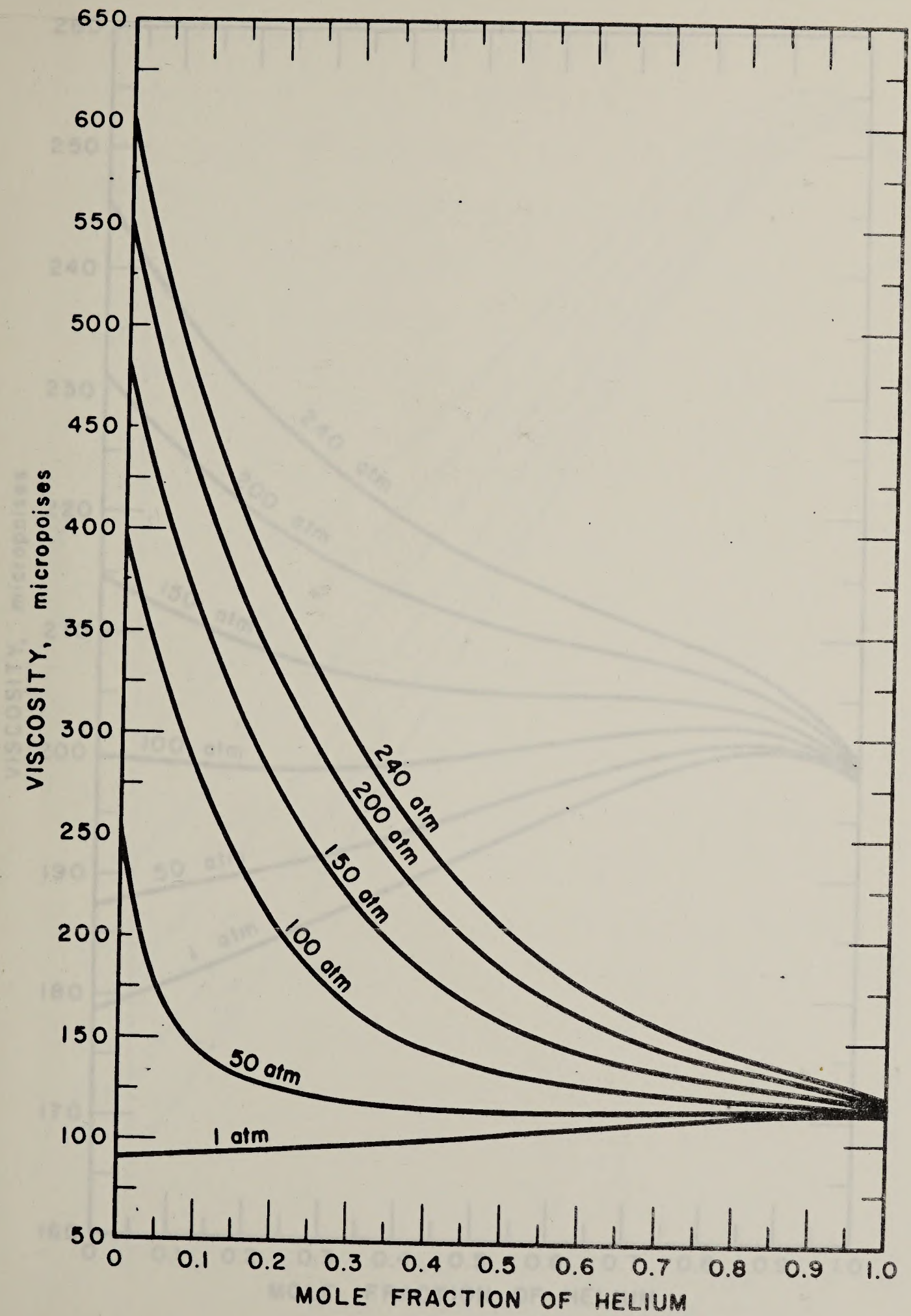


FIGURE II. - Viscosity of the Helium-Nitrogen System at 133° K.





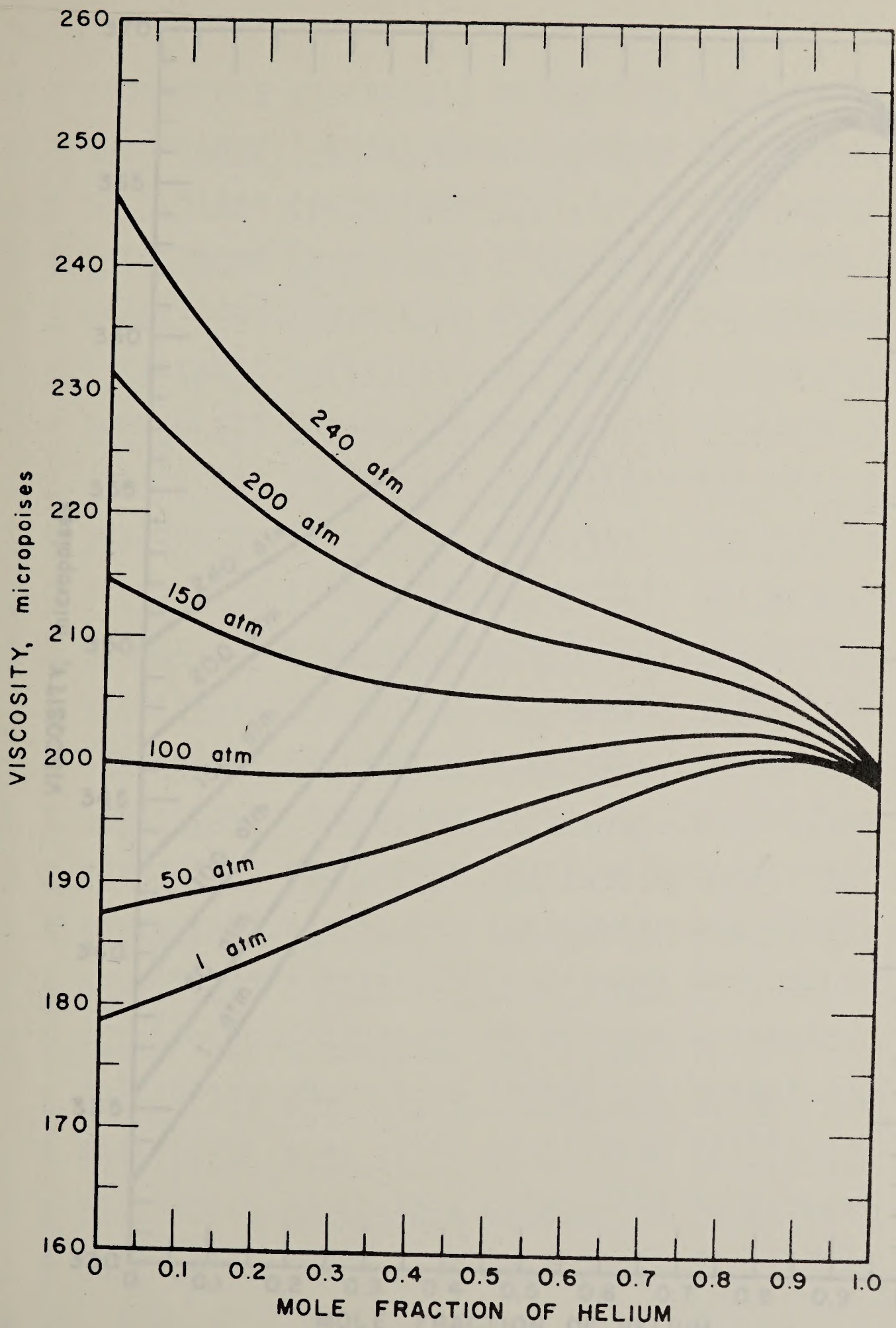


FIGURE 12. - Viscosity of the Helium-Nitrogen System at 300° K.



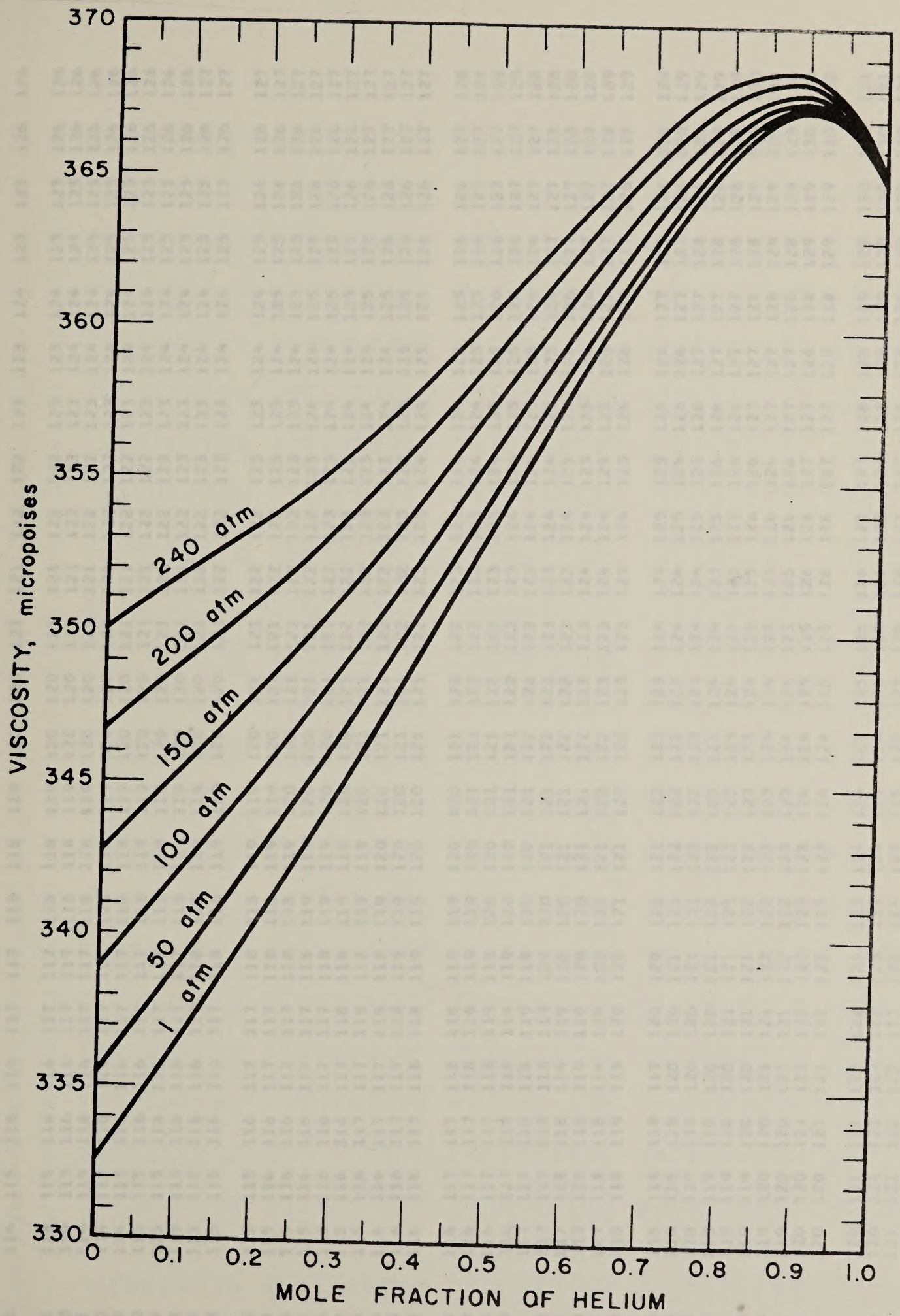


FIGURE 13. - Viscosity of the Helium-Nitrogen System at 740° K.



































TABLE 6. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

		MOLE FRACTION OF HELIUM 0.9500																					
T, DEG K		200	205	210	215	220	225	230	235	240	245	250	255	260	265	270	275	280	285	290	295	300	305
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	152	154	157	159	162	164	167	169	172	174	177	179	181	184	186	188	191	193	195	198	200	202	
5	152	154	157	159	162	164	167	169	172	174	177	179	181	184	186	188	191	193	195	198	200	202	
10	152	154	157	160	162	165	167	169	172	174	177	179	181	184	186	188	191	193	195	198	200	202	
15	152	154	157	160	162	165	167	169	172	174	177	179	181	184	186	188	191	193	195	198	200	202	
20	152	155	157	160	162	165	167	169	172	174	177	179	181	184	186	188	191	193	195	198	200	202	
25	152	155	157	160	162	165	167	170	172	174	177	179	181	184	186	188	191	193	195	198	200	202	
30	152	155	157	160	162	165	167	170	172	174	177	179	182	184	186	189	191	193	195	198	200	202	
35	152	155	157	160	162	165	167	170	172	174	177	179	182	184	186	189	191	193	195	198	200	202	
40	152	155	157	160	162	165	167	170	172	174	177	179	182	184	186	189	191	193	195	198	200	202	
45	152	155	157	160	162	165	167	170	172	175	177	179	182	184	186	189	191	193	195	198	200	202	
50	152	155	157	160	162	165	167	170	172	175	177	179	182	184	186	189	191	193	196	198	200	202	
55	152	155	157	160	162	165	167	170	172	175	177	179	182	184	186	189	191	193	196	198	200	202	
60	152	155	158	160	163	165	167	170	172	175	177	179	182	184	186	189	191	193	196	198	200	202	
65	153	155	158	160	163	165	168	170	172	175	177	179	182	184	187	189	191	193	196	198	200	202	
70	153	155	158	160	163	165	168	170	172	175	177	180	182	184	187	189	191	193	196	198	200	202	
75	153	155	158	160	163	165	168	170	172	175	177	180	182	184	187	189	191	193	196	198	200	202	
80	153	155	158	160	163	165	168	170	173	175	177	180	182	184	187	189	191	194	196	198	200	203	
85	153	155	158	160	163	165	168	170	173	175	177	180	182	184	187	189	191	194	196	198	200	203	
90	153	156	158	161	163	165	168	170	173	175	177	180	182	185	187	189	191	194	196	198	200	203	
95	153	156	158	161	163	166	168	170	173	175	178	180	182	185	187	189	191	194	196	198	200	203	
100	153	156	158	161	163	166	168	171	173	175	178	180	182	185	187	189	192	194	196	198	201	203	
105	153	156	158	161	163	166	168	171	173	175	178	180	182	185	187	189	192	194	196	198	201	203	
110	154	156	159	161	163	166	168	171	173	175	178	180	182	185	187	189	192	194	196	198	201	203	
115	154	156	159	161	164	166	168	171	173	176	178	180	183	185	187	189	192	194	196	198	201	203	
120	154	156	159	161	164	166	169	171	173	176	178	180	183	185	187	190	192	194	196	199	201	203	
125	154	156	159	161	164	166	169	171	173	176	178	180	183	185	187	190	192	194	196	199	201	203	
130	154	157	159	162	164	166	169	171	174	176	178	181	183	185	187	190	192	194	196	199	201	203	
135	154	157	159	162	164	166	169	171	174	176	178	181	183	185	188	190	192	194	197	199	201	203	
140	154	157	159	162	164	167	169	171	174	176	178	181	183	185	188	190	192	194	197	199	201	203	
145	155	157	159	162	164	167	169	171	174	176	179	181	183	185	188	190	192	194	197	199	201	203	
150	155	157	160	162	164	167	169	172	174	176	179	181	183	186	188	190	192	195	197	199	201	203	
155	155	157	160	162	165	167	169	172	174	176	179	181	183	186	188	190	192	195	197	199	201	204	
160	155	158	160	162	165	167	170	172	174	177	179	181	183	186	188	190	193	195	197	199	201	204	
165	155	158	160	163	165	167	170	172	174	177	179	181	184	186	188	190	193	195	197	199	201	204	
170	155	158	160	163	165	167	170	172	174	177	179	181	184	186	188	190	193	195	197	199	202	204	
175	156	158	160	163	165	168	170	172	175	177	179	182	184	186	188	191	193	195	197	199	202	204	
180	156	158	161	163	165	168	170	172	175	177	179	182	184	186	188	191	193	195	197	200	202	204	
185	156	158	161	163	166	168	170	173	175	177	179	182	184	186	189	191	193	195	197	200	202	204	
190	156	159	161	163	166	168	170	173	175	177	180	182	184	186	189	191	193	195	198	200	202	204	
195	156	159	161	164	166	168	171	173	175	177	180	182	184	187	189	191	193	195	198	200	202	204	
200	157	159	161	164	166	168	171	173	175	178	180	182	184	187	189	191	193	196	198	200	202	204	
205	157	159	162	164	166	169	171	173	175	178	180	182	185	187	189	191	193	196	198	200	202	204	
210	157	159	162	164	166	169	171	173	176	178	180	182	185	187	189	191	194	196	198	200	202	205	
215	157	160	162	164	167	169	171	173	176	178	180	183	185	187	189	191	194	196	198	200	202	205	
220	157	160	162	164	167	169	171	174	176	178	180	183	185	187	189	192	194	196	198	200	203	205	
225	158	160	162	165	167	169	171	174	176	178	181	183	185	187	190	192	194	196	198	200	203	205	
230	158	160	162	165	167	169	172	174	176	178	181	183	185	187	190	192	194	196	198	201	203	205	
235	158	160	163	165	167	170	172	174	176	179	181	183	185	188	190	192	194	196	199	201	203	205	
240	158	161	163	165	167	170	172	174	177	179	181	183	185	188	190	192	194	196	199	201	203	205	













TABLE 7. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICRORPOISES

		MOLE FRACTION OF HELIUM 0.9000																					
T, DEG K		133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	115	115	116	116	117	118	118	119	119	120	121	121	122	122	123	123	124	125	125	126	126	127	
5	115	115	116	116	117	118	118	119	119	120	121	121	122	122	123	123	124	125	125	126	126	127	
10	115	115	116	116	117	118	118	119	119	120	121	121	122	122	123	124	124	125	125	126	126	127	
15	115	115	116	117	117	118	118	119	120	120	121	121	122	122	123	124	124	125	125	126	126	127	
20	115	115	116	117	117	118	118	119	120	120	121	121	122	122	123	124	124	125	125	126	126	127	
25	115	116	116	117	117	118	119	119	120	120	121	122	122	123	123	124	124	125	125	126	126	127	
30	115	116	116	117	118	118	119	119	120	121	121	122	122	123	123	124	125	125	126	126	126	127	
35	115	116	117	117	118	118	119	120	120	121	121	122	122	123	124	124	125	125	126	126	126	127	
40	116	116	117	117	118	119	119	120	120	121	121	122	123	123	124	124	125	126	126	126	127	128	
45	116	116	117	118	118	119	119	120	120	121	121	122	123	123	124	124	125	126	126	126	127	128	
50	116	117	117	118	118	119	120	120	121	121	122	122	123	124	124	125	125	126	126	127	127	128	
55	116	117	118	118	119	119	120	120	121	122	122	123	123	124	124	125	126	126	127	127	128	128	
60	117	117	118	118	119	120	120	121	121	122	122	123	124	124	125	125	126	126	127	127	128	129	
65	117	117	118	119	119	120	120	121	121	122	123	123	124	124	125	125	126	127	127	128	128	129	
70	117	118	118	119	119	120	121	121	122	122	123	123	124	124	125	125	126	126	127	127	128	129	
75	118	118	119	119	120	120	121	121	122	123	123	124	124	125	125	126	126	127	127	128	128	129	
80	118	118	119	120	120	121	121	122	122	123	123	124	124	125	125	126	126	127	127	128	128	129	
85	118	119	119	120	120	121	122	122	123	123	124	124	125	125	126	126	127	127	128	128	129	130	
90	119	119	120	120	121	121	122	122	123	124	124	125	125	126	126	127	127	128	128	129	129	130	
95	119	119	120	121	121	122	122	123	123	124	124	125	125	126	126	127	127	128	128	129	130	130	
100	119	120	120	121	121	122	123	123	124	124	125	125	126	126	127	127	128	128	129	129	130	130	
105	120	120	121	121	122	122	123	123	124	125	125	126	126	127	127	128	128	129	129	130	130	131	
110	120	121	121	122	122	123	123	124	124	125	125	126	126	127	127	128	128	129	129	130	130	131	
115	120	121	122	122	123	123	124	124	125	125	126	126	127	127	128	128	129	129	130	131	131	132	
120	121	121	122	122	123	124	124	125	125	126	126	127	127	128	128	129	129	130	130	131	131	132	
125	121	122	122	123	123	124	124	125	125	126	126	127	127	128	128	129	129	130	130	131	131	132	
130	122	122	123	123	124	124	125	125	126	126	127	127	128	128	129	129	130	130	131	131	132	132	
135	122	123	123	124	124	125	125	126	126	127	127	128	128	129	129	130	130	131	131	132	132	133	
140	123	123	124	124	125	125	126	126	127	127	128	128	129	129	130	130	131	131	132	132	133	133	
145	123	124	124	125	125	126	126	127	127	128	128	129	129	130	130	131	131	132	132	133	133	134	
150	124	124	125	125	126	126	127	127	128	128	129	129	130	130	131	131	132	132	133	133	133	134	
155	124	125	125	126	126	127	127	128	128	128	129	129	130	130	131	131	132	132	133	133	134	134	
160	125	125	126	126	127	127	127	128	128	129	129	130	130	131	131	132	132	133	133	134	134	135	
165	125	126	126	127	127	127	128	128	129	129	130	130	131	131	132	132	133	133	134	134	135	135	
170	126	126	127	127	127	128	128	129	129	130	130	131	131	132	132	133	133	134	134	135	135	136	
175	126	127	127	128	128	128	129	129	130	130	131	131	132	132	133	133	134	134	135	135	135	136	
180	127	127	128	128	128	129	129	130	130	131	131	132	132	133	133	134	134	135	135	135	136	136	
185	127	128	128	129	129	129	130	130	131	131	132	132	133	133	134	134	135	135	135	136	136	136	
190	128	128	129	129	130	130	130	131	131	132	132	133	133	134	134	134	135	135	136	136	137	137	
195	128	129	129	130	130	130	131	131	132	132	133	133	134	134	134	135	135	136	136	137	137	138	
200	129	129	130	130	131	131	131	132	132	133	133	134	134	135	135	135	136	136	137	137	138	138	
205	129	130	130	131	131	132	132	132	133	133	134	134	135	135	135	136	136	137	137	138	138	139	
210	130	130	131	131	132	132	133	133	133	134	134	135	135	135	136	136	137	137	138	138	139	139	
215	131	131	131	132	132	133	133	133	134	134	135	135	136	136	136	137	137	138	138	139	139	139	
220	131	132	132	132	133	133	134	134	134	135	135	136	136	136	137	137	138	138	139	139	139	139	
225	132	132	133	133	133	134	134	135	135	135	136	136	137	137	137	138	138	139	139	139	139	140	
230	132	133	133	134	134	134	135	135	136	136	136	137	137	137	138	138	139	139	140	140	140	140	
235	133	133	134	134	135	135	135	136	136	136	137	137	138	138	138	139	139	140	140	140	140	141	
240	134	134	134	135	135	136	136	136	137	137	137	138	138	139	139	139	140	140	141	141	141	141	



TABLE 7. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

		MOLE FRACTION OF HELIUM 0.9000																				
T, DEG K	156	158	160	162	164	166	168	170	172	174	176	178	180	182	184	186	188	190	192	194	196	198
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	128	129	130	131	133	134	135	136	137	138	139	140	141	143	144	145	146	147	148	149	150	151
5	128	129	130	131	133	134	135	136	137	138	139	140	141	143	144	145	146	147	148	149	150	151
10	128	129	130	132	133	134	135	136	137	138	139	140	141	143	144	145	146	147	148	149	150	151
15	128	129	131	132	133	134	135	136	137	138	139	140	141	143	144	145	146	147	148	149	150	151
20	128	129	131	132	133	134	135	136	137	138	139	141	142	143	144	145	146	147	148	149	150	151
25	128	130	131	132	133	134	135	136	137	138	140	141	142	143	144	145	146	147	148	149	150	151
30	129	130	131	132	133	134	135	136	138	139	140	141	142	143	144	145	146	147	148	149	150	151
35	129	130	131	132	133	134	135	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151
40	129	130	131	132	133	134	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151
45	129	130	131	132	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	150	151	152
50	129	130	131	133	134	135	136	137	138	139	140	141	142	143	144	145	146	148	149	150	151	152
55	129	131	132	133	134	135	136	137	138	139	140	141	143	144	145	146	147	148	149	150	151	152
60	130	131	132	133	134	135	136	137	138	139	141	142	143	144	145	146	147	148	149	150	151	152
65	130	131	132	133	134	135	136	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152
70	130	131	132	133	134	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152
75	130	131	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152
80	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	151	152	153
85	131	132	133	134	135	136	137	138	139	140	142	143	144	145	146	147	148	149	150	151	152	153
90	131	132	133	134	135	136	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153
95	131	132	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153
100	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153
105	132	133	134	135	136	137	138	139	140	141	142	143	145	146	147	148	149	150	151	152	153	154
110	132	133	134	135	136	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154
115	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154
120	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154
125	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154
130	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155
135	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155
140	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155
145	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	155
150	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	152	153	154	155
155	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156
160	136	137	138	139	140	141	142	143	144	145	146	146	147	148	149	150	151	152	153	154	155	156
165	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	155	156
170	137	137	138	139	140	141	142	143	144	145	146	146	147	148	149	150	151	152	153	154	155	156
175	137	138	139	140	141	142	143	144	145	146	146	147	148	149	150	151	152	153	154	155	156	157
180	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	152	153	154	155	156	157
185	138	139	140	141	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	157
190	138	139	140	141	142	143	144	145	146	147	147	148	149	150	151	152	153	154	155	156	157	157
195	139	139	140	141	142	143	144	145	146	147	147	148	149	150	151	152	153	154	155	156	157	158
200	139	140	141	142	143	144	144	145	146	147	148	149	150	151	152	152	153	154	155	156	157	158
205	139	140	141	142	143	144	145	146	147	148	149	149	150	151	152	153	154	155	156	157	158	159
210	140	141	142	143	143	144	145	146	147	148	149	150	151	152	153	153	154	155	156	157	158	159
215	140	141	142	143	144	145	146	147	147	148	149	150	151	152	153	154	155	156	157	158	159	159
220	141	142	143	143	144	145	146	147	148	149	150	150	151	152	153	154	155	156	157	158	159	160
225	141	142	143	144	145	146	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	160
230	142	143	143	144	145	146	147	148	149	149	150	151	152	153	154	155	156	157	158	159	160	160
235	142	143	144	145	146	146	147	148	149	150	151	152	152	153	154	155	156	157	158	159	160	160
240	143	143	144	145	146	147	148	149	149	150	151	152	153	154	155	155	156	157	158	159	160	161



TABLE 7. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

		MOLE FRACTION OF HELIUM 0.9000																					
T, DEG K		200	205	210	215	220	225	230	235	240	245	250	255	260	265	270	275	280	285	290	295	300	305
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	152	155	157	160	162	165	167	170	172	175	177	180	182	184	187	189	191	194	196	198	200	203	
5	152	155	157	160	162	165	167	170	172	175	177	180	182	184	187	189	191	194	196	198	200	203	
10	152	155	157	160	162	165	167	170	172	175	177	180	182	184	187	189	191	194	196	198	200	203	
15	152	155	157	160	162	165	167	170	172	175	177	180	182	184	187	189	191	194	196	198	200	203	
20	152	155	157	160	162	165	167	170	172	175	177	180	182	184	187	189	191	194	196	198	200	203	
25	152	155	157	160	163	165	168	170	172	175	177	180	182	184	187	189	191	194	196	198	201	203	
30	152	155	158	160	163	165	168	170	173	175	177	180	182	185	187	189	191	194	196	198	201	203	
35	153	155	158	160	163	165	168	170	173	175	177	180	182	185	187	189	192	194	196	198	201	203	
40	153	155	158	160	163	165	168	170	173	175	178	180	182	185	187	189	192	194	196	198	201	203	
45	153	155	158	160	163	165	168	170	173	175	178	180	182	185	187	189	192	194	196	198	201	203	
50	153	155	158	161	163	166	168	170	173	175	178	180	182	185	187	189	192	194	196	199	201	203	
55	153	156	158	161	163	166	168	171	173	175	178	180	183	185	187	190	192	194	196	199	201	203	
60	153	156	158	161	163	166	168	171	173	175	178	180	183	185	187	190	192	194	196	199	201	203	
65	153	156	158	161	163	166	168	171	173	176	178	180	183	185	187	190	192	194	197	199	201	203	
70	153	156	159	161	164	166	168	171	173	176	178	180	183	185	187	190	192	194	197	199	201	203	
75	154	156	159	161	164	166	169	171	173	176	178	181	183	185	188	190	192	194	197	199	201	203	
80	154	156	159	161	164	166	169	171	174	176	178	181	183	185	188	190	192	195	197	199	201	204	
85	154	156	159	161	164	166	169	171	174	176	178	181	183	185	188	190	192	195	197	199	201	204	
90	154	157	159	162	164	167	169	171	174	176	179	181	183	186	188	190	192	195	197	199	201	204	
95	154	157	159	162	164	167	169	172	174	176	179	181	183	186	188	190	193	195	197	199	202	204	
100	154	157	159	162	164	167	169	172	174	176	179	181	183	186	188	190	193	195	197	199	202	204	
105	155	157	160	162	165	167	169	172	174	177	179	181	184	186	188	191	193	195	197	200	202	204	
110	155	157	160	162	165	167	170	172	174	177	179	181	184	186	188	191	193	195	197	200	202	204	
115	155	158	160	162	165	167	170	172	174	177	179	182	184	186	188	191	193	195	198	200	202	204	
120	155	158	160	163	165	167	170	172	175	177	179	182	184	186	189	191	193	195	198	200	202	204	
125	155	158	160	163	165	168	170	172	175	177	180	182	184	186	189	191	193	196	198	200	202	204	
130	156	158	161	163	165	168	170	173	175	177	180	182	184	187	189	191	193	196	198	200	202	205	
135	156	158	161	163	166	168	170	173	175	177	180	182	184	187	189	191	194	196	198	200	202	205	
140	156	159	161	163	166	168	171	173	175	178	180	182	185	187	189	191	194	196	198	200	203	205	
145	156	159	161	164	166	168	171	173	175	178	180	182	185	187	189	192	194	196	198	200	203	205	
150	157	159	161	164	166	169	171	173	176	178	180	183	185	187	189	192	194	196	198	201	203	205	
155	157	159	162	164	166	169	171	174	176	178	180	183	185	187	190	192	194	196	199	201	203	205	
160	157	160	162	164	167	169	171	174	176	178	181	183	185	187	190	192	194	196	199	201	203	205	
165	157	160	162	165	167	169	172	174	176	179	181	183	185	188	190	192	194	197	199	201	203	205	
170	158	160	162	165	167	169	172	174	176	179	181	183	186	188	190	192	194	197	199	201	203	205	
175	158	160	163	165	167	170	172	174	177	179	181	183	186	188	190	192	194	197	199	201	203	205	
180	158	161	163	165	168	170	172	174	177	179	181	184	186	188	190	193	195	197	199	201	204	206	
185	158	161	163	165	168	170	172	175	177	179	182	184	186	188	191	193	195	197	199	202	204	206	
190	159	161	163	166	168	170	173	175	177	179	182	184	186	188	191	193	195	197	199	202	204	206	
195	159	161	164	166	168	171	173	175	177	180	182	184	186	189	191	193	195	197	200	202	204	206	
200	159	162	164	166	168	171	173	175	178	180	182	184	187	189	191	193	195	198	200	202	204	206	
205	160	162	164	166	169	171	173	176	178	180	182	185	187	189	191	193	196	198	200	202	204	206	
210	160	162	164	167	169	171	174	176	178	180	182	185	187	189	191	194	196	198	200	202	204	207	
215	160	162	165	167	169	171	174	176	178	180	183	185	187	189	192	194	196	198	200	202	205	207	
220	160	163	165	167	169	172	174	176	178	181	183	185	187	190	192	194	196	198	200	203	205	207	
225	161	163	165	167	170	172	174	176	179	181	183	185	188	190	192	194	196	198	201	203	205	207	
230	161	163	166	168	170	172	174	177	179	181	183	186	188	190	192	194	196	199	201	203	205	207	
235	161	164	166	168	170	172	175	177	179	181	184	186	188	190	192	194	197	199	201	203	205	207	
240	162	164	166	168	171	173	175	177	179	182	184	186	188	190	192	195	197	199	201	203	205	207	













TABLE 8. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROROISES

MOLE FRACTION OF HELIUM 0.8000

T, DEG K	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	113	113	114	114	115	116	116	117	117	118	119	119	120	120	121	122	122	123	123	124	125	125
5	113	113	114	115	115	116	116	117	118	118	119	119	120	121	121	122	122	123	124	124	125	125
10	113	113	114	115	115	116	117	117	118	118	119	120	120	121	121	122	123	123	124	124	125	125
15	113	114	114	115	116	116	117	117	118	119	119	120	120	121	121	122	123	123	124	124	125	125
20	113	114	115	115	116	116	117	118	118	119	119	120	121	121	122	122	123	124	124	125	125	126
25	114	114	115	116	116	117	117	118	119	119	120	120	121	122	122	123	123	124	124	125	125	126
30	114	115	115	116	116	117	118	118	119	119	120	121	121	122	122	123	124	124	125	125	126	126
35	114	115	116	116	117	117	118	119	119	120	121	121	122	122	123	124	124	125	125	126	126	126
40	115	115	116	117	117	118	118	119	120	120	121	121	122	122	123	123	124	124	125	126	126	127
45	115	116	117	117	118	118	119	119	120	121	121	122	122	123	123	124	124	125	125	126	127	127
50	116	116	117	118	118	119	119	120	120	121	122	122	123	123	124	124	125	125	126	126	127	127
55	116	117	117	118	119	119	120	120	121	121	122	123	123	124	124	125	125	126	127	127	128	128
60	117	117	118	118	119	120	120	121	121	122	122	123	123	124	124	125	126	126	127	127	128	129
65	117	118	118	119	120	120	121	121	122	122	123	123	124	124	125	125	126	126	127	127	128	129
70	118	118	119	120	120	121	121	122	122	123	123	124	124	125	125	126	126	127	127	128	128	129
75	118	119	120	120	121	121	122	122	123	123	124	124	125	125	126	126	127	127	128	128	129	129
80	119	120	120	121	121	122	122	123	123	124	124	125	125	126	127	127	128	128	129	129	130	130
85	120	120	121	121	122	122	123	123	124	124	125	125	126	127	127	128	128	129	129	130	130	131
90	120	121	121	122	122	123	123	124	124	125	125	126	127	127	128	128	129	129	130	130	131	131
95	121	121	122	122	123	123	124	124	125	126	126	127	127	128	128	129	129	130	130	131	131	131
100	121	122	123	123	124	124	125	125	126	126	127	127	128	128	129	129	130	130	131	131	132	132
105	122	123	123	124	124	125	125	126	126	127	127	128	128	129	129	130	130	131	131	132	132	133
110	123	123	124	124	125	125	126	126	127	127	128	128	129	129	130	130	131	131	132	132	133	133
115	124	124	124	125	125	126	126	127	127	128	128	129	129	130	130	131	131	132	132	133	133	134
120	124	125	125	126	126	127	127	128	128	129	129	130	130	131	131	132	132	133	133	134	134	134
125	125	125	126	126	127	127	128	128	129	129	130	130	131	131	132	132	133	133	134	134	135	135
130	126	126	127	127	128	128	128	129	129	130	130	131	131	132	132	133	133	134	134	135	135	136
135	126	127	127	128	128	129	129	130	130	131	131	132	132	133	133	134	134	135	135	136	136	136
140	127	128	128	128	129	129	130	130	131	131	132	132	133	133	133	134	134	135	135	136	136	137
145	128	128	129	129	130	130	131	131	131	132	132	133	133	134	134	135	135	135	136	136	137	137
150	129	129	130	130	130	131	131	132	132	133	133	133	134	134	135	135	136	136	137	137	137	138
155	130	130	130	131	131	132	132	132	133	133	134	134	135	135	135	136	136	137	137	138	138	138
160	130	131	131	132	132	132	133	133	134	134	134	135	135	136	136	137	137	137	138	138	139	139
165	131	132	132	132	133	133	133	134	134	135	135	136	136	137	137	137	138	138	139	139	140	140
170	132	132	133	133	133	134	134	135	135	135	136	136	137	137	137	138	138	139	139	140	140	140
175	133	133	134	134	134	135	135	135	136	136	137	137	137	138	138	139	139	139	140	140	141	141
180	134	134	134	135	135	135	136	136	137	137	137	138	138	138	139	139	140	140	140	141	141	142
185	134	135	135	136	136	136	137	137	137	138	138	138	139	139	140	140	140	141	141	142	142	142
190	135	136	136	136	137	137	137	138	138	138	139	139	139	140	140	140	141	141	142	142	143	143
195	136	137	137	137	138	138	138	139	139	139	140	140	140	141	141	141	142	142	143	143	143	144
200	137	137	138	138	138	139	139	139	140	140	140	141	141	141	142	142	143	143	144	144	144	144
205	138	138	139	139	139	140	140	140	140	141	141	141	142	142	143	143	143	144	144	144	145	145
210	139	139	139	140	140	140	141	141	141	142	142	142	143	143	143	144	144	144	145	145	145	146
215	140	140	140	141	141	141	142	142	142	142	143	143	143	144	144	144	145	145	145	146	146	146
220	141	141	141	141	142	142	142	143	143	143	144	144	144	145	145	145	146	146	147	147	147	147
225	142	142	142	142	143	143	143	143	144	144	144	145	145	145	146	146	146	147	147	147	148	148
230	143	143	143	143	144	144	144	144	145	145	145	145	146	146	146	147	147	147	148	148	148	149
235	143	144	144	144	144	145	145	145	145	146	146	146	147	147	147	147	148	148	148	149	149	149
240	144	145	145	145	145	146	146	146	146	147	147	147	147	148	148	148	149	149	149	150	150	150



TABLE 8. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICRPOISES

		MOLE FRACTION OF HELIUM 0.8000																					
T, DEG K	156	158	160	162	164	166	168	170	172	174	176	178	180	182	184	186	188	190	192	194	196	198	
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	
1	126	128	129	130	131	132	133	134	136	137	138	139	140	141	142	143	144	145	147	148	149	150	
5	126	128	129	130	131	132	133	134	136	137	138	139	140	141	142	143	144	146	147	148	149	150	
10	127	128	129	130	131	132	134	135	136	137	138	139	140	141	142	143	145	146	147	148	149	150	
15	127	128	129	130	131	133	134	135	136	137	138	139	140	141	143	144	145	146	147	148	149	150	
20	127	128	129	130	132	133	134	135	136	137	138	139	141	142	143	144	145	146	147	148	149	150	
25	127	128	130	131	132	133	134	135	136	137	139	140	141	142	143	144	145	146	147	148	149	150	
30	128	129	130	131	132	133	134	135	137	138	139	140	141	142	143	144	145	146	147	149	150	151	
35	128	129	130	131	132	134	135	136	137	138	139	140	141	142	143	144	146	147	148	149	150	151	
40	128	129	130	132	133	134	135	136	137	138	139	140	141	142	143	144	146	147	148	149	150	151	
45	129	130	131	132	133	134	135	136	137	139	140	141	142	143	144	145	146	147	148	149	150	151	
50	129	130	131	132	133	134	136	137	138	139	140	141	142	143	144	145	146	147	148	149	151	152	
55	129	130	132	133	134	135	136	137	138	139	140	141	142	143	144	146	147	148	149	150	151	152	
60	130	131	132	133	134	135	136	137	138	139	141	142	143	144	145	146	147	148	149	150	151	152	
65	130	131	132	133	134	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	
70	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	149	150	151	152	153	
75	131	132	133	134	135	136	137	138	139	141	142	143	144	145	146	147	148	149	150	151	152	153	
80	131	132	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	
85	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	151	152	153	154	
90	132	133	134	135	136	138	139	140	141	142	143	144	145	146	147	148	149	151	152	153	154	154	
95	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	
100	133	134	135	136	137	138	139	140	141	142	143	145	146	147	148	149	150	151	152	153	154	155	
105	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	
110	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	
115	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	
120	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	
125	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	151	152	153	154	155	156	
130	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	
135	137	138	139	140	141	142	143	144	145	146	147	148	148	149	150	151	152	153	154	155	156	157	
140	138	139	139	140	141	142	143	144	145	146	147	148	148	149	150	151	152	153	154	155	156	157	
145	138	139	140	141	142	143	144	145	146	147	148	148	149	150	151	152	153	154	155	156	157	157	
150	139	140	141	142	142	143	144	145	146	147	148	149	150	151	152	153	154	155	155	156	157	158	
155	139	140	141	142	143	144	145	146	147	148	148	149	150	151	152	153	154	155	156	157	158	159	
160	140	141	142	143	144	144	145	146	147	148	149	150	151	152	153	154	154	155	156	157	158	159	
165	141	141	142	143	144	145	146	147	148	149	149	150	151	152	153	154	155	156	157	158	159	160	
170	141	142	143	144	145	146	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	160	
175	142	143	144	144	145	146	147	148	149	150	151	151	152	153	154	155	156	157	158	159	159	160	
180	143	143	144	145	146	147	148	148	149	150	151	152	153	154	155	155	156	157	158	159	160	161	
185	143	144	145	146	146	147	148	149	150	151	152	152	153	154	155	156	157	158	159	159	160	161	
190	144	145	145	146	147	148	149	150	150	151	152	153	154	155	156	156	157	158	159	160	161	162	
195	144	145	146	147	148	148	149	150	151	152	153	154	154	155	156	157	158	159	160	160	161	162	
200	145	146	147	147	148	149	150	151	152	152	153	154	155	156	157	157	158	159	160	160	161	162	
205	146	147	147	148	149	150	151	151	152	153	154	155	155	156	157	158	159	160	160	161	162	163	
210	147	147	148	149	150	150	151	152	153	154	154	155	156	157	158	158	159	160	161	162	163	163	
215	147	148	149	149	150	151	152	153	153	154	155	156	157	157	158	159	160	161	161	162	163	164	
220	148	149	149	150	151	152	152	153	154	155	155	156	157	158	159	159	160	161	162	163	164	164	
225	149	149	150	151	151	152	153	154	154	155	156	157	158	158	159	160	161	162	162	163	164	165	
230	149	150	151	151	152	153	154	154	155	156	157	157	158	159	160	161	161	162	163	164	165	165	
235	150	151	151	152	153	154	154	155	156	156	157	158	159	160	160	161	162	163	163	164	165	166	
240	151	151	152	153	153	154	155	156	156	157	158	159	159	160	161	162	162	163	164	165	166	166	



TABLE 8. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

		MOLE FRACTION OF HELIUM 0.8000																					
T, DEG K		200	205	210	215	220	225	230	235	240	245	250	255	260	265	270	275	280	285	290	295	300	305
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	151	153	156	159	161	164	166	169	171	174	176	179	181	183	186	188	191	193	195	197	200	202	
5	151	154	156	159	161	164	166	169	171	174	176	179	181	184	186	188	191	193	195	198	200	202	
10	151	154	156	159	161	164	166	169	171	174	176	179	181	184	186	188	191	193	195	198	200	202	
15	151	154	156	159	162	164	167	169	172	174	176	179	181	184	186	188	191	193	195	198	200	202	
20	151	154	157	159	162	164	167	169	172	174	177	179	181	184	186	189	191	193	195	198	200	202	
25	151	154	157	159	162	164	167	169	172	174	177	179	182	184	186	189	191	193	195	198	200	202	
30	152	154	157	159	162	165	167	170	172	174	177	179	182	184	186	189	191	193	196	198	200	202	
35	152	154	157	160	162	165	167	170	172	175	177	179	182	184	187	189	191	194	196	198	200	203	
40	152	155	157	160	162	165	167	170	172	175	177	180	182	184	187	189	191	194	196	198	201	203	
45	152	155	158	160	163	165	168	170	172	175	177	180	182	184	187	189	191	194	196	198	201	203	
50	153	155	158	160	163	165	168	170	173	175	178	180	182	185	187	189	192	194	196	199	201	203	
55	153	155	158	160	163	166	168	170	173	175	178	180	182	185	187	189	192	194	196	199	201	203	
60	153	156	158	161	163	166	168	171	173	175	178	180	183	185	187	190	192	194	197	199	201	203	
65	153	156	158	161	163	166	168	171	173	176	178	180	183	185	188	190	192	194	197	199	201	203	
70	154	156	159	161	164	166	169	171	173	176	178	181	183	185	188	190	192	195	197	199	201	203	
75	154	156	159	161	164	166	169	171	174	176	178	181	183	186	188	190	192	195	197	199	201	204	
80	154	157	159	162	164	167	169	172	174	176	179	181	183	186	188	190	193	195	197	199	202	204	
85	155	157	160	162	164	167	169	172	174	177	179	181	184	186	188	191	193	195	197	200	202	204	
90	155	157	160	162	165	167	170	172	174	177	179	182	184	186	188	191	193	195	198	200	202	204	
95	155	158	160	163	165	167	170	172	175	177	179	182	184	186	189	191	193	195	198	200	202	204	
100	156	158	160	163	165	168	170	173	175	177	180	182	184	187	189	191	193	196	198	200	202	205	
105	156	158	161	163	166	168	170	173	175	178	180	182	184	187	189	191	194	196	198	200	203	205	
110	156	159	161	164	166	168	171	173	175	178	180	182	185	187	189	192	194	196	198	201	203	205	
115	157	159	161	164	166	169	171	173	176	178	180	183	185	187	190	192	194	196	199	201	203	205	
120	157	159	162	164	167	169	171	174	176	178	181	183	185	187	190	192	194	196	199	201	203	205	
125	157	160	162	164	167	169	172	174	176	179	181	183	185	188	190	192	194	196	199	201	203	206	
130	158	160	162	165	167	170	172	174	177	179	181	183	186	188	190	192	195	197	199	201	203	206	
135	158	160	163	165	167	170	172	174	177	179	181	184	186	188	190	193	195	197	199	202	204	206	
140	158	161	163	165	168	170	172	175	177	179	182	184	186	188	191	193	195	197	200	202	204	206	
145	159	161	163	166	168	170	173	175	177	180	182	184	186	189	191	193	195	198	200	202	204	206	
150	159	162	164	166	168	171	173	175	178	180	182	184	187	189	191	193	196	198	200	202	204	207	
155	160	162	164	167	169	171	173	176	178	180	182	185	187	189	191	194	196	198	200	202	205	207	
160	160	162	165	167	169	171	174	176	178	181	183	185	187	189	192	194	196	198	200	203	205	207	
165	160	163	165	167	170	172	174	176	179	181	183	185	188	190	192	194	196	199	201	203	205	207	
170	161	163	165	168	170	172	174	177	179	181	183	186	188	190	192	194	197	199	201	203	205	207	
175	161	164	166	168	170	173	175	177	179	181	184	186	188	190	192	195	197	199	201	203	205	208	
180	162	164	166	168	171	173	175	177	180	182	184	186	188	191	193	195	197	199	201	204	206	208	
185	162	164	167	169	171	173	175	178	180	182	184	186	189	191	193	195	197	199	202	204	206	208	
190	163	165	167	169	171	174	176	178	180	182	185	187	189	191	193	195	198	200	202	204	206	208	
195	163	165	167	170	172	174	176	178	181	183	185	187	189	191	194	196	198	200	202	204	206	208	
200	163	166	168	170	172	174	176	179	181	183	185	187	190	192	194	196	198	200	202	205	207	209	
205	164	166	168	170	173	175	177	179	181	183	186	188	190	192	194	196	198	201	203	205	207	209	
210	164	166	169	171	173	175	177	179	182	184	186	188	190	192	194	197	199	201	203	205	207	209	
215	165	167	169	171	173	175	178	180	182	184	186	188	190	193	195	197	199	201	203	205	207	209	
220	165	167	169	172	174	176	178	180	182	184	186	189	191	193	195	197	199	201	203	205	208	210	
225	166	168	170	172	174	176	178	180	183	185	187	189	191	193	195	197	199	202	204	206	208	210	
230	166	168	170	172	175	177	179	181	183	185	187	189	191	193	195	198	200	202	204	206	208	210	
235	167	169	171	173	175	177	179	181	183	185	187	190	192	194	196	198	200	202	204	206	208	210	
240	167	169	171	173	175	177	179	182	184	186	188	190	192	194	196	198	200	202	204	207	209	211	





TABLE 8. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICRPOISES

		MOLE FRACTION OF HELIUM 0.8000																					
T, DEG K		310	320	330	340	350	360	370	380	390	400	410	420	430	440	450	460	470	480	490	500	510	520
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	204	209	213	218	222	226	230	235	239	243	247	251	255	259	263	267	271	274	278	282	286	289	
5	204	209	213	218	222	226	230	235	239	243	247	251	255	259	263	267	271	274	278	282	286	289	
10	204	209	213	218	222	226	230	235	239	243	247	251	255	259	263	267	271	274	278	282	286	289	
15	204	209	213	218	222	226	231	235	239	243	247	251	255	259	263	267	271	274	278	282	286	289	
20	205	209	213	218	222	226	231	235	239	243	247	251	255	259	263	267	271	274	278	282	286	289	
25	205	209	214	218	222	226	231	235	239	243	247	251	255	259	263	267	271	275	278	282	286	290	
30	205	209	214	218	222	227	231	235	239	243	247	251	255	259	263	267	271	275	278	282	286	290	
35	205	209	214	218	222	227	231	235	239	243	247	251	255	259	263	267	271	275	278	282	286	290	
40	205	209	214	218	222	227	231	235	239	243	247	251	255	259	263	267	271	275	279	282	286	290	
45	205	210	214	218	223	227	231	235	239	243	247	251	255	259	263	267	271	275	279	282	286	290	
50	205	210	214	218	223	227	231	235	239	243	248	252	255	259	263	267	271	275	279	282	286	290	
55	205	210	214	219	223	227	231	235	239	244	248	252	256	260	263	267	271	275	279	282	286	290	
60	206	210	214	219	223	227	231	235	240	244	248	252	256	260	263	267	271	275	279	283	286	290	
65	206	210	214	219	223	227	231	236	240	244	248	252	256	260	264	267	271	275	279	283	286	290	
70	206	210	215	219	223	227	232	236	240	244	248	252	256	260	264	268	271	275	279	283	286	290	
75	206	210	215	219	223	227	232	236	240	244	248	252	256	260	264	268	271	275	279	283	286	290	
80	206	211	215	219	223	228	232	236	240	244	248	252	256	260	264	268	272	275	279	283	287	290	
85	206	211	215	219	224	228	232	236	240	244	248	252	256	260	264	268	272	275	279	283	287	290	
90	206	211	215	219	224	228	232	236	240	244	248	252	256	260	264	268	272	276	279	283	287	290	
95	207	211	215	220	224	228	232	236	240	244	248	252	256	260	264	268	272	276	279	283	287	290	
100	207	211	215	220	224	228	232	236	240	245	249	253	256	260	264	268	272	276	279	283	287	291	
105	207	211	216	220	224	228	232	237	241	245	249	253	257	260	264	268	272	276	280	283	287	291	
110	207	211	216	220	224	228	233	237	241	245	249	253	257	261	264	268	272	276	280	283	287	291	
115	207	212	216	220	224	229	233	237	241	245	249	253	257	261	265	268	272	276	280	283	287	291	
120	207	212	216	220	225	229	233	237	241	245	249	253	257	261	265	268	272	276	280	284	287	291	
125	208	212	216	221	225	229	233	237	241	245	249	253	257	261	265	269	272	276	280	284	287	291	
130	208	212	216	221	225	229	233	237	241	245	249	253	257	261	265	269	272	276	280	284	287	291	
135	208	212	217	221	225	229	233	237	241	245	249	253	257	261	265	269	273	276	280	284	288	291	
140	208	213	217	221	225	229	233	238	242	246	250	253	257	261	265	269	273	276	280	284	288	291	
145	208	213	217	221	225	230	234	238	242	246	250	254	257	261	265	269	273	277	280	284	288	291	
150	209	213	217	221	226	230	234	238	242	246	250	254	258	261	265	269	273	277	280	284	288	291	
155	209	213	217	222	226	230	234	238	242	246	250	254	258	262	265	269	273	277	281	284	288	292	
160	209	213	218	222	226	230	234	238	242	246	250	254	258	262	266	269	273	277	281	284	288	292	
165	209	214	218	222	226	230	234	238	242	246	250	254	258	262	266	269	273	277	281	284	288	292	
170	209	214	218	222	226	230	234	238	242	246	250	254	258	262	266	270	273	277	281	285	288	292	
175	210	214	218	222	226	231	235	239	243	247	250	254	258	262	266	270	274	277	281	285	288	292	
180	210	214	218	222	227	231	235	239	243	247	251	255	258	262	266	270	274	277	281	285	288	292	
185	210	214	219	223	227	231	235	239	243	247	251	255	259	262	266	270	274	277	281	285	289	292	
190	210	215	219	223	227	231	235	239	243	247	251	255	259	263	266	270	274	278	281	285	289	292	
195	211	215	219	223	227	231	235	239	243	247	251	255	259	263	266	270	274	278	281	285	289	292	
200	211	215	219	223	227	231	235	239	243	247	251	255	259	263	267	270	274	278	282	285	289	292	
205	211	215	219	223	228	232	236	240	244	247	251	255	259	263	267	270	274	278	282	285	289	293	
210	211	215	220	224	228	232	236	240	244	248	252	255	259	263	267	271	274	278	282	285	289	293	
215	212	216	220	224	228	232	236	240	244	248	252	256	259	263	267	271	274	278	282	286	289	293	
220	212	216	220	224	228	232	236	240	244	248	252	256	260	263	267	271	275	278	282	286	289	293	
225	212	216	220	224	228	232	236	240	244	248	252	256	260	263	267	271	275	278	282	286	289	293	
230	212	216	220	224	229	233	236	240	244	248	252	256	260	264	267	271	275	279	282	286	290	293	
235	212	217	221	225	229	233	237	241	245	248	252	256	260	264	268	271	275	279	282	286	290	293	
240	213	217	221	225	229	233	237	241	245	249	252	256	260	264	268	271	275	279	282	286	290	293	







TABLE 9. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICRPOISES

		MOLE FRACTION OF HELIUM 0.7000																				
T, DEG K	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	110	110	111	112	112	113	113	114	115	115	116	116	117	118	118	119	120	120	121	121	122	122
5	110	111	111	112	112	113	114	114	115	115	116	117	117	118	118	119	120	120	121	121	122	123
10	110	111	112	112	113	113	114	115	115	116	116	117	118	118	119	120	120	121	121	122	122	123
15	111	111	112	113	113	114	114	115	116	116	117	117	118	119	119	120	120	121	121	122	122	123
20	111	112	112	113	114	114	115	115	116	117	117	118	118	119	120	120	121	121	122	122	123	123
25	112	112	113	114	114	115	115	116	117	117	118	118	119	120	120	121	121	122	122	123	123	124
30	112	113	114	114	115	115	116	116	117	118	118	119	120	120	121	121	122	122	123	123	124	124
35	113	114	114	115	115	116	116	117	118	118	119	119	120	121	121	122	122	123	123	124	124	125
40	114	114	115	115	116	117	117	118	118	119	119	120	121	121	122	122	123	123	124	124	125	125
45	114	115	115	116	117	117	118	118	119	119	120	121	121	122	122	123	123	124	124	125	125	126
50	115	116	116	117	117	118	118	119	120	120	121	121	122	122	123	123	124	125	125	126	126	127
55	116	116	117	117	118	119	119	120	120	121	121	122	122	123	124	124	125	125	126	126	127	127
60	117	117	118	118	119	119	120	120	121	122	122	123	123	124	124	125	125	126	126	127	127	128
65	117	118	119	119	120	120	121	121	122	122	123	123	124	124	125	125	126	126	127	127	128	128
70	118	119	119	120	120	121	121	122	122	123	124	124	125	125	126	126	127	127	128	128	129	129
75	119	120	120	121	121	122	122	123	123	124	124	125	125	126	126	127	127	128	128	129	129	130
80	120	121	121	122	122	123	123	124	124	125	125	126	126	127	127	128	128	129	129	130	130	131
85	121	121	122	122	123	123	124	124	125	125	126	126	127	127	128	128	129	129	130	130	131	131
90	122	122	123	123	124	124	125	125	126	126	127	127	128	128	129	129	130	130	131	131	132	132
95	123	123	124	124	125	125	126	126	127	127	128	128	129	129	129	130	130	131	131	132	132	133
100	124	124	125	125	126	126	127	127	128	128	128	129	129	130	130	131	131	132	132	133	133	134
105	125	125	126	126	127	127	128	128	128	129	129	130	130	131	131	132	132	133	133	133	134	134
110	126	126	127	127	128	128	129	129	129	130	130	131	131	132	132	133	133	133	134	134	135	135
115	127	127	128	128	129	129	129	130	130	131	131	132	132	133	133	133	134	134	135	135	136	136
120	128	129	129	129	130	130	130	131	131	132	132	133	133	133	134	134	135	135	136	136	137	137
125	129	130	130	130	131	131	131	132	132	133	133	133	134	134	135	135	136	136	137	137	138	138
130	130	131	131	131	132	132	133	133	133	134	134	135	135	136	136	137	137	138	138	139	139	139
135	131	132	132	132	133	133	134	134	135	135	135	136	136	137	137	138	138	139	139	140	140	140
140	133	133	133	134	134	134	135	135	135	136	136	137	137	138	138	139	139	140	140	141	141	141
145	134	134	134	135	135	135	136	136	136	137	137	137	138	138	139	139	140	140	141	141	142	142
150	135	135	136	136	136	136	137	137	137	138	138	138	139	139	139	140	140	141	141	142	142	142
155	136	136	137	137	137	138	138	138	138	139	139	139	140	140	140	141	141	141	142	142	143	143
160	137	138	138	138	138	139	139	139	140	140	140	141	141	141	142	142	142	143	143	143	143	144
165	139	139	139	139	140	140	140	140	141	141	141	142	142	142	143	143	143	144	144	144	144	145
170	140	140	140	140	141	141	141	141	142	142	142	143	143	143	144	144	144	145	145	145	145	146
175	141	141	141	142	142	142	143	143	143	143	144	144	144	144	145	145	145	146	146	146	146	147
180	142	142	143	143	143	143	144	144	144	144	145	145	145	146	146	146	146	147	147	147	147	148
185	143	144	144	144	144	144	145	145	145	145	146	146	146	146	147	147	147	148	148	148	148	149
190	145	145	145	145	145	146	146	146	146	146	147	147	147	147	148	148	148	148	149	149	149	150
195	146	146	146	146	147	147	147	147	147	148	148	148	148	148	149	149	149	149	150	150	150	151
200	147	147	148	148	148	148	148	148	149	149	149	149	149	150	150	150	150	151	151	151	151	152
205	149	149	149	149	149	149	149	150	150	150	150	150	150	151	151	151	151	152	152	152	152	153
210	150	150	150	150	150	150	151	151	151	151	151	151	152	152	152	152	153	153	153	153	153	154
215	151	151	151	151	152	152	152	152	152	152	152	153	153	153	153	154	154	154	154	154	154	155
220	152	153	153	153	153	153	153	153	153	153	153	154	154	154	154	155	155	155	155	155	155	156
225	154	154	154	154	154	154	154	154	154	155	155	155	155	155	155	156	156	156	156	156	156	157
230	155	155	155	155	155	155	155	156	156	156	156	156	156	156	156	157	157	157	157	157	157	158
235	156	156	156	156	157	157	157	157	157	157	157	157	157	157	158	158	158	158	158	158	158	159
240	158	158	158	158	158	158	158	158	158	158	158	158	158	159	159	159	159	159	159	159	160	160



TABLE 9. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICRPOISES

		MOLE FRACTION OF HELIUM 0.7000																					
T, DEG K	P, ATM	156	158	160	162	164	166	168	170	172	174	176	178	180	182	184	186	188	190	192	194	196	198
		VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1		124	125	126	127	128	130	131	132	133	134	135	136	137	139	140	141	142	143	144	145	146	147
5		124	125	126	127	129	130	131	132	133	134	135	136	138	139	140	141	142	143	144	145	146	147
10		124	125	126	128	129	130	131	132	133	134	136	137	138	139	140	141	142	143	144	146	147	148
15		124	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	146	147
20		125	126	127	128	129	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147
25		125	126	128	129	130	131	132	133	134	135	137	138	139	140	141	142	143	144	145	146	147	148
30		126	127	128	129	130	131	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	149
35		126	127	129	130	131	132	133	134	135	136	137	138	140	141	142	143	144	145	146	147	148	149
40		127	128	129	130	131	132	133	134	135	136	137	138	140	141	142	143	144	145	146	147	148	149
45		127	128	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	150
50		128	129	130	131	132	133	134	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
55		128	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	146	147	148	149	150	151
60		129	130	131	132	133	134	135	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151
65		130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151
70		130	131	132	133	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152
75		131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152
80		132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	152
85		132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153
90		133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	153
95		134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	154
100		135	136	136	137	138	139	140	141	142	143	144	145	146	147	148	148	149	150	151	152	153	154
105		135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	152	153	154	155
110		136	137	138	139	140	141	142	143	144	145	145	146	147	148	149	150	151	152	153	154	155	156
115		137	138	139	140	141	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	155	156
120		138	139	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	157
125		139	139	140	141	142	143	144	145	146	147	147	148	149	150	151	152	153	154	155	156	157	157
130		139	140	141	142	143	144	145	145	146	147	148	149	150	151	152	153	154	155	156	157	157	157
135		140	141	142	143	144	144	145	146	147	148	149	150	151	151	152	153	154	155	156	157	158	158
140		141	142	143	143	144	145	146	147	148	149	149	150	151	152	153	154	155	156	157	158	159	159
145		142	143	143	144	145	146	147	148	148	149	150	151	152	153	154	155	156	157	157	158	159	159
150		143	144	144	145	146	147	148	148	149	150	151	152	153	153	154	155	156	157	158	159	159	160
155		144	144	145	146	147	148	148	149	150	151	152	152	153	154	155	156	157	157	158	159	160	161
160		145	145	146	147	148	148	149	150	151	152	152	153	154	155	156	156	157	158	159	160	161	162
165		145	146	147	148	148	149	150	151	151	152	153	154	155	155	156	157	158	159	160	160	161	162
170		146	147	148	148	149	150	151	151	152	153	154	155	155	156	157	158	159	160	160	161	162	162
175		147	148	149	149	150	151	152	152	153	154	155	155	156	157	158	158	159	160	161	162	163	163
180		148	149	150	150	151	152	152	153	154	155	155	156	157	158	158	159	160	161	162	162	163	163
185		149	150	150	151	152	152	153	154	155	155	156	157	158	158	159	160	161	162	162	163	164	164
190		150	151	151	152	153	153	154	155	155	156	157	158	158	159	160	161	161	162	163	164	165	165
195		151	152	152	153	154	154	155	156	156	157	158	158	159	160	161	161	162	163	164	164	165	165
200		152	153	153	154	154	155	156	156	157	158	158	159	160	161	161	162	163	164	164	165	166	166
205		153	154	154	155	155	156	157	157	158	159	159	160	161	161	162	163	163	164	165	166	166	167
210		154	155	155	156	156	157	157	158	159	159	160	161	161	162	163	163	164	165	166	166	167	168
215		155	156	156	157	157	158	158	159	159	160	160	161	161	162	163	164	165	166	166	167	168	169
220		156	156	157	158	158	159	159	160	160	161	161	162	162	163	164	165	166	166	167	168	168	169
225		157	157	158	158	159	160	160	161	161	162	162	163	164	164	165	166	166	167	168	168	169	170
230		158	158	159	159	160	160	161	162	162	163	163	164	164	165	166	166	167	168	168	169	170	171
235		159	159	160	160	161	161	162	162	163	164	164	165	165	166	166	167	168	168	169	170	171	171
240		160	160	161	161	162	162	163	163	164	164	165	166	166	167	167	168	169	170	171	171	171	172





TABLE 9. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

		MOLE FRACTION OF HELIUM 0.7000																					
T, DEG K		200	205	210	215	220	225	230	235	240	245	250	255	260	265	270	275	280	285	290	295	300	305
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	148	151	154	156	159	161	164	167	169	172	174	176	179	181	184	186	188	191	193	195	198	200	
5	149	151	154	156	159	162	164	167	169	172	174	177	179	181	184	186	189	191	193	196	198	200	
10	149	151	154	157	159	162	164	167	169	172	174	177	179	182	184	186	189	191	193	196	198	200	
15	149	152	154	157	159	162	165	167	170	172	174	177	179	182	184	186	189	191	193	196	198	200	
20	149	152	155	157	160	162	165	167	170	172	174	177	179	182	184	186	189	191	193	196	198	200	
25	150	152	155	157	160	162	165	168	170	172	175	177	180	182	184	187	189	191	194	196	198	201	
30	150	153	155	158	160	163	165	168	170	173	175	178	180	182	185	187	189	192	194	196	198	201	
35	150	153	155	158	161	163	166	168	171	173	175	178	180	183	185	187	189	192	194	196	199	201	
40	151	153	156	158	161	163	166	168	171	173	175	178	180	183	185	187	190	192	194	197	199	201	
45	151	154	156	159	161	164	166	169	171	174	176	178	180	183	185	188	190	192	194	197	199	201	
50	151	154	156	159	161	164	166	169	171	174	176	179	181	183	185	188	190	192	195	197	199	201	
55	152	154	157	159	162	164	167	169	172	174	176	179	181	184	186	188	191	193	195	197	200	202	
60	152	155	157	160	162	165	167	170	172	174	177	179	182	184	186	189	191	193	195	198	200	202	
65	153	155	158	160	163	165	167	170	172	175	177	179	182	184	186	189	191	193	196	198	200	202	
70	153	156	158	160	163	165	168	170	173	175	177	180	182	184	186	189	191	193	196	198	200	202	
75	153	156	158	161	163	166	168	171	173	175	178	180	182	185	187	189	191	194	196	198	200	203	
80	154	156	159	161	164	166	169	171	173	176	178	180	182	185	187	189	192	194	196	198	201	203	
85	154	157	159	162	164	167	169	171	174	176	178	181	183	185	188	190	192	194	196	199	201	203	
90	155	157	160	162	165	167	169	172	174	176	179	181	183	186	188	190	192	194	197	199	201	203	
95	155	158	160	163	165	167	170	172	174	176	179	181	183	186	188	190	192	195	197	199	201	204	
100	156	158	161	163	165	168	170	172	174	177	179	181	184	186	188	191	193	195	197	199	202	204	
105	156	159	161	163	166	168	171	173	175	177	180	182	184	187	189	191	193	196	198	200	202	204	
110	157	159	162	164	166	169	171	173	176	178	180	182	185	187	189	191	194	196	198	200	202	204	
115	157	160	162	164	167	169	171	174	176	178	181	183	185	187	190	192	194	196	198	201	203	205	
120	158	160	163	165	167	169	172	174	176	179	181	183	185	188	190	192	194	196	198	201	203	205	
125	158	161	163	165	168	170	172	174	177	179	181	184	186	188	190	192	194	197	199	201	203	205	
130	159	161	164	166	168	170	173	175	177	179	182	184	186	188	191	193	195	197	199	201	203	205	
135	160	162	164	166	169	171	173	175	178	180	182	184	186	188	191	193	195	197	199	201	204	206	
140	160	162	165	167	169	171	174	176	178	180	182	185	187	189	191	193	195	197	200	202	204	206	
145	161	163	165	167	170	172	174	176	178	181	183	185	187	189	191	193	196	198	200	202	204	206	
150	161	163	166	168	170	172	174	177	179	181	183	185	188	190	192	194	196	198	200	202	205	207	
155	162	164	166	168	171	173	175	177	179	181	184	186	188	190	192	194	197	199	201	203	205	207	
160	162	165	167	169	171	173	175	178	180	182	184	186	188	191	193	195	197	199	201	203	205	208	
165	163	165	167	169	172	174	176	178	180	182	184	187	189	191	193	195	197	199	202	204	206	208	
170	164	166	168	170	172	174	176	178	181	183	185	187	189	191	193	196	198	200	202	204	206	208	
175	164	166	168	170	173	175	177	179	181	183	185	187	189	191	193	196	198	200	202	204	206	208	
180	165	167	169	171	173	175	177	179	182	184	186	188	190	192	194	196	198	200	202	204	206	209	
185	165	167	169	172	174	176	178	180	182	184	186	188	190	193	195	197	199	201	203	205	207	209	
190	166	168	170	172	174	176	178	180	182	185	187	189	191	193	195	197	199	201	203	205	207	209	
195	167	169	171	173	175	177	179	181	183	185	187	189	191	193	195	197	199	201	203	205	207	209	
200	167	169	171	173	175	177	179	181	183	185	188	190	192	194	196	198	200	202	204	206	208	210	
205	168	170	172	174	176	178	180	182	184	186	188	190	192	194	196	198	200	202	204	206	208	210	
210	169	171	172	174	176	178	180	182	184	186	188	190	193	195	197	199	201	203	205	207	209	211	
215	169	171	173	175	177	179	181	183	185	187	189	191	193	195	197	199	201	203	205	207	209	211	
220	170	172	174	176	177	179	181	183	185	187	189	191	193	195	197	199	201	203	205	207	209	211	
225	171	172	174	176	178	180	182	184	186	188	190	192	194	196	198	200	202	204	206	208	210	212	
230	171	173	175	177	179	181	182	184	186	188	190	192	194	196	198	200	202	204	206	208	210	212	
235	172	174	175	177	179	181	183	185	187	189	191	193	195	197	199	201	203	205	207	209	211	213	
240	173	174	176	178	180	182	184	185	187	189	191	193	195	197	199	201	203	205	207	209	211	213	



TABLE 9. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

		MOLE FRACTION OF HELIUM 0.7000																					
T, DEG K	P, ATM	310	320	330	340	350	360	370	380	390	400	410	420	430	440	450	460	470	480	490	500	510	520
		VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1		202	207	211	216	220	224	228	233	237	241	245	249	253	257	261	265	268	272	276	280	283	287
5		202	207	211	216	220	224	228	233	237	241	245	249	253	257	261	265	268	272	276	280	283	287
10		202	207	211	216	220	224	229	233	237	241	245	249	253	257	261	265	269	272	276	280	283	287
15		203	207	212	216	220	224	229	233	237	241	245	249	253	257	261	265	269	272	276	280	283	287
20		203	207	212	216	220	225	229	233	237	241	245	249	253	257	261	265	269	272	276	280	284	287
25		203	207	212	216	220	225	229	233	237	241	245	249	253	257	261	265	269	272	276	280	284	287
30		203	208	212	216	221	225	229	233	237	241	245	249	253	257	261	265	269	273	276	280	284	287
35		203	208	212	216	221	225	229	233	237	241	245	249	253	257	261	265	269	273	276	280	284	287
40		203	208	212	217	221	225	229	234	238	242	246	250	254	258	261	265	269	273	277	280	284	288
45		204	208	212	217	221	225	230	234	238	242	246	250	254	258	261	265	269	273	277	280	284	288
50		204	208	213	217	221	226	230	234	238	242	246	250	254	258	262	265	269	273	277	280	284	288
55		204	209	213	217	221	226	230	234	238	242	246	250	254	258	262	266	269	273	277	281	284	288
60		204	209	213	217	222	226	230	234	238	242	246	250	254	258	262	266	269	273	277	281	284	288
65		205	209	213	218	222	226	230	234	238	242	246	250	254	258	262	266	270	273	277	281	284	288
70		205	209	214	218	222	226	230	234	239	243	247	251	254	258	262	266	270	273	277	281	285	288
75		205	209	214	218	222	226	231	235	239	243	247	251	255	259	262	266	270	274	277	281	285	288
80		205	210	214	218	222	227	231	235	239	243	247	251	255	259	263	266	270	274	278	281	285	289
85		206	210	214	218	223	227	231	235	239	243	247	251	255	259	263	266	270	274	278	281	285	289
90		206	210	214	219	223	227	231	235	239	243	247	251	255	259	263	266	270	274	278	281	285	289
95		206	210	215	219	223	227	231	235	239	243	247	251	255	259	263	267	270	274	278	282	285	289
100		206	211	215	219	223	227	232	236	240	244	248	252	255	259	263	267	271	274	278	282	285	289
105		207	211	215	219	224	228	232	236	240	244	248	252	256	259	263	267	271	275	278	282	286	289
110		207	211	215	220	224	228	232	236	240	244	248	252	256	260	263	267	271	275	278	282	286	289
115		207	211	216	220	224	228	232	236	240	244	248	252	256	260	264	267	271	275	279	282	286	289
120		207	212	216	220	224	228	232	236	240	244	248	252	256	260	264	268	271	275	279	282	286	289
125		208	212	216	220	224	229	233	237	241	245	249	252	256	260	264	268	271	275	279	282	286	290
130		208	212	216	221	225	229	233	237	241	245	249	253	256	260	264	268	272	275	279	283	286	290
135		208	212	217	221	225	229	233	237	241	245	249	253	256	260	264	268	272	275	279	283	286	290
140		208	213	217	221	225	229	233	237	241	245	249	253	257	260	264	268	272	275	279	283	286	290
145		209	213	217	221	225	229	234	238	241	245	249	253	257	261	264	268	272	276	279	283	287	290
150		209	213	217	222	226	230	234	238	242	246	250	253	257	261	265	269	272	276	279	283	287	290
155		209	214	218	222	226	230	234	238	242	246	250	254	257	261	265	269	272	276	280	283	287	291
160		210	214	218	222	226	230	234	238	242	246	250	254	258	261	265	269	273	276	280	284	287	291
165		210	214	218	222	226	230	234	238	242	246	250	254	258	262	265	269	273	276	280	284	287	291
170		210	214	219	223	227	231	235	239	243	246	250	254	258	262	266	269	273	276	280	284	287	291
175		211	215	219	223	227	231	235	239	243	247	251	254	258	262	266	269	273	277	280	284	287	291
180		211	215	219	223	227	231	235	239	243	247	251	255	258	262	266	269	273	277	280	284	288	291
185		211	215	219	223	227	231	235	239	243	247	251	255	258	262	266	270	273	277	281	284	288	291
190		212	216	220	224	228	232	236	240	243	247	251	255	259	262	266	270	273	277	281	284	288	292
195		212	216	220	224	228	232	236	240	244	248	251	255	259	263	266	270	274	277	281	285	288	292
200		212	216	220	224	228	232	236	240	244	248	252	255	259	263	266	270	274	277	281	285	288	292
205		213	217	221	225	229	232	236	240	244	248	252	256	259	263	267	271	274	278	281	285	288	292
210		213	217	221	225	229	233	237	241	244	248	252	256	260	263	267	271	274	278	281	285	289	292
215		213	217	221	225	229	233	237	241	245	248	252	256	260	263	267	271	274	278	282	285	289	292
220		214	218	221	225	229	233	237	241	245	249	252	256	260	264	267	271	275	278	282	285	289	292
225		214	218	222	226	230	234	237	241	245	249	253	256	260	264	267	271	275	278	282	286	289	293
230		214	218	222	226	230	234	238	242	245	249	253	257	260	264	268	271	275	279	282	286	289	293
235		215	218	222	226	230	234	238	242	246	249	253	257	260	264	268	271	275	279	282	286	289	293
240		215	219	223	227	231	234	238	242	246	250	253	257	261	264	268	272	275	279	282	286	290	293



TABLE 9. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICRPOISES

		MOLE FRACTION OF HELIUM 0.7000																				
T, DEG K	530	540	550	560	570	580	590	600	610	620	630	640	650	660	670	680	690	700	710	720	730	740
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	291	294	298	302	305	309	312	316	319	322	326	329	333	336	339	343	346	349	352	356	359	362
5	291	294	298	302	305	309	312	316	319	322	326	329	333	336	339	343	346	349	352	356	359	362
10	291	294	298	302	305	309	312	316	319	322	326	329	333	336	339	343	346	349	352	356	359	362
15	291	295	298	302	305	309	312	316	319	323	326	329	333	336	339	343	346	349	352	356	359	362
20	291	295	298	302	305	309	312	316	319	323	326	329	333	336	339	343	346	349	352	356	359	362
25	291	295	298	302	305	309	312	316	319	323	326	329	333	336	339	343	346	349	352	356	359	362
30	291	295	298	302	305	309	312	316	319	323	326	329	333	336	339	343	346	349	353	356	359	362
35	291	295	298	302	306	309	312	316	319	323	326	330	333	336	340	343	346	349	353	356	359	362
40	291	295	299	302	306	309	313	316	319	323	326	330	333	336	340	343	346	349	353	356	359	362
45	291	295	299	302	306	309	313	316	320	323	326	330	333	336	340	343	346	349	353	356	359	362
50	292	295	299	302	306	309	313	316	320	323	326	330	333	336	340	343	346	350	353	356	359	362
55	292	295	299	302	306	309	313	316	320	323	327	330	333	337	340	343	346	350	353	356	359	363
60	292	295	299	302	306	309	313	316	320	323	327	330	333	337	340	343	347	350	353	356	359	363
65	292	295	299	303	306	310	313	316	320	323	327	330	333	337	340	343	347	350	353	356	359	363
70	292	296	299	303	306	310	313	317	320	323	327	330	333	337	340	343	347	350	353	356	359	363
75	292	296	299	303	306	310	313	317	320	324	327	330	333	337	340	343	347	350	353	356	360	363
80	292	296	299	303	306	310	313	317	320	324	327	330	334	337	340	343	347	350	353	356	360	363
85	292	296	299	303	306	310	313	317	320	324	327	330	334	337	340	344	347	350	353	357	360	363
90	292	296	300	303	307	310	314	317	320	324	327	331	334	337	340	344	347	350	353	357	360	363
95	293	296	300	303	307	310	314	317	321	324	327	331	334	337	341	344	347	350	353	357	360	363
100	293	296	300	303	307	310	314	317	321	324	327	331	334	337	341	344	347	350	354	357	360	363
105	293	296	300	303	307	310	314	317	321	324	327	331	334	337	341	344	347	351	354	357	360	363
110	293	297	300	304	307	311	314	317	321	324	328	331	334	338	341	344	347	351	354	357	360	363
115	293	297	300	304	307	311	314	318	321	324	328	331	334	338	341	344	347	351	354	357	360	363
120	293	297	300	304	307	311	314	318	321	324	328	331	334	338	341	344	347	351	354	357	360	363
125	293	297	300	304	307	311	314	318	321	325	328	331	334	338	341	344	348	351	354	357	360	364
130	293	297	301	304	308	311	314	318	321	325	328	331	335	338	341	344	348	351	354	357	360	364
135	294	297	301	304	308	311	315	318	321	325	328	331	335	338	341	344	348	351	354	357	361	364
140	294	297	301	304	308	311	315	318	321	325	328	332	335	338	341	345	348	351	354	357	361	364
145	294	297	301	304	308	311	315	318	322	325	328	332	335	338	341	345	348	351	354	358	361	364
150	294	298	301	305	308	312	315	318	322	325	328	332	335	338	342	345	348	351	354	358	361	364
155	294	298	301	305	308	312	315	318	322	325	329	332	335	338	342	345	348	351	355	358	361	364
160	294	298	301	305	308	312	315	319	322	325	329	332	335	339	342	345	348	352	355	358	361	364
165	294	298	302	305	308	312	315	319	322	325	329	332	335	339	342	345	348	352	355	358	361	364
170	295	298	302	305	309	312	315	319	322	326	329	332	336	339	342	345	349	352	355	358	361	364
175	295	298	302	305	309	312	316	319	322	326	329	332	336	339	342	345	349	352	355	358	361	364
180	295	298	302	305	309	312	316	319	322	326	329	332	336	339	342	345	349	352	355	358	361	365
185	295	299	302	306	309	312	316	319	323	326	329	333	336	339	342	346	349	352	355	358	361	365
190	295	299	302	306	309	313	316	319	323	326	329	333	336	339	343	346	349	352	355	358	362	365
195	295	299	302	306	309	313	316	319	323	326	329	333	336	339	343	346	349	352	355	359	362	365
200	296	299	303	306	309	313	316	320	323	326	330	333	336	339	343	346	349	352	355	359	362	365
205	296	299	303	306	310	313	316	320	323	326	330	333	336	340	343	346	349	352	356	359	362	365
210	296	299	303	306	310	313	316	320	323	327	330	333	336	340	343	346	349	353	356	359	362	365
215	296	299	303	306	310	313	317	320	323	327	330	333	337	340	343	346	350	353	356	359	362	365
220	296	300	303	307	310	313	317	320	323	327	330	333	337	340	343	346	350	353	356	359	362	365
225	296	300	303	307	310	314	317	320	323	327	330	333	337	340	343	346	350	353	356	359	362	365
230	296	300	303	307	310	314	317	320	324	327	330	334	337	340	343	347	350	353	356	359	362	366
235	297	300	304	307	310	314	317	321	324	327	330	334	337	340	343	347	350	353	356	359	363	366
240	297	300	304	307	311	314	317	321	324	327	331	334	337	340	344	347	350	353	356	359	363	366



TABLE 10. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

		MOLE FRACTION OF HELIUM 0.6000																				
T, DEG K	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	107	107	108	108	109	110	110	111	112	112	113	113	114	115	115	116	116	117	118	118	119	119
5	107	108	108	109	109	110	111	111	112	112	113	114	114	115	116	116	117	117	118	119	119	120
10	107	108	109	109	110	111	111	112	112	113	114	114	115	115	116	117	117	118	118	119	120	120
15	108	109	109	110	111	111	112	112	113	114	114	115	115	116	117	117	118	118	119	120	120	121
20	109	109	110	111	111	112	112	113	114	114	115	115	116	117	117	118	118	119	120	120	121	121
25	110	110	111	111	112	113	113	114	114	115	116	116	117	117	118	118	119	120	120	121	121	122
30	110	111	112	112	113	113	114	115	115	116	116	117	117	118	118	119	120	120	121	121	122	122
35	111	112	113	113	114	114	115	115	116	116	117	117	118	118	119	119	120	120	121	121	122	123
40	112	113	113	114	115	115	116	116	117	117	118	118	119	119	120	120	121	121	122	122	123	123
45	113	114	114	115	116	116	117	117	118	118	119	119	120	120	121	121	122	122	123	123	124	124
50	114	115	116	116	117	117	118	118	119	119	120	120	121	121	122	122	123	124	124	125	125	126
55	116	116	117	117	118	118	119	119	120	120	121	121	122	122	123	123	124	124	125	125	126	127
60	117	117	118	118	119	119	120	120	121	121	122	122	123	123	124	124	125	125	126	126	127	127
65	118	118	119	119	120	120	121	121	122	122	123	123	124	124	125	125	126	126	127	127	128	128
70	119	120	120	121	121	122	122	123	123	124	124	125	125	126	126	127	127	128	128	129	129	129
75	121	121	121	122	122	123	123	124	124	125	125	126	126	127	127	128	128	129	129	130	130	130
80	122	122	123	123	124	124	124	125	125	126	126	127	127	128	128	128	129	129	130	130	131	131
85	123	124	124	125	125	126	126	127	127	128	128	129	129	130	130	130	131	131	132	132	133	133
90	125	125	125	126	126	127	127	128	128	129	129	130	130	131	131	132	132	133	133	134	134	134
95	126	127	127	127	128	128	128	129	129	130	130	131	131	132	132	133	133	134	134	135	135	136
100	128	128	128	129	129	129	130	130	130	131	131	132	132	133	133	133	134	134	135	135	136	136
105	129	130	130	130	131	131	131	132	132	132	133	133	134	134	134	135	135	135	136	136	137	137
110	131	131	131	132	132	132	133	133	133	134	134	135	135	136	136	137	137	138	138	139	139	139
115	132	133	133	133	134	134	134	135	135	135	136	136	137	137	138	138	139	139	140	140	141	141
120	134	134	134	135	135	135	136	136	136	137	137	138	138	139	139	140	140	140	141	141	142	142
125	136	136	136	136	137	137	137	137	138	138	138	139	139	140	140	141	141	141	142	142	143	143
130	137	137	138	138	138	138	139	139	139	140	140	140	140	141	141	141	142	142	142	143	143	144
135	139	139	139	140	140	140	140	140	141	141	141	141	142	142	142	142	143	143	143	144	144	144
140	141	141	141	141	141	142	142	142	142	143	143	143	143	143	143	144	144	144	145	145	145	145
145	142	142	143	143	143	143	143	143	144	144	144	144	144	144	145	145	145	145	146	146	146	146
150	144	144	144	144	145	145	145	145	145	145	146	146	146	146	146	147	147	147	147	147	148	148
155	146	146	146	146	146	146	146	146	147	147	147	147	147	147	148	148	148	148	148	149	149	149
160	148	148	148	148	148	148	148	148	148	148	148	149	149	149	149	149	149	149	150	150	150	150
165	149	149	149	149	149	149	150	150	150	150	150	150	150	150	151	151	151	151	151	151	151	151
170	151	151	151	151	151	151	151	151	151	151	151	152	152	152	152	152	152	152	153	153	153	153
175	153	153	153	153	153	153	153	153	153	153	153	153	153	153	154	154	154	154	154	154	154	154
180	155	155	155	155	154	154	154	154	154	154	155	155	155	155	155	155	155	155	155	155	156	156
185	157	156	156	156	156	156	156	156	156	156	156	156	156	156	156	156	156	156	157	157	157	157
190	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158
195	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160
200	162	162	162	162	161	161	161	161	161	161	161	161	161	161	161	161	161	161	161	161	161	161
205	164	164	164	163	163	163	163	163	163	163	163	163	162	162	162	162	162	162	163	163	163	163
210	166	166	165	165	165	165	165	164	164	164	164	164	164	164	164	164	164	164	164	164	164	164
215	168	167	167	167	167	166	166	166	166	166	166	166	166	166	166	166	165	165	165	165	165	166
220	169	169	169	169	168	168	168	168	168	167	167	167	167	167	167	167	167	167	167	167	167	167
225	171	171	171	170	170	170	170	170	169	169	169	169	169	169	169	169	169	168	168	168	168	168
230	173	173	173	172	172	172	172	171	171	171	171	171	170	170	170	170	170	170	170	170	170	170
235	175	175	174	174	174	174	173	173	173	173	172	172	172	172	172	172	172	172	171	171	171	171
240	177	177	176	176	176	175	175	175	175	174	174	174	174	174	173	173	173	173	173	173	173	173





TABLE 10. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICRPOISES

		MOLE FRACTION OF HELIUM 0.6000																					
T, DEG K	156	158	160	162	164	166	168	170	172	174	176	178	180	182	184	186	188	190	192	194	196	198	
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	
1	121	122	123	124	125	126	128	129	130	131	132	133	134	136	137	138	139	140	141	142	143	144	
5	121	122	123	124	126	127	128	129	130	131	132	134	135	136	137	138	139	140	141	142	144	145	
10	121	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	144	145
15	122	123	124	125	126	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145
20	122	124	125	126	127	128	129	130	132	133	134	135	136	137	138	139	140	141	142	143	144	145	145
25	123	124	125	126	128	129	130	131	132	133	134	135	136	138	139	140	141	142	143	144	145	146	146
30	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146
35	124	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	146	147	147
40	125	126	127	128	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	147
45	126	127	128	129	130	131	132	133	135	136	137	138	139	140	141	142	143	144	146	147	148	148	148
50	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	143	144	145	146	147	148	149	149
55	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	149
60	128	129	130	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	150
65	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	150
70	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	151
75	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	152
80	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	153
85	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	154
90	134	135	136	137	138	139	140	141	141	142	143	144	145	146	147	148	149	150	151	152	153	154	154
95	135	136	137	138	139	140	141	141	142	143	144	145	146	147	148	149	150	151	152	153	153	154	154
100	136	137	138	139	140	141	142	142	143	144	145	146	147	148	149	150	150	151	152	153	154	155	155
105	137	138	139	140	141	142	142	143	144	145	146	147	148	149	149	150	151	152	153	154	155	156	156
110	139	139	140	141	142	143	143	144	145	146	147	148	149	149	150	151	152	153	154	155	156	157	157
115	140	140	141	142	143	144	144	145	146	147	148	149	149	150	151	152	153	154	155	155	156	157	157
120	141	142	142	143	144	145	145	146	147	148	149	149	150	151	152	153	154	155	155	156	157	158	158
125	142	143	143	144	145	146	146	147	148	149	150	150	151	152	153	154	155	155	156	157	158	159	159
130	143	144	145	145	146	147	147	148	149	150	151	151	152	153	154	155	155	156	157	158	159	160	160
135	144	145	146	146	147	148	149	149	150	151	152	152	153	154	155	155	156	157	158	159	159	160	160
140	146	146	147	148	148	149	150	150	151	152	152	153	154	155	155	156	157	158	159	159	160	161	161
145	147	148	148	149	149	150	151	151	152	153	153	154	155	156	156	157	158	159	159	160	161	162	162
150	148	149	149	150	150	151	152	152	153	154	154	155	156	157	157	158	159	160	160	161	162	163	163
155	149	150	151	151	152	152	153	154	154	155	155	156	157	158	158	159	160	161	161	162	163	164	164
160	151	151	152	152	153	153	154	155	155	156	157	158	159	159	160	161	161	162	162	163	164	164	164
165	152	152	153	153	154	155	155	156	156	157	158	159	160	160	161	162	162	163	163	164	165	165	165
170	153	154	154	155	155	156	156	157	158	159	160	160	161	161	162	163	163	164	164	165	166	166	166
175	155	155	155	156	156	157	157	158	158	159	160	160	161	161	162	163	163	164	165	165	166	167	167
180	156	156	157	157	158	158	159	159	160	160	161	161	162	162	163	164	164	165	166	166	167	168	168
185	157	158	158	158	159	159	160	160	161	161	162	162	163	164	164	165	166	166	167	168	169	169	169
190	159	159	159	160	160	160	161	161	162	162	163	164	164	165	165	166	167	167	168	168	169	170	170
195	160	160	161	161	161	162	162	163	163	164	164	165	165	166	166	167	168	168	169	170	171	171	171
200	161	162	162	162	163	163	163	164	164	165	165	166	166	167	167	168	168	169	169	170	171	171	171
205	163	163	163	164	164	164	165	165	165	166	166	167	167	168	168	169	169	170	170	171	172	172	172
210	164	164	165	165	165	166	166	166	166	167	167	168	168	169	169	170	170	171	171	172	172	173	173
215	166	166	166	166	166	167	167	167	168	168	168	169	169	170	170	171	171	172	172	173	174	174	174
220	167	167	167	167	168	168	168	168	169	169	170	170	170	171	171	172	172	173	173	174	175	175	175
225	168	169	169	169	169	169	169	170	170	170	171	171	171	172	172	173	173	174	174	175	176	176	176
230	170	170	170	170	170	171	171	171	171	171	172	172	173	173	173	174	174	175	175	176	176	177	177
235	171	171	171	171	172	172	172	172	172	173	173	173	174	174	174	175	175	176	176	177	177	178	178
240	173	173	173	173	173	173	173	173	174	174	174	174	175	175	175	176	176	177	177	178	178	179	179



TABLE 10. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

		MOLE FRACTION OF HELIUM 0.6000																					
T, DEG K		200	205	210	215	220	225	230	235	240	245	250	255	260	265	270	275	280	285	290	295	300	305
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	145	148	151	153	156	159	161	164	166	169	171	174	176	179	181	183	186	188	190	193	195	197	
5	146	148	151	154	156	159	161	164	166	169	171	174	176	179	181	184	186	188	191	193	195	197	
10	146	149	151	154	157	159	162	164	167	169	172	174	177	179	181	184	186	188	191	193	195	197	
15	146	149	152	154	157	159	162	164	167	169	172	174	177	179	182	184	186	189	191	193	195	198	
20	147	149	152	155	157	160	162	165	167	170	172	175	177	179	182	184	187	189	191	194	196	198	
25	147	150	152	155	158	160	163	165	168	170	173	175	177	180	182	185	187	189	191	194	196	198	
30	148	150	153	155	158	161	163	166	168	170	173	175	178	180	182	185	187	189	191	194	196	198	
35	148	151	153	156	158	161	163	166	168	171	173	176	178	180	182	185	187	189	192	194	196	199	
40	149	151	154	156	159	161	164	166	169	171	174	176	178	181	183	185	188	190	192	194	197	199	
45	149	152	154	157	159	162	164	167	169	172	174	176	179	181	183	186	188	190	193	195	197	199	
50	150	152	155	157	160	162	165	167	170	172	174	177	179	181	184	186	188	191	193	195	198	200	
55	150	153	155	158	160	163	165	168	170	172	175	177	180	182	184	186	189	191	193	196	198	200	
60	151	153	156	158	161	163	166	168	170	173	175	178	180	182	185	187	189	191	194	196	198	200	
65	151	154	156	159	161	164	166	169	171	173	176	178	180	183	185	187	189	192	194	196	198	201	
70	152	155	157	159	162	164	167	169	171	174	176	178	181	183	185	188	190	192	194	197	199	201	
75	153	155	158	160	162	165	167	169	172	174	177	179	181	183	186	188	190	192	195	197	199	201	
80	153	156	158	161	163	165	168	170	172	175	177	179	182	184	186	188	191	193	195	197	200	202	
85	154	156	159	161	163	166	168	170	173	175	177	180	182	184	187	189	191	193	195	198	200	202	
90	155	157	159	162	164	166	169	171	173	176	178	180	182	185	187	189	191	194	196	198	200	202	
95	155	158	160	162	165	167	169	172	174	176	178	181	183	185	187	190	192	194	196	198	201	203	
100	156	158	161	163	165	167	170	172	174	177	179	181	183	186	188	190	192	194	197	199	201	203	
105	157	159	161	164	166	168	170	173	175	177	179	182	184	186	188	190	193	195	197	199	201	203	
110	157	160	162	164	166	169	171	173	175	178	180	182	184	187	189	191	193	195	197	200	202	204	
115	158	160	163	165	167	169	171	174	176	178	180	183	185	187	189	191	194	196	198	200	202	204	
120	159	161	163	165	168	170	172	174	176	179	181	183	185	187	190	192	194	196	198	200	203	205	
125	160	162	164	166	168	170	173	175	177	179	181	184	186	188	190	192	194	197	199	201	203	205	
130	160	163	165	167	169	171	173	175	178	180	182	184	186	188	191	193	195	197	199	201	203	205	
135	161	163	165	167	170	172	174	176	178	180	182	185	187	189	191	193	195	197	199	201	203	205	
140	162	164	166	168	170	172	174	177	179	181	183	185	187	189	192	194	196	198	200	202	204	206	
145	163	165	167	169	171	173	175	177	179	181	184	186	188	190	192	194	196	198	200	202	204	206	
150	164	166	168	170	172	174	176	178	180	182	184	186	188	190	192	195	197	199	201	203	205	207	
155	164	166	168	170	172	174	176	178	181	183	185	187	189	191	193	195	197	199	201	203	205	207	
160	165	167	169	171	173	175	177	179	181	183	185	187	189	191	193	196	198	200	202	204	206	208	
165	166	168	170	172	174	176	178	180	182	184	186	188	190	192	194	196	198	200	202	204	206	208	
170	167	169	171	172	174	176	178	180	182	184	186	188	190	192	195	197	199	201	203	205	207	209	
175	168	169	171	173	175	177	179	181	183	185	187	189	191	193	195	197	199	201	203	205	207	209	
180	168	170	172	174	176	178	180	182	184	186	188	190	192	194	196	198	200	202	204	206	208	210	
185	169	171	173	175	177	178	180	182	184	186	188	190	192	194	196	198	200	202	204	206	208	210	
190	170	172	174	175	177	179	181	183	185	187	189	191	193	195	197	199	201	203	205	206	208	210	
195	171	173	174	176	178	180	182	184	185	187	189	191	193	195	197	199	201	203	205	206	208	210	
200	172	174	175	177	179	181	182	184	186	188	190	192	194	196	198	200	202	204	205	207	209	211	
205	173	174	176	178	180	181	183	185	187	189	191	192	194	196	198	200	202	204	206	208	210	212	
210	174	175	177	179	180	182	184	186	187	189	191	193	195	197	199	201	203	205	206	208	210	212	
215	175	176	178	179	181	183	185	186	188	190	192	194	196	197	199	201	203	205	207	209	211	213	
220	176	177	179	180	182	184	185	187	189	191	192	194	196	198	200	202	204	206	207	209	211	213	
225	176	178	179	181	183	184	186	188	189	191	193	195	197	199	200	202	204	206	208	210	212	214	
230	177	179	180	182	183	185	187	188	190	192	194	195	197	199	201	203	205	207	208	210	212	214	
235	178	180	181	183	184	186	187	189	191	193	194	196	198	200	202	203	205	207	209	211	213	215	
240	179	181	182	183	185	187	188	190	191	193	195	197	198	200	202	204	206	208	209	211	213	215	



TABLE 10. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

		MOLE FRACTION OF HELIUM 0.6000																				
T, DEG K	310	320	330	340	350	360	370	380	390	400	410	420	430	440	450	460	470	480	490	500	510	520
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	200	204	209	213	217	221	226	230	234	238	242	246	250	254	258	262	265	269	273	277	280	284
5	200	204	209	213	217	222	226	230	234	238	242	246	250	254	258	262	266	269	273	277	280	284
10	200	204	209	213	217	222	226	230	234	238	242	246	250	254	258	262	266	269	273	277	280	284
15	200	205	209	213	218	222	226	230	234	238	242	246	250	254	258	262	266	270	273	277	281	284
20	200	205	209	214	218	222	226	230	235	239	243	247	251	254	258	262	266	270	273	277	281	284
25	201	205	209	214	218	222	226	231	235	239	243	247	251	254	258	262	266	270	273	277	281	284
30	201	205	210	214	218	223	227	231	235	239	243	247	251	255	258	262	266	270	274	277	281	285
35	201	206	210	214	219	223	227	231	235	239	243	247	251	255	259	262	266	270	274	277	281	285
40	201	206	210	214	219	223	227	231	235	239	243	247	251	255	259	263	266	270	274	278	281	285
45	202	206	210	215	219	223	227	231	235	239	243	247	251	255	259	263	267	270	274	278	281	285
50	202	206	211	215	219	223	228	232	236	240	244	248	251	255	259	263	267	270	274	278	281	285
55	202	207	211	215	219	224	228	232	236	240	244	248	252	256	260	263	267	271	274	278	282	285
60	203	207	211	216	220	224	228	232	236	240	244	248	252	256	260	263	267	271	274	278	282	285
65	203	207	212	216	220	224	228	232	236	240	244	248	252	256	260	263	267	271	275	278	282	286
70	203	208	212	216	220	224	229	233	237	241	245	249	252	256	260	264	267	271	275	278	282	286
75	204	208	212	216	221	225	229	233	237	241	245	249	253	256	260	264	268	271	275	279	282	286
80	204	208	212	217	221	225	229	233	237	241	245	249	253	256	260	264	268	272	275	279	282	286
85	204	209	213	217	221	225	229	233	237	241	245	249	253	257	261	264	268	272	275	279	283	286
90	205	209	213	217	221	226	230	234	238	242	246	249	253	257	261	264	268	272	276	279	283	286
95	205	209	213	218	222	226	230	234	238	242	246	249	253	257	261	265	268	272	276	279	283	287
100	205	210	214	218	222	226	230	234	238	242	246	250	254	258	261	265	269	272	276	280	283	287
105	206	210	214	218	222	226	230	234	238	242	246	250	254	258	262	265	269	272	276	280	283	287
110	206	210	214	219	223	227	231	235	239	243	247	250	254	258	262	266	269	273	276	280	284	287
115	206	211	215	219	223	227	231	235	239	243	247	251	254	258	262	266	269	273	277	280	284	287
120	207	211	215	219	223	227	231	235	239	243	247	251	254	258	262	266	269	273	277	280	284	287
125	207	211	215	220	224	228	232	236	240	243	247	251	255	258	262	266	270	273	277	281	284	288
130	208	212	216	220	224	228	232	236	240	244	248	251	255	259	262	266	270	274	277	281	284	288
135	208	212	216	220	224	228	232	236	240	244	248	252	255	259	263	266	270	274	277	281	284	288
140	208	212	217	221	225	229	233	236	240	244	248	252	256	259	263	267	270	274	278	281	285	288
145	209	213	217	221	225	229	233	237	241	245	248	252	256	259	263	267	271	274	278	281	285	288
150	209	213	217	221	225	229	233	237	241	245	249	252	256	260	263	267	271	274	278	282	285	289
155	209	214	218	222	226	230	233	237	241	245	249	253	256	260	264	268	271	275	278	282	285	289
160	210	214	218	222	226	230	234	238	242	245	249	253	257	260	264	268	271	275	279	282	286	289
165	210	214	218	222	226	230	234	238	242	246	249	253	257	261	264	268	272	275	279	282	286	289
170	211	215	219	223	227	231	234	238	242	246	250	254	257	261	265	268	272	275	279	282	286	289
175	211	215	219	223	227	231	235	239	242	246	250	254	258	261	265	268	272	275	279	283	286	290
180	212	216	219	223	227	231	235	239	242	246	250	254	258	261	265	269	272	276	279	283	286	290
185	212	216	220	224	228	232	235	239	243	247	250	254	258	261	265	269	272	276	279	283	287	290
190	212	216	220	224	228	232	236	240	243	247	251	255	258	262	265	269	273	276	280	283	287	290
195	213	217	221	225	228	232	236	240	244	247	251	255	258	262	266	269	273	276	280	283	287	290
200	213	217	221	225	229	233	236	240	244	248	251	255	259	262	266	269	273	277	280	284	287	291
205	214	218	221	225	229	233	237	241	244	248	252	255	259	263	266	270	273	277	280	284	287	291
210	214	218	222	226	230	233	237	241	245	248	252	256	259	263	266	270	274	277	281	284	288	291
215	215	218	222	226	230	234	237	241	245	249	252	256	260	263	267	270	274	277	281	284	288	291
220	215	219	223	226	230	234	237	241	245	249	252	256	260	263	267	270	274	278	281	285	288	291
225	215	219	223	227	231	234	238	242	245	249	253	256	260	264	267	271	274	278	281	285	288	292
230	216	220	223	227	231	235	239	242	246	250	253	257	260	264	267	271	275	278	282	285	288	292
235	216	220	224	228	231	235	239	243	246	250	254	257	261	264	268	271	275	278	282	285	289	292
240	217	221	224	228	232	236	239	243	247	250	254	257	261	264	268	272	275	279	282	286	289	292



TABLE 10. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

		MOLE FRACTION OF HELIUM 0.6000																				
T, DEG K	530	540	550	560	570	580	590	600	610	620	630	640	650	660	670	680	690	700	710	720	730	740
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	288	291	295	298	302	305	309	312	315	319	322	326	329	332	335	339	342	345	348	351	355	358
5	288	291	295	298	302	305	309	312	316	319	322	326	329	332	335	339	342	345	348	351	355	358
10	288	291	295	298	302	305	309	312	316	319	322	326	329	332	335	339	342	345	348	351	355	358
15	288	291	295	298	302	305	309	312	316	319	322	326	329	332	335	339	342	345	348	351	355	358
20	288	292	295	299	302	306	309	312	316	319	322	326	329	332	336	339	342	345	348	351	355	358
25	288	292	295	299	302	306	309	313	316	319	322	326	329	332	336	339	342	345	348	351	355	358
30	288	292	295	299	302	306	309	313	316	319	323	326	329	332	336	339	342	345	349	352	355	358
35	288	292	295	299	302	306	309	313	316	319	323	326	329	333	336	339	342	345	349	352	355	358
40	289	292	296	299	303	306	309	313	316	320	323	326	329	333	336	339	342	346	349	352	355	358
45	289	292	296	299	303	306	310	313	316	320	323	326	330	333	336	339	342	346	349	352	355	358
50	289	292	296	299	303	306	310	313	316	320	323	326	330	333	336	339	343	346	349	352	355	358
55	289	293	296	300	303	306	310	313	317	320	323	327	330	333	336	340	343	346	349	352	355	358
60	289	293	296	300	303	307	310	313	317	320	323	327	330	333	336	340	343	346	349	352	355	359
65	289	293	296	300	303	307	310	314	317	320	324	327	330	333	336	340	343	346	349	352	356	359
70	289	293	296	300	303	307	310	314	317	320	324	327	330	333	337	340	343	346	349	353	356	359
75	290	293	297	300	304	307	310	314	317	320	324	327	330	333	337	340	343	346	349	353	356	359
80	290	293	297	300	304	307	311	314	317	321	324	327	330	334	337	340	343	346	350	353	356	359
85	290	293	297	300	304	307	311	314	317	321	324	327	331	334	337	340	343	347	350	353	356	359
90	290	294	297	301	304	307	311	314	318	321	324	327	331	334	337	340	344	347	350	353	356	359
95	290	294	297	301	304	308	311	314	318	321	324	328	331	334	337	340	344	347	350	353	356	359
100	290	294	297	301	304	308	311	315	318	321	324	328	331	334	337	341	344	347	350	353	356	359
105	291	294	298	301	304	308	311	315	318	321	325	328	331	334	338	341	344	347	350	353	356	360
110	291	294	298	301	305	308	311	315	318	321	325	328	331	335	338	341	344	347	350	353	357	360
115	291	294	298	301	305	308	312	315	318	322	325	328	331	335	338	341	344	347	350	354	357	360
120	291	295	298	302	305	308	312	315	318	322	325	328	332	335	338	341	344	347	351	354	357	360
125	291	295	298	302	305	309	312	315	319	322	325	328	332	335	338	341	344	348	351	354	357	360
130	292	295	298	302	305	309	312	315	319	322	325	328	332	335	338	341	345	348	351	354	357	360
135	292	295	299	302	305	309	312	316	319	322	325	329	332	335	338	341	345	348	351	354	357	360
140	292	295	299	302	306	309	312	316	319	322	326	329	332	335	338	342	345	348	351	354	357	360
145	292	296	299	302	306	309	313	316	319	323	326	329	332	335	339	342	345	348	351	354	357	361
150	292	296	299	303	306	309	313	316	319	323	326	329	332	336	339	342	345	348	351	354	358	361
155	292	296	299	303	306	310	313	316	320	323	326	329	333	336	339	342	345	348	351	355	358	361
160	293	296	300	303	306	310	313	316	320	323	326	330	333	336	339	342	345	348	352	355	358	361
165	293	296	300	303	307	310	313	317	320	323	326	330	333	336	339	342	345	349	352	355	358	361
170	293	297	300	303	307	310	313	317	320	323	327	330	333	336	339	342	346	349	352	355	358	361
175	293	297	300	304	307	310	314	317	320	323	327	330	333	336	340	343	346	349	352	355	358	361
180	293	297	300	304	307	310	314	317	320	323	327	330	333	336	340	343	346	349	352	355	358	361
185	294	297	301	304	307	311	314	317	321	324	327	330	333	337	340	343	346	349	352	355	358	362
190	294	297	301	304	307	311	314	317	321	324	327	330	334	337	340	343	346	349	352	356	359	362
195	294	298	301	304	308	311	314	318	321	324	327	331	334	337	340	343	346	349	353	356	359	362
200	294	298	301	304	308	311	314	318	321	324	328	331	334	337	340	343	346	350	353	356	359	362
205	295	298	301	305	308	311	315	318	321	324	328	331	334	337	340	343	347	350	353	356	359	362
210	295	298	302	305	308	312	315	318	321	325	328	331	334	337	341	344	347	350	353	356	359	362
215	295	298	302	305	308	312	315	318	322	325	328	331	334	338	341	344	347	350	353	356	359	362
220	295	299	302	305	309	312	315	318	322	325	328	331	334	338	341	344	347	350	353	356	359	362
225	295	299	302	305	309	312	315	319	322	325	328	332	335	338	341	344	347	350	353	356	360	363
230	296	299	302	306	309	312	316	319	322	325	329	332	335	338	341	344	347	350	354	357	360	363
235	296	299	303	306	309	312	316	319	322	326	329	332	335	338	341	344	348	351	354	357	360	363
240	296	299	303	306	309	313	316	319	322	326	329	332	335	338	341	345	348	351	354	357	360	363





TABLE 11. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

		MOLE FRACTION OF HELIUM 0.5000																					
T, DEG K		133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154
P, ATM		VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1		103	104	105	105	106	107	107	108	108	109	110	110	111	111	112	113	113	114	114	115	116	116
5		104	105	105	106	106	107	108	108	109	109	110	111	111	112	112	113	114	114	115	115	116	117
10		105	105	106	107	107	108	108	109	110	110	111	111	112	112	113	113	114	114	115	116	116	117
15		106	106	107	107	108	109	109	110	110	111	111	112	112	113	113	114	114	115	116	116	117	117
20		107	107	108	108	109	110	110	111	111	112	112	113	113	114	114	115	115	116	116	117	117	118
25		108	108	109	109	110	111	111	112	112	113	113	114	114	115	115	116	116	117	117	118	118	119
30		109	109	110	111	111	112	112	113	113	114	114	115	115	116	116	117	117	118	118	119	119	120
35		110	111	111	112	112	113	113	114	114	115	115	116	116	117	117	118	118	119	119	120	120	121
40		112	112	113	113	114	114	115	115	116	116	117	117	118	118	119	119	120	120	121	121	122	122
45		113	113	114	114	115	115	116	116	117	117	118	118	119	119	120	120	121	121	122	122	123	123
50		115	115	115	116	116	117	117	118	118	119	119	120	120	121	121	122	122	123	123	124	124	125
55		116	117	117	117	118	118	119	119	120	120	121	121	122	122	123	123	124	124	125	125	126	126
60		118	118	119	119	120	120	120	121	121	122	122	123	123	124	124	124	125	125	126	126	127	127
65		120	120	120	121	121	122	122	122	123	123	124	124	125	125	126	126	127	127	128	128	129	129
70		122	122	122	123	123	123	124	124	124	125	125	126	126	127	127	128	128	129	129	130	130	131
75		123	124	124	124	125	125	125	126	126	127	127	127	128	128	128	129	129	130	130	131	131	131
80		125	126	126	126	127	127	127	128	128	128	129	129	129	130	130	130	131	131	131	132	132	133
85		128	128	128	128	129	129	129	129	130	130	131	131	131	131	132	132	132	133	133	133	134	134
90		130	130	130	130	131	131	131	131	132	132	132	132	133	133	133	134	134	134	135	135	135	136
95		132	132	132	132	133	133	133	133	133	134	134	134	134	135	135	135	136	136	136	137	137	137
100		134	134	134	134	135	135	135	135	135	136	136	136	136	137	137	137	138	138	138	138	139	139
105		136	136	137	137	137	137	137	137	137	138	138	138	138	138	139	139	139	139	140	140	140	140
110		139	139	139	139	139	139	139	139	139	140	140	140	140	140	141	141	141	141	141	141	142	142
115		141	141	141	141	141	141	141	141	141	142	142	142	142	142	142	143	143	143	143	143	143	144
120		144	143	143	143	143	143	143	143	144	144	144	144	144	144	144	144	145	145	145	145	145	145
125		146	146	146	146	146	146	146	146	146	146	146	146	146	146	146	146	146	147	147	147	147	147
130		148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	149	149	149
135		151	151	151	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	151	151
140		153	153	153	153	153	153	152	152	152	152	152	152	152	152	152	152	152	152	152	152	152	152
145		156	156	155	155	155	155	155	155	154	154	154	154	154	154	154	154	154	154	154	154	154	154
150		159	158	158	158	157	157	157	157	157	156	156	156	156	156	156	156	156	156	156	156	156	156
155		161	161	160	160	160	160	159	159	159	159	159	158	158	158	158	158	158	158	158	158	158	158
160		164	163	163	163	162	162	161	161	161	161	161	160	160	160	160	160	160	160	160	160	160	160
165		166	166	165	165	165	164	164	164	163	163	163	163	162	162	162	162	162	162	162	162	162	162
170		169	168	168	168	167	167	166	166	166	165	165	165	165	164	164	164	164	164	164	164	164	164
175		171	171	170	170	170	169	169	168	168	168	167	167	167	167	166	166	166	166	166	166	166	166
180		174	174	173	173	172	172	171	171	170	170	170	169	169	169	168	168	168	168	168	168	168	168
185		177	176	176	175	174	174	174	173	173	172	172	172	171	171	171	171	170	170	170	170	169	169
190		179	179	178	177	177	176	176	175	175	175	174	174	174	173	173	173	172	172	172	172	172	171
195		182	181	181	180	179	179	178	178	177	177	176	176	175	175	175	175	174	174	174	174	174	173
200		184	184	183	182	182	181	181	180	180	179	179	178	178	178	177	177	177	176	176	176	176	175
205		187	186	186	185	184	184	183	183	182	182	181	181	180	180	179	179	179	178	178	178	178	177
210		190	189	188	187	187	186	186	185	184	184	183	183	182	182	182	181	181	181	180	180	180	179
215		192	191	191	190	189	189	188	187	187	186	185	185	184	184	183	183	183	182	182	182	182	181
220		195	194	193	192	192	191	190	190	189	189	188	187	187	186	186	185	185	184	184	184	184	183
225		197	197	196	195	194	193	193	192	191	191	190	190	189	189	188	188	187	187	186	186	186	185
230		200	199	198	197	197	196	195	194	194	193	193	192	191	191	190	189	189	189	188	188	188	187
235		203	202	201	200	199	198	198	197	196	195	195	194	194	193	193	192	191	191	190	189	188	187
240		205	204	203	202	202	201	200	199	199	198	197	197	196	195	195	194	193	193	192	192	192	191



TABLE 11. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

		MOLE FRACTION OF HELIUM 0.5000																					
T, DEG K	P, ATM	156	158	160	162	164	166	168	170	172	174	176	178	180	182	184	186	188	190	192	194	196	198
		VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
	1	117	119	120	121	122	123	124	126	127	128	129	130	131	132	134	135	136	137	138	139	140	141
	5	118	119	120	121	123	124	125	126	127	128	129	131	132	133	134	135	136	137	138	139	140	142
	10	118	120	121	122	123	124	125	127	128	129	130	131	132	133	134	135	136	137	138	139	140	142
	15	119	120	121	123	124	125	126	127	128	129	130	131	132	133	134	135	137	138	139	140	141	142
	20	120	121	122	123	124	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	143
	25	121	122	123	124	125	126	127	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143
	30	122	123	124	125	126	127	128	129	130	132	133	134	135	136	137	138	139	140	141	142	143	144
	35	123	124	125	126	127	128	129	130	131	132	133	134	136	137	138	139	140	141	142	143	144	145
	40	124	125	126	127	128	129	130	131	132	133	134	136	137	138	139	140	141	142	143	144	145	146
	45	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	142	143	144	145	146	147
	50	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147
	55	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148
	60	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149
	65	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
	70	131	132	133	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151
	75	132	133	134	135	136	136	137	138	139	140	141	142	143	144	145	146	146	147	148	149	150	151
	80	133	134	135	136	137	138	138	139	140	141	142	143	144	145	146	147	147	148	149	150	151	152
	85	135	136	136	137	138	139	140	141	141	142	143	144	145	146	147	147	148	149	150	151	152	153
	90	136	137	138	139	139	140	141	142	143	143	144	145	146	147	148	148	149	150	151	152	153	154
	95	138	139	139	140	141	141	142	143	144	145	146	147	148	149	149	150	151	152	153	154	155	156
	100	139	140	141	141	142	143	144	144	145	146	147	147	148	149	150	151	151	152	153	154	155	156
	105	141	142	142	143	143	144	145	146	146	147	148	149	149	150	151	152	153	153	154	155	156	157
	110	143	143	144	144	145	146	146	147	148	148	149	150	151	152	153	154	154	155	156	157	158	159
	115	144	145	145	146	146	147	148	148	149	150	151	152	152	153	154	155	156	157	158	159	160	161
	120	146	146	147	147	148	148	149	150	151	152	152	153	154	154	155	156	157	158	159	160	161	162
	125	147	148	148	149	149	150	150	151	152	152	153	154	154	155	156	157	158	159	160	161	162	163
	130	149	150	150	150	151	151	152	152	153	154	154	155	155	156	157	158	159	160	161	162	163	164
	135	151	151	152	152	153	153	154	154	155	156	156	157	157	158	159	159	160	161	161	162	163	164
	140	153	153	153	154	154	155	155	156	156	157	157	158	159	159	160	160	161	162	162	163	164	165
	145	154	155	155	155	156	156	157	157	158	158	159	159	160	160	161	162	162	163	164	164	165	166
	150	156	156	157	157	157	158	158	159	159	160	160	161	161	162	162	163	164	164	165	165	166	167
	155	158	158	158	159	159	159	160	160	161	161	162	162	163	163	164	164	165	165	166	167	168	169
	160	160	160	160	160	161	161	161	162	162	162	163	163	164	164	165	165	166	166	167	168	169	170
	165	162	162	162	162	162	163	163	163	164	164	164	165	165	166	166	167	167	168	168	169	170	171
	170	164	164	164	164	164	164	164	165	165	165	166	166	167	167	167	168	168	169	169	170	171	172
	175	165	165	165	165	165	166	166	166	167	167	167	168	168	168	169	169	170	170	171	171	172	173
	180	167	167	167	167	167	167	168	168	168	168	169	169	169	170	170	170	171	171	172	172	173	174
	185	169	169	169	169	169	169	169	169	170	170	170	170	171	171	171	171	172	172	173	173	174	175
	190	171	171	171	171	171	171	171	171	171	171	171	171	172	172	172	173	173	173	174	174	175	176
	195	173	173	173	172	172	172	172	172	173	173	173	173	173	174	174	174	175	175	176	176	177	178
	200	175	175	174	174	174	174	174	174	174	174	174	174	175	175	175	176	176	176	177	177	178	179
	205	177	177	176	176	176	176	176	176	176	176	176	176	177	177	177	177	178	178	178	179	180	181
	210	179	178	178	178	177	177	177	177	177	177	177	178	178	178	178	179	179	179	180	180	181	182
	215	181	180	180	180	179	179	179	179	179	179	179	180	180	181	181	181	181	182	182	183	183	184
	220	183	182	182	181	181	181	181	180	180	180	180	181	181	181	181	181	181	182	182	183	184	185
	225	185	184	184	183	183	183	182	182	182	182	182	182	182	182	182	183	183	183	183	184	185	186
	230	187	186	186	185	185	184	184	184	184	184	184	184	184	184	184	184	184	184	184	185	186	187
	235	189	188	187	187	187	186	186	186	185	185	185	185	185	185	185	185	185	185	186	186	187	188
	240	191	190	189	189	188	188	188	187	187	187	187	187	187	187	187	187	187	187	187	187	188	189



TABLE 11. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

		MOLE FRACTION OF HELIUM 0.5000																					
T, DEG K	P, ATM	200	205	210	215	220	225	230	235	240	245	250	255	260	265	270	275	280	285	290	295	300	305
		VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
	1	142	145	148	150	153	156	158	161	163	166	168	171	173	176	178	180	183	185	187	190	192	194
5		143	145	148	151	153	156	158	161	163	166	168	171	173	176	178	181	183	185	188	190	192	195
10		143	146	148	151	154	156	159	161	164	166	169	171	174	176	179	181	183	186	188	190	193	195
15		144	146	149	152	154	157	159	162	164	167	169	172	174	176	179	181	184	186	188	191	193	195
20		144	147	149	152	155	157	160	162	165	167	170	172	174	176	179	181	184	186	188	191	193	195
25		145	147	150	153	155	158	160	163	165	168	170	172	174	177	179	182	184	186	189	191	193	195
30		145	148	151	153	156	158	161	163	166	168	170	173	175	177	180	182	184	187	189	191	193	196
35		146	149	151	154	156	159	161	164	166	169	171	173	176	178	180	182	185	187	189	192	194	196
40		147	149	152	154	157	159	162	164	167	169	171	174	176	179	181	183	185	187	190	192	194	196
45		147	150	152	155	157	160	162	165	167	170	172	174	177	179	181	183	185	188	190	192	195	197
50		148	151	153	156	158	160	163	165	168	170	172	175	177	179	182	184	186	188	190	193	195	197
	55	149	151	154	156	159	161	163	166	168	171	173	175	178	180	182	185	187	189	191	193	195	198
	60	150	152	154	157	159	162	164	166	169	171	174	176	178	180	183	185	187	189	191	194	196	198
	65	150	153	155	158	160	162	165	167	169	172	174	176	179	181	183	186	188	190	192	194	196	198
	70	151	154	156	158	161	163	165	168	170	172	175	177	179	182	184	186	188	190	192	194	196	198
	75	152	154	157	159	161	164	166	168	171	173	175	177	179	182	184	186	188	190	193	195	197	199
	80	153	155	158	160	162	164	167	169	171	174	176	178	180	182	184	187	189	191	193	195	198	200
	85	154	156	158	161	163	165	167	170	172	174	176	179	181	183	185	187	189	191	194	196	198	200
	90	155	157	159	161	164	166	168	170	173	175	177	179	182	184	186	188	190	192	194	196	198	201
	95	156	158	160	162	164	167	169	171	173	175	178	180	182	184	186	188	190	192	195	197	199	201
	100	157	159	161	163	165	167	170	172	174	176	178	181	183	185	187	189	191	193	195	197	199	202
	105	157	160	162	164	166	168	170	172	175	177	179	181	183	185	188	190	192	194	196	198	200	202
	110	158	161	163	165	167	169	171	173	175	178	180	182	184	186	188	190	192	194	196	198	200	202
	115	159	161	163	166	168	170	172	174	176	178	180	182	185	187	189	191	193	195	197	199	201	203
	120	160	162	164	166	168	171	173	175	177	179	181	183	185	187	189	192	194	196	198	200	202	204
	125	161	163	165	167	169	171	173	175	178	180	182	184	186	188	190	192	194	196	198	200	202	204
	130	162	164	166	168	170	172	174	176	178	180	182	184	186	188	190	192	194	196	198	200	202	204
	135	163	165	167	169	171	173	175	177	179	181	183	185	187	189	191	193	195	197	199	201	203	205
	140	165	166	168	170	172	174	176	178	180	182	184	186	188	190	192	194	196	198	200	202	204	206
	145	166	167	169	171	173	175	177	179	181	183	185	187	189	191	193	195	197	199	201	203	205	207
	150	167	168	170	172	174	176	178	179	181	183	185	187	189	191	193	195	197	199	201	203	205	207
	155	168	169	171	173	175	176	178	180	182	184	186	188	190	192	194	196	198	200	202	204	206	208
	160	169	170	172	174	176	177	179	181	183	185	187	189	191	193	194	196	198	200	202	204	206	208
	165	170	172	173	175	177	178	180	182	184	186	187	189	191	193	195	197	199	201	203	205	207	209
	170	171	173	174	176	177	179	181	183	185	186	188	190	192	194	196	198	200	202	203	205	207	209
	175	172	174	175	177	178	180	182	184	185	187	189	191	193	195	196	198	200	202	203	205	207	209
	180	173	175	176	178	179	181	183	184	186	188	190	192	193	195	196	198	200	202	204	206	208	210
	185	175	176	177	179	180	182	184	185	187	189	191	192	194	196	198	200	202	203	205	207	208	210
	190	176	177	178	180	181	183	185	186	188	190	191	193	195	197	199	200	202	203	205	207	209	211
	195	177	178	179	181	182	184	185	187	189	190	192	194	196	197	199	201	202	204	206	208	210	212
	200	178	179	181	182	183	185	186	188	190	191	193	195	196	198	200	202	204	205	207	209	211	213
	205	179	180	182	183	184	186	187	189	190	192	194	195	197	199	201	202	204	206	208	210	211	213
	210	180	182	183	184	185	187	188	190	191	193	195	196	198	200	201	202	204	206	208	210	211	213
	215	182	183	184	185	186	188	189	191	192	194	195	197	199	200	202	203	205	207	209	211	212	214
	220	183	184	185	186	187	189	190	192	193	195	196	198	199	201	202	204	206	208	210	211	213	214
	225	184	185	186	187	188	190	191	192	194	195	197	199	200	202	203	205	207	209	210	211	213	215
	230	185	186	187	188	189	191	192	193	195	196	198	199	201	202	204	205	207	209	210	212	214	216
	235	187	187	188	189	190	192	193	194	196	197	199	200	201	203	204	206	208	209	211	213	214	216
	240	188	189	189	190	192	193	194	195	197	198	199	201	202	203	205	207	208	210	212	213	215	217



TABLE 11. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICRPOISES

		MOLE FRACTION OF HELIUM 0.5000																					
T, DEG K	P, ATM	310	320	330	340	350	360	370	380	390	400	410	420	430	440	450	460	470	480	490	500	510	520
		VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	197	201	206	210	214	219	223	227	231	235	239	243	247	251	255	259	262	266	270	273	277	281	
5	197	201	206	210	214	219	223	227	231	235	239	243	247	251	255	259	262	266	270	273	277	281	
10	197	202	206	210	215	219	223	227	231	235	239	243	247	251	255	259	263	266	270	274	277	281	
15	197	202	206	211	215	219	223	227	232	236	240	244	247	251	255	259	263	266	270	274	277	281	
20	198	202	207	211	215	219	224	228	232	236	240	244	248	252	255	259	263	266	270	274	277	281	
25	198	202	207	211	215	220	224	228	232	236	240	244	248	252	255	259	263	267	270	274	278	281	
30	198	203	207	211	216	220	224	228	232	236	240	244	248	252	256	259	263	267	270	274	278	281	
35	199	203	207	212	216	220	224	228	233	237	241	244	248	252	256	260	263	267	271	274	278	281	
40	199	203	208	212	216	221	225	229	233	237	241	245	249	252	256	260	263	267	271	274	278	282	
45	199	204	208	212	217	221	225	229	233	237	241	245	249	252	256	260	264	267	271	275	278	282	
50	200	204	208	213	217	221	225	229	233	237	241	245	249	253	256	260	264	268	271	275	278	282	
55	200	205	209	213	217	221	226	230	234	238	242	245	249	253	257	261	264	268	272	275	279	282	
60	201	205	209	213	218	222	226	230	234	238	242	246	250	253	257	261	265	268	272	276	279	282	
65	201	205	210	214	218	222	226	230	234	238	242	246	250	254	257	261	265	269	272	276	279	283	
70	201	206	210	214	218	222	227	231	235	239	242	246	250	254	258	261	265	269	272	276	279	283	
75	202	206	210	215	219	223	227	231	235	239	243	247	250	254	258	262	265	269	272	276	280	283	
80	202	207	211	215	219	223	227	231	235	239	243	247	251	254	258	262	265	269	273	276	280	283	
85	203	207	211	215	219	224	228	232	236	239	243	247	251	255	258	262	266	269	273	276	280	284	
90	203	207	212	216	220	224	228	232	236	240	244	247	251	255	259	262	266	270	273	277	280	284	
95	204	208	212	216	220	224	228	232	236	240	244	248	252	255	259	262	266	270	273	277	280	284	
100	204	208	212	217	221	225	229	233	237	240	244	248	252	256	259	263	266	270	274	277	281	284	
105	205	209	213	217	221	225	229	233	237	241	245	248	252	256	260	263	267	271	274	278	281	285	
110	205	209	213	217	221	225	229	233	237	241	245	249	252	256	260	264	267	271	274	278	281	285	
115	206	210	214	218	222	226	230	234	238	241	245	249	253	256	260	264	267	271	275	278	282	285	
120	206	210	214	218	222	226	230	234	238	242	246	249	253	257	260	264	268	271	275	278	282	285	
125	207	211	215	219	223	227	231	234	238	242	246	250	253	257	261	264	268	271	275	278	282	285	
130	207	211	215	219	223	227	231	235	239	242	246	250	254	257	261	265	268	272	275	279	282	286	
135	208	212	216	220	223	227	231	235	239	243	247	250	254	258	261	265	269	272	276	279	283	286	
140	208	212	216	220	224	228	232	236	239	243	247	251	254	258	262	265	269	272	276	279	283	286	
145	209	213	217	220	224	228	232	236	240	244	247	251	254	258	262	265	269	272	276	279	283	286	
150	209	213	217	221	225	229	233	236	240	244	248	251	255	259	262	266	269	273	276	280	283	287	
155	210	214	217	221	225	229	233	237	240	244	248	252	255	259	263	266	270	273	277	280	284	287	
160	210	214	218	222	226	230	233	237	241	245	248	252	256	259	263	266	270	274	277	281	284	287	
165	211	215	218	222	226	230	234	238	241	245	249	252	256	260	263	267	270	274	277	281	284	288	
170	211	215	219	223	227	230	234	238	242	245	249	253	256	260	264	267	271	274	278	281	285	288	
175	212	216	219	223	227	231	235	238	242	246	249	253	257	260	264	267	271	274	278	281	285	288	
180	212	216	220	224	227	231	235	239	242	246	250	253	257	261	264	268	271	274	278	281	285	288	
185	213	217	220	224	228	232	235	239	243	246	250	254	257	261	264	268	271	275	278	282	285	288	
190	213	217	221	225	228	232	236	240	243	247	251	254	258	261	265	268	272	275	278	282	285	289	
195	214	218	221	225	229	233	236	240	244	247	251	254	258	261	265	268	272	275	279	282	286	289	
200	215	218	222	226	229	233	237	240	244	248	251	255	258	262	265	269	272	276	279	282	286	289	
205	215	219	222	226	230	233	237	241	244	248	252	255	259	262	266	269	273	276	280	283	286	290	
210	216	219	223	227	230	234	238	241	245	248	252	256	259	263	266	270	273	277	280	283	286	290	
215	216	220	223	227	231	234	238	242	245	249	252	256	259	263	266	270	273	277	280	283	287	290	
220	217	220	224	228	231	235	238	242	246	249	253	256	260	263	267	270	274	277	281	284	287	291	
225	217	221	225	228	232	235	239	242	246	250	253	256	260	263	267	270	274	277	281	284	287	291	
230	218	222	225	229	232	236	239	243	246	250	253	257	260	264	267	271	274	277	281	284	288	291	
235	219	222	226	229	233	236	240	243	247	250	254	257	261	264	267	271	274	278	281	285	288	291	
240	219	223	226	230	233	237	240	244	247	251	254	258	261	264	268	271	275	278	281	285	288	291	





TABLE 11. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICRPOISES

		MOLE FRACTION OF HELIUM 0.5000																					
T, DEG K	530	540	550	560	570	580	590	600	610	620	630	640	650	660	670	680	690	700	710	720	730	740	
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	
1	284	288	291	295	298	302	305	308	312	315	318	322	325	328	331	334	338	341	344	347	350	353	
5	284	288	291	295	298	302	305	308	312	315	318	322	325	328	331	334	338	341	344	347	350	353	
10	284	288	291	295	298	302	305	308	312	315	318	322	325	328	331	334	338	341	344	347	350	353	
15	285	288	292	295	298	302	305	309	312	315	319	322	325	328	331	335	338	341	344	347	350	353	
20	285	288	292	295	299	302	305	309	312	315	319	322	325	328	331	335	338	341	344	347	350	353	
25	285	288	292	295	299	302	306	309	312	316	319	322	325	329	332	335	338	341	344	347	350	353	
30	285	289	292	295	299	302	306	309	312	316	319	322	325	329	332	335	338	341	344	347	351	354	
35	285	289	292	296	299	302	306	309	313	316	319	322	326	329	332	335	338	341	344	348	351	354	
40	285	289	292	296	299	303	306	309	313	316	319	322	326	329	332	335	338	341	345	348	351	354	
45	286	289	293	296	299	303	306	309	313	316	319	323	326	329	332	335	338	342	345	348	351	354	
50	286	289	293	296	300	303	306	310	313	316	319	323	326	329	332	335	339	342	345	348	351	354	
55	286	289	293	296	300	303	307	310	313	316	320	323	326	329	333	336	339	342	345	348	351	354	
60	286	290	293	297	300	303	307	310	313	316	320	323	326	330	333	336	339	342	345	348	351	354	
65	286	290	293	297	300	304	307	310	314	317	320	323	326	330	333	336	339	342	345	348	351	354	
70	287	290	294	297	300	304	307	310	314	317	320	323	327	330	333	336	339	342	345	348	351	354	
75	287	290	294	297	301	304	307	311	314	317	320	323	327	330	333	336	339	342	346	349	352	355	
80	287	290	294	297	301	304	307	311	314	317	320	324	327	330	333	336	339	343	346	349	352	355	
85	287	291	294	298	301	304	308	311	314	318	321	324	327	330	333	337	340	343	346	349	352	355	
90	287	291	294	298	301	305	308	311	314	318	321	324	327	330	334	337	340	343	346	349	352	355	
95	288	291	295	298	301	305	308	311	314	318	321	324	327	331	334	337	340	343	346	349	352	355	
100	288	291	295	298	302	305	308	311	315	318	321	324	328	331	334	337	340	343	346	349	352	355	
105	288	292	295	298	302	305	308	312	315	318	321	325	328	331	334	337	340	343	346	350	353	356	
110	288	292	295	299	302	305	309	312	315	318	322	325	328	331	334	338	341	344	347	350	353	356	
115	289	292	295	299	302	306	309	312	315	319	322	325	328	331	335	338	341	344	347	350	353	356	
120	289	292	296	299	302	306	309	312	316	319	322	325	328	331	335	338	341	344	347	350	353	356	
125	289	293	296	299	303	306	309	313	316	319	322	325	328	332	335	338	341	344	347	350	353	356	
130	289	293	296	299	303	306	309	313	316	319	322	325	329	332	335	338	341	344	347	350	353	356	
135	290	293	296	300	303	306	310	313	316	319	322	326	329	332	335	338	341	344	347	350	354	357	
140	290	293	297	300	303	307	310	313	316	320	323	326	329	332	335	338	341	345	348	351	354	357	
145	290	293	297	300	304	307	310	313	316	320	323	326	329	332	335	339	342	345	348	351	354	357	
150	290	294	297	300	304	307	310	313	317	320	323	326	329	332	336	339	342	345	348	351	354	357	
155	291	294	297	301	304	307	311	314	317	320	323	326	330	333	336	339	342	345	348	351	354	357	
160	291	294	298	301	304	307	311	314	317	320	324	327	330	333	336	339	342	345	348	351	354	357	
165	291	294	298	301	304	308	311	314	317	321	324	327	330	333	336	339	342	345	348	351	355	358	
170	291	295	298	301	305	308	311	314	318	321	324	327	330	333	336	339	343	346	349	352	355	358	
175	292	295	298	302	305	308	311	315	318	321	324	327	330	333	337	340	343	346	349	352	355	358	
180	292	295	299	302	305	308	312	315	318	321	324	327	331	334	337	340	343	346	349	352	355	358	
185	292	295	299	302	305	309	312	315	318	321	324	328	331	334	337	340	343	346	349	352	355	358	
190	292	296	299	302	306	309	312	315	318	322	325	328	331	334	337	340	343	346	349	352	355	358	
195	293	296	299	303	306	309	312	316	319	322	325	328	331	334	337	340	343	346	350	353	356	359	
200	293	296	300	303	306	309	313	316	319	322	325	328	331	334	338	341	344	347	350	353	356	359	
205	293	296	300	303	306	310	313	316	319	322	325	329	332	335	338	341	344	347	350	353	356	359	
210	293	297	300	303	307	310	313	316	319	323	326	329	332	335	338	341	344	347	350	353	356	359	
215	294	297	300	304	307	310	313	316	320	323	326	329	332	335	338	341	344	347	350	353	356	359	
220	294	297	301	304	307	310	313	317	320	323	326	329	332	335	338	342	345	348	351	354	357	360	
225	294	298	301	304	307	311	314	317	320	323	326	329	332	335	338	342	345	348	351	354	357	360	
230	294	298	301	304	308	311	314	317	320	323	326	329	333	336	339	342	345	348	351	354	357	360	
235	295	298	301	305	308	311	314	317	321	324	327	330	333	336	339	342	345	348	351	354	357	360	
240	295	298	302	305	308	311	314	318	321	324	327	330	333	336	339	342	345	348	351	354	357	360	



TABLE 12. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROROISES

		MOLE FRACTION OF HELIUM 0.4000																					
T, DEG K		133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	100	101	102	102	103	104	104	104	105	105	106	107	107	108	108	109	110	110	111	111	112	113	113
5	101	102	102	103	104	104	104	105	105	106	107	107	108	108	109	110	110	111	111	112	113	113	114
10	102	103	103	104	104	104	105	106	106	107	107	108	109	109	110	110	111	112	112	113	113	114	115
15	103	104	104	105	106	106	107	107	108	109	109	110	110	111	111	112	113	113	114	114	115	115	116
20	105	105	106	106	107	107	108	109	109	110	110	111	111	112	113	113	114	114	115	115	116	116	117
25	106	107	107	108	108	109	109	110	110	111	112	112	113	113	114	114	115	115	116	116	117	117	118
30	108	108	109	109	110	110	111	111	112	112	113	114	114	115	115	116	116	117	117	118	118	119	119
35	109	110	110	111	111	112	112	113	113	114	114	115	116	116	117	117	118	118	119	119	120	120	120
40	111	112	112	113	113	114	114	115	115	116	117	117	118	118	119	119	120	120	121	121	122	122	123
45	113	114	114	115	115	116	116	116	117	117	118	118	119	119	120	120	121	121	122	122	123	123	123
50	116	116	116	117	117	118	118	118	119	119	120	120	121	121	121	122	122	123	123	124	124	125	125
55	118	118	119	119	119	120	120	121	121	121	122	122	122	123	123	124	124	125	125	125	126	126	126
60	121	121	121	121	122	122	122	123	123	123	124	124	124	125	125	126	126	126	127	127	128	128	128
65	123	124	124	124	124	124	125	125	125	126	126	126	127	127	127	128	128	128	129	129	129	129	130
70	126	126	126	127	127	127	127	127	128	128	128	128	129	129	129	130	130	130	131	131	131	131	132
75	129	129	129	129	129	130	130	130	130	130	131	131	131	131	132	132	132	132	133	133	133	133	134
80	132	132	132	132	132	132	132	133	133	133	133	133	133	134	134	134	134	134	135	135	135	135	136
85	135	135	135	135	135	135	135	135	135	135	136	136	136	136	136	136	137	137	137	137	137	137	138
90	139	138	138	138	138	138	138	138	138	138	138	138	138	138	139	139	139	139	139	139	139	140	140
95	142	142	142	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	142	142	142
100	145	145	145	145	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
105	149	149	148	148	148	147	147	147	147	147	146	146	146	146	146	146	146	146	146	146	146	146	147
110	153	152	152	151	151	151	150	150	150	150	149	149	149	149	149	149	149	149	149	149	149	149	149
115	156	156	155	155	154	154	153	153	153	153	152	152	152	152	152	152	151	151	151	151	151	151	151
120	160	159	159	158	158	157	157	156	156	156	155	155	155	155	154	154	154	154	154	154	154	154	154
125	163	163	162	162	161	160	160	159	159	159	158	158	158	157	157	157	157	157	157	157	157	156	156
130	167	166	166	165	164	164	163	163	162	162	161	161	161	160	160	160	160	160	159	159	159	159	159
135	171	170	169	169	168	167	167	166	165	165	164	164	164	163	163	163	162	162	162	162	162	161	161
140	175	174	173	172	171	171	170	169	169	168	168	167	167	166	166	165	165	165	165	165	164	164	164
145	178	177	176	176	175	174	173	173	172	171	171	170	170	169	169	168	168	168	167	167	167	167	166
150	182	181	180	179	178	177	177	176	175	174	174	173	173	172	172	171	171	170	170	170	169	169	169
155	186	185	184	183	182	181	180	179	178	178	177	176	176	175	175	174	174	173	173	172	172	172	172
160	189	188	187	186	185	184	183	182	182	181	180	179	179	178	178	177	177	176	176	175	175	174	174
165	193	192	191	190	189	188	187	186	185	184	183	183	182	181	181	180	179	179	178	178	177	177	177
170	197	195	194	193	192	191	190	189	188	187	186	186	185	184	184	183	182	182	181	181	180	180	180
175	200	199	198	197	195	194	193	192	191	190	190	189	188	187	187	186	185	185	184	183	183	182	182
180	204	202	201	200	199	198	197	196	195	194	193	192	191	190	190	189	188	187	187	186	186	185	185
185	207	206	205	203	202	201	200	199	198	197	196	195	194	193	192	192	191	190	190	189	188	188	188
190	211	210	208	207	206	204	203	202	201	200	199	198	197	196	195	195	194	193	192	192	191	191	191
195	214	213	212	210	209	208	207	205	204	203	202	201	200	199	198	198	197	196	195	195	194	193	193
200	218	217	215	214	212	211	210	209	208	206	205	204	203	202	201	200	199	198	197	197	197	196	196
205	221	220	219	217	216	214	213	212	211	210	208	207	206	205	204	203	203	202	201	200	199	199	199
210	225	223	222	220	219	218	216	215	214	213	212	210	209	208	207	206	206	205	204	203	202	201	201
215	228	227	225	224	222	221	220	218	217	216	215	214	212	211	210	209	208	207	207	206	205	204	204
220	232	230	229	227	226	224	223	222	220	219	218	217	215	214	213	212	211	210	209	209	208	207	207
225	235	234	232	230	229	227	226	225	223	222	221	220	218	217	216	215	214	213	212	211	210	209	209
230	239	237	235	234	232	231	229	228	227	225	224	223	221	220	219	218	217	216	215	214	213	212	212
235	242	240	239	237	235	234	232	231	230	228	227	226	224	223	222	221	220	219	218	217	216	215	215
240	245	244	242	240	239	237	236	234	233	231	230	229	227	226	225	224	223	222	221	220	219	218	218



TABLE 12. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

		MOLE FRACTION OF HELIUM 0.4000																					
T, DEG K		156	158	160	162	164	166	168	170	172	174	176	178	180	182	184	186	188	190	192	194	196	198
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	114	116	117	118	119	120	121	123	124	125	126	127	128	129	131	132	133	134	135	136	137	138	
5	115	116	117	118	120	121	122	123	124	125	126	128	129	130	131	132	133	134	135	136	138	139	
10	116	117	118	119	120	121	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139
15	117	118	119	120	121	122	123	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
20	118	119	120	121	122	123	124	125	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141
25	119	120	121	122	123	124	125	126	127	129	130	131	132	133	134	135	136	137	138	139	140	141	142
30	120	121	122	123	124	125	126	127	128	130	131	132	133	134	135	136	137	138	139	140	141	142	143
35	121	122	123	124	125	126	127	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144
40	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145
45	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146
50	126	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147
55	127	128	129	130	131	132	133	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148
60	129	130	130	131	132	133	134	135	136	137	138	138	139	140	141	142	143	144	145	146	147	148	149
65	130	131	132	133	134	135	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151
70	132	133	134	135	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153
75	134	135	136	136	137	138	138	139	140	141	142	142	143	144	145	146	147	148	149	150	151	152	153
80	136	137	137	138	139	139	140	141	142	142	143	144	145	146	146	147	148	149	150	151	152	153	154
85	138	139	139	140	140	141	142	142	143	144	145	145	146	147	148	148	149	150	151	152	153	154	155
90	140	141	141	142	142	143	144	144	145	145	146	147	148	149	150	151	151	152	153	154	155	156	157
95	142	143	143	144	144	145	145	146	146	147	148	148	149	150	151	151	152	153	154	155	156	157	158
100	145	145	145	146	146	147	147	148	148	149	149	150	151	151	152	153	153	154	155	156	157	158	159
105	147	147	147	148	148	148	149	149	150	150	151	152	152	153	153	154	155	155	156	157	158	159	160
110	149	149	149	150	150	150	151	151	152	152	153	153	154	154	155	155	156	156	157	158	158	159	160
115	151	151	152	152	152	152	153	153	154	154	154	155	155	156	156	157	157	158	158	159	160	160	161
120	154	154	154	154	154	154	155	155	155	156	156	157	157	158	158	159	159	160	160	161	161	162	162
125	156	156	156	156	156	156	157	157	157	158	158	158	159	159	160	160	161	161	161	162	162	163	163
130	159	158	158	158	158	159	159	159	159	159	160	160	161	161	161	162	162	163	163	164	164	165	165
135	161	161	161	161	161	161	161	161	161	161	162	162	162	163	163	163	164	164	165	165	166	166	167
140	163	163	163	163	163	163	163	163	163	163	163	164	164	164	165	165	166	166	166	167	167	168	168
145	166	166	165	165	165	165	165	165	165	165	166	166	166	166	166	167	167	168	168	168	169	169	170
150	169	168	168	167	167	167	167	167	167	167	167	167	168	168	168	168	169	169	170	170	170	171	171
155	171	171	170	170	170	169	169	169	169	169	169	169	169	170	170	170	170	171	171	172	172	172	172
160	174	173	173	172	172	172	171	171	171	171	171	171	171	171	172	172	172	172	173	173	173	174	174
165	176	176	175	175	174	174	174	173	173	173	173	173	173	173	173	174	174	174	174	175	175	175	175
170	179	178	178	177	176	176	176	176	175	175	175	175	175	175	175	175	176	176	176	177	177	177	177
175	181	181	180	179	179	178	178	178	177	177	177	177	177	177	177	177	177	177	178	178	178	178	178
180	184	183	182	182	181	181	180	180	180	179	179	179	179	179	179	179	179	179	179	180	180	180	180
185	187	186	185	184	184	183	182	182	182	181	181	181	181	181	181	181	181	181	181	181	181	181	182
190	189	188	187	187	186	185	185	184	184	183	183	183	183	183	183	183	183	183	183	183	183	183	183
195	192	191	190	189	188	188	187	186	186	186	186	185	185	185	185	184	184	184	184	184	184	185	185
200	195	194	192	192	191	190	189	189	188	188	187	187	187	186	186	186	186	186	186	186	186	186	186
205	197	196	195	194	193	192	192	191	190	190	189	189	189	188	188	188	188	188	188	188	188	188	188
210	200	199	198	196	195	195	194	193	192	192	191	191	191	190	190	190	190	190	190	190	190	190	190
215	203	201	200	199	198	197	196	195	195	194	194	193	193	192	192	192	192	191	191	191	191	191	191
220	205	204	203	201	200	199	198	198	197	196	196	195	195	194	194	194	193	193	193	193	193	193	193
225	208	206	205	204	203	202	201	200	199	198	198	197	197	196	196	196	195	195	195	195	195	195	195
230	211	209	208	206	205	204	203	202	201	200	200	199	199	198	198	197	197	197	197	196	196	196	196
235	213	212	210	209	208	206	205	204	203	203	202	201	201	200	200	199	199	199	198	198	198	198	198
240	216	214	213	211	210	209	208	207	206	205	204	203	203	202	202	201	201	200	200	200	200	200	200



TABLE 12. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

		MOLE FRACTION OF HELIUM 0.4000																					
T, DEG K		200	205	210	215	220	225	230	235	240	245	250	255	260	265	270	275	280	285	290	295	300	305
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	139	142	145	147	150	153	155	158	160	163	165	168	170	173	175	177	180	182	184	187	189	191	
5	140	142	145	148	150	153	155	158	161	163	166	168	170	173	175	178	180	182	185	187	189	192	
10	140	143	146	148	151	153	156	158	161	163	166	168	171	173	176	178	180	183	185	187	189	192	
15	141	144	146	149	151	154	156	159	161	164	166	169	171	174	176	178	181	183	185	188	190	192	
20	142	144	147	149	152	155	157	160	162	165	167	169	172	174	177	179	181	184	186	188	190	192	
25	142	145	148	150	153	155	158	160	163	165	168	170	172	175	177	179	182	184	186	189	191	193	
30	143	146	148	151	153	156	158	161	163	166	168	170	173	175	178	180	182	185	187	189	191	193	
35	144	147	149	152	154	157	159	161	164	166	169	171	173	175	178	180	182	185	187	189	191	194	
40	145	147	150	152	155	157	160	162	165	167	169	172	174	176	178	180	183	185	187	190	192	194	
45	146	148	151	153	156	158	160	163	165	168	170	172	175	177	179	182	184	186	188	190	192	195	
50	147	149	152	154	156	159	161	164	166	168	171	173	175	178	180	182	184	187	189	191	193	195	
55	148	150	152	155	157	160	162	164	167	169	171	174	176	178	180	183	185	187	189	192	194	196	
60	149	151	153	156	158	160	163	165	167	170	172	174	177	179	181	183	186	188	190	192	194	197	
65	150	152	154	157	159	161	164	166	168	170	173	175	177	179	182	184	186	188	191	193	195	197	
70	151	153	155	158	160	162	164	167	169	171	173	176	178	180	182	185	187	189	191	193	195	197	
75	152	154	156	159	161	163	165	167	170	172	174	176	179	181	183	185	187	190	192	194	196	198	
80	153	155	157	160	162	164	166	168	171	173	175	177	179	182	184	186	188	190	192	194	197	199	
85	154	156	158	161	163	165	167	169	171	174	176	178	180	182	184	187	189	191	193	195	197	199	
90	155	157	159	162	164	166	168	170	172	174	177	179	181	183	185	187	189	191	193	195	197	199	
95	157	159	161	163	165	167	169	171	173	175	177	179	182	184	186	188	190	192	194	196	198	200	
100	158	160	162	164	166	168	170	172	174	176	178	180	182	184	187	189	191	193	195	197	199	201	
105	159	161	163	165	167	169	171	173	175	177	179	181	183	185	187	189	191	193	196	198	200	202	
110	160	162	164	166	168	170	172	174	176	178	180	182	184	186	188	190	192	194	196	198	200	202	
115	162	163	165	167	169	171	173	175	177	179	181	183	185	187	189	191	193	195	197	199	201	203	
120	163	165	166	168	170	172	174	176	178	180	182	184	186	188	190	192	194	196	198	200	202	204	
125	164	166	168	169	171	173	175	177	179	181	182	184	186	188	190	192	194	196	198	200	202	204	
130	166	167	169	171	172	174	176	178	180	181	183	185	187	189	191	193	195	197	199	201	203	205	
135	167	169	170	172	173	175	177	179	181	182	184	186	188	190	192	194	196	198	200	202	204	206	
140	168	170	171	173	175	176	178	180	182	183	185	187	189	191	193	195	197	198	200	202	204	206	
145	170	171	173	174	176	177	179	181	183	184	186	188	190	192	194	195	197	199	201	203	205	207	
150	171	173	174	175	177	179	180	182	184	185	187	189	191	192	194	196	198	200	202	204	206	208	
155	173	174	175	177	178	180	181	183	185	186	188	190	192	193	195	197	199	201	203	204	206	208	
160	174	175	177	178	179	181	182	184	186	187	189	191	192	194	196	198	200	201	203	205	207	209	
165	176	177	178	179	181	182	183	185	187	188	190	192	193	195	197	199	200	202	204	206	208	210	
170	177	178	179	181	182	183	185	186	188	189	191	193	194	196	198	199	201	203	205	207	208	210	
175	179	180	181	182	183	184	186	187	189	190	192	194	195	197	199	200	202	204	206	207	209	211	
180	180	181	182	183	184	186	187	188	190	191	193	194	196	198	199	201	203	205	206	208	210	212	
185	182	183	183	184	186	187	188	189	191	192	193	194	196	198	199	201	203	205	206	208	210	212	
190	183	184	185	186	187	188	189	191	192	193	195	196	197	199	200	202	204	205	207	209	211	212	
195	185	186	186	187	188	189	190	192	193	194	196	197	199	200	202	204	205	207	208	210	211	213	
200	187	187	188	189	189	191	192	193	194	196	197	198	200	201	203	205	206	208	210	211	213	215	
205	188	189	189	190	191	192	193	194	195	197	198	199	201	202	204	205	207	209	210	212	214	215	
210	190	190	191	191	192	193	194	195	196	198	199	200	202	203	205	206	208	209	211	213	214	216	
215	191	192	192	193	193	194	195	196	198	199	200	201	203	204	206	207	209	210	212	214	215	217	
220	193	193	194	194	195	196	197	198	199	200	201	202	204	205	207	208	210	211	213	214	216	218	
225	195	195	195	196	196	197	198	199	200	201	202	203	205	206	208	209	210	212	214	215	217	218	
230	196	196	197	197	197	198	199	200	201	202	203	204	206	207	208	210	211	213	214	216	217	219	
235	198	198	198	198	199	200	200	201	202	203	204	206	207	208	209	211	212	214	215	217	218	220	
240	199	199	199	200	200	201	202	202	203	204	205	207	208	209	210	212	213	215	216	218	219	221	





TABLE 12. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

		MOLE FRACTION OF HELIUM 0.4000																				
T, DEG K	310	320	330	340	350	360	370	380	390	400	410	420	430	440	450	460	470	480	490	500	510	520
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	194	198	203	207	211	215	220	224	228	232	236	240	244	248	251	255	259	263	266	270	274	277
5	194	198	203	207	211	216	220	224	228	232	236	240	244	248	252	255	259	263	266	270	274	277
10	194	199	203	207	212	216	220	224	228	232	236	240	244	248	252	256	259	263	267	270	274	277
15	195	199	203	208	212	216	220	225	229	233	237	241	244	248	252	256	260	263	267	270	274	278
20	195	199	204	208	212	217	221	225	229	233	237	241	245	249	252	256	260	263	267	271	274	278
25	195	200	204	208	213	217	221	225	229	233	237	241	245	249	253	256	260	264	267	271	275	278
30	196	200	205	209	213	217	221	226	230	234	237	241	245	249	253	257	260	264	268	271	275	278
35	196	201	205	209	213	218	222	226	230	234	238	242	246	249	253	257	261	264	268	271	275	279
40	197	201	205	210	214	218	222	226	230	234	238	242	246	250	253	257	261	264	268	272	275	279
45	197	202	206	210	214	218	223	227	231	235	238	242	246	250	254	257	261	265	268	272	275	279
50	198	202	206	211	215	219	223	227	231	235	239	243	246	250	254	258	261	265	269	272	276	279
55	198	202	207	211	215	219	223	227	231	235	239	243	247	251	254	258	262	265	269	272	276	280
60	199	203	207	211	216	220	224	228	232	236	240	243	247	251	255	258	262	266	269	273	276	280
65	199	203	208	212	216	220	224	228	232	236	240	244	247	251	255	259	262	266	269	273	277	280
70	200	204	208	212	216	221	225	229	232	236	240	244	248	252	255	259	263	266	270	273	277	280
75	200	205	209	213	217	221	225	229	233	237	241	244	248	252	256	259	263	267	270	274	277	281
80	201	205	209	213	217	221	225	229	233	237	241	245	249	252	256	260	263	267	270	274	277	281
85	201	206	210	214	218	222	226	230	234	238	241	245	249	253	256	260	264	267	271	274	278	281
90	202	206	210	214	218	222	226	230	234	238	242	246	249	253	257	260	264	267	271	274	278	281
95	203	207	211	215	219	223	227	231	235	238	242	246	250	253	257	261	264	268	271	275	278	282
100	203	207	211	215	219	223	227	231	235	239	243	246	250	254	257	261	265	268	272	275	279	282
105	204	208	212	216	220	224	228	232	235	239	243	247	250	254	258	261	265	268	272	275	279	282
110	204	208	212	216	220	224	228	232	236	240	243	247	251	254	258	262	265	269	272	276	279	283
115	205	209	213	217	221	225	229	232	236	240	244	247	251	255	258	262	266	269	273	276	279	283
120	206	210	213	217	221	225	229	233	237	240	244	248	252	255	259	262	266	269	273	276	280	283
125	206	210	214	218	222	226	230	233	237	241	245	248	252	256	259	263	266	270	273	277	280	283
130	207	211	215	219	222	226	230	234	238	241	245	249	252	256	260	263	267	270	274	277	280	284
135	207	211	215	219	223	227	231	234	238	242	245	249	253	256	260	263	267	270	274	277	281	284
140	208	212	216	220	223	227	231	235	238	242	246	249	253	257	260	264	267	271	274	278	281	284
145	209	213	216	220	224	228	232	235	239	243	246	250	254	257	261	264	268	271	275	278	281	285
150	209	213	217	221	225	228	232	236	239	243	247	250	254	257	261	265	268	271	275	278	282	285
155	210	214	218	221	225	229	233	236	240	244	247	251	254	258	261	265	268	272	275	279	282	285
160	211	214	218	222	226	229	233	237	240	244	248	251	255	258	262	265	269	272	276	279	282	286
165	211	215	219	223	226	230	234	237	241	244	248	252	255	259	262	266	269	273	276	279	283	286
170	212	216	219	223	227	230	234	238	241	245	248	252	256	259	263	266	269	273	276	280	283	286
175	213	216	220	224	227	231	235	238	242	245	249	252	256	259	263	266	270	273	277	280	283	287
180	213	217	221	224	228	232	235	239	242	246	249	253	256	260	263	267	270	274	277	280	284	287
185	214	218	221	225	228	232	236	239	243	246	250	253	257	260	264	267	271	274	277	281	284	287
190	215	218	222	226	229	233	236	240	243	247	250	254	257	261	264	268	271	274	278	281	284	288
195	216	219	223	226	230	233	237	240	244	247	251	254	258	261	265	268	271	275	278	281	285	288
200	216	220	223	227	230	234	237	241	244	248	251	255	258	262	265	268	272	275	278	282	285	288
205	217	220	224	227	231	234	238	241	245	248	252	255	259	262	265	269	272	275	279	282	285	289
210	218	221	225	228	231	235	238	242	245	249	252	256	259	262	266	269	273	276	279	282	286	289
215	218	222	225	229	232	235	239	242	246	249	253	256	259	263	266	270	273	276	280	283	286	289
220	219	223	226	229	233	236	239	243	246	250	253	257	260	263	267	270	273	277	280	283	286	290
225	220	223	227	230	233	237	240	243	247	250	254	257	260	264	267	270	274	277	280	284	287	290
230	221	224	227	231	234	237	241	244	247	251	254	257	261	264	267	271	274	277	281	284	287	290
235	221	225	228	231	234	238	241	245	248	251	255	258	261	265	268	271	275	278	281	284	288	291
240	222	225	229	232	235	238	242	245	248	252	255	258	262	265	268	272	275	278	281	285	288	291



TABLE 12. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

		MOLE FRACTION OF HELIUM 0.4000																					
T, DEG K		530	540	550	560	570	580	590	600	610	620	630	640	650	660	670	680	690	700	710	720	730	740
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	281	284	288	291	294	298	301	304	308	311	314	317	321	324	327	330	333	336	339	342	346	349	
5	281	284	288	291	295	298	301	305	308	311	314	318	321	324	327	330	333	336	340	343	346	349	
10	281	284	288	291	295	298	301	305	308	311	315	318	321	324	327	330	333	337	340	343	346	349	
15	281	285	288	291	295	298	302	305	308	311	315	318	321	324	327	331	334	337	340	343	346	349	
20	281	285	288	292	295	298	302	305	308	312	315	318	321	324	328	331	334	337	340	343	346	349	
25	282	285	288	292	295	299	302	305	309	312	315	318	321	324	328	331	334	337	340	343	346	349	
30	282	285	289	292	295	299	302	305	309	312	315	318	322	325	328	331	334	337	340	343	346	349	
35	282	285	289	292	296	299	302	306	309	312	315	319	322	325	328	331	334	337	340	343	346	349	
40	282	286	289	293	296	299	303	306	309	312	316	319	322	325	328	331	334	338	341	344	347	350	
45	282	286	289	293	296	299	303	306	309	313	316	319	322	325	328	332	335	338	341	344	347	350	
50	283	286	290	293	296	300	303	306	310	313	316	319	322	325	329	332	335	338	341	344	347	350	
55	283	286	290	293	297	300	303	306	310	313	316	319	323	326	329	332	335	338	341	344	347	350	
60	283	287	290	293	297	300	303	307	310	313	316	320	323	326	329	332	335	338	341	344	347	350	
65	284	287	290	294	297	300	304	307	310	313	317	320	323	326	329	332	335	338	341	344	347	350	
70	284	287	291	294	297	301	304	307	310	314	317	320	323	326	329	332	336	339	342	345	348	351	
75	284	287	291	294	298	301	304	307	311	314	317	320	323	326	330	333	336	339	342	345	348	351	
80	284	288	291	294	298	301	304	308	311	314	317	320	324	327	330	333	336	339	342	345	348	351	
85	285	288	291	295	298	301	305	308	311	314	317	321	324	327	330	333	336	339	342	345	348	351	
90	285	288	292	295	298	302	305	308	311	315	318	321	324	327	330	333	336	339	342	345	348	351	
95	285	289	292	295	299	302	305	308	312	315	318	321	324	327	330	333	337	340	343	346	349	352	
100	285	289	292	295	299	302	305	309	312	315	318	321	324	328	331	334	337	340	343	346	349	352	
105	286	289	292	296	299	302	306	309	312	315	318	322	325	328	331	334	337	340	343	346	349	352	
110	286	289	293	296	299	303	306	309	312	315	319	322	325	328	331	334	337	340	343	346	349	352	
115	286	290	293	296	300	303	306	309	313	316	319	322	325	328	331	334	337	340	343	346	349	352	
120	287	290	293	297	300	303	306	310	313	316	319	322	325	328	331	335	338	341	344	347	350	352	
125	287	290	294	297	300	303	307	310	313	316	319	322	325	328	331	335	338	341	344	347	350	352	
130	287	291	294	297	300	304	307	310	313	316	320	323	326	329	332	335	338	341	344	347	350	353	
135	287	291	294	297	301	304	307	310	313	317	320	323	326	329	332	335	338	341	344	347	350	353	
140	288	291	294	298	301	304	307	311	314	317	320	323	326	329	332	335	338	341	344	347	350	353	
145	288	291	295	298	301	304	308	311	314	317	320	323	326	330	333	336	339	342	345	348	351	353	
150	288	292	295	298	302	305	308	311	314	317	321	324	327	330	333	336	339	342	345	348	351	354	
155	289	292	295	299	302	305	308	311	315	318	321	324	327	330	333	336	339	342	345	348	351	354	
160	289	292	296	299	302	305	308	312	315	318	321	324	327	330	333	336	339	342	345	348	351	354	
165	289	293	296	299	302	306	309	312	315	318	321	324	327	330	334	337	340	343	345	348	351	354	
170	290	293	296	299	303	306	309	312	315	318	322	325	328	331	334	337	340	343	346	349	352	354	
175	290	293	296	300	303	306	309	312	316	319	322	325	328	331	334	337	340	343	346	349	352	355	
180	290	294	297	300	303	306	310	313	316	319	322	325	328	331	334	337	340	343	346	349	352	355	
185	291	294	297	300	304	307	310	313	316	319	322	325	328	331	334	337	340	343	346	349	352	355	
190	291	294	297	301	304	307	310	313	316	319	323	326	329	332	335	338	341	344	347	350	352	355	
195	291	294	298	301	304	307	310	314	317	320	323	326	329	332	335	338	341	344	347	350	353	356	
200	292	295	298	301	304	308	311	314	317	320	323	326	329	332	335	338	341	344	347	350	353	356	
205	292	295	299	302	305	308	311	314	317	320	323	326	329	332	335	338	341	344	347	350	353	356	
210	292	295	299	302	305	308	311	314	317	321	324	327	330	333	336	339	342	345	347	350	353	356	
215	293	296	299	302	305	308	312	315	318	321	324	327	330	333	336	339	342	345	348	351	354	356	
220	293	296	299	302	306	309	312	315	318	321	324	327	330	333	336	339	342	345	348	351	354	357	
225	293	296	300	303	306	309	312	315	318	321	324	327	330	333	336	339	342	345	348	351	354	357	
230	294	297	300	303	306	309	312	316	319	322	325	328	331	334	337	340	343	345	348	351	354	357	
235	294	297	300	303	307	310	313	316	319	322	325	328	331	334	337	340	343	345	348	351	354	357	
240	294	297	301	304	307	310	313	316	319	322	325	328	331	334	337	340	343	346	349	352	354	357	



TABLE 13. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

		MOLE FRACTION OF HELIUM 0.3000																				
T, DEG K	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	98	98	99	99	100	101	101	102	103	103	104	104	105	106	106	107	107	108	109	109	110	110
5	98	99	100	100	101	101	102	103	103	104	104	105	106	106	107	107	108	109	109	110	110	111
10	100	100	101	102	102	103	103	104	104	105	106	106	107	107	108	109	109	110	110	111	111	112
15	101	102	102	103	104	104	105	105	106	106	107	108	108	109	109	110	110	111	112	112	113	113
20	103	104	104	105	105	106	106	107	107	108	109	109	110	110	111	111	112	112	113	113	114	114
25	105	105	106	107	107	108	108	109	109	110	110	111	111	112	112	113	113	114	114	115	115	116
30	107	108	108	109	109	110	110	111	111	112	112	113	113	114	114	115	115	116	116	117	117	118
35	110	110	111	111	111	112	112	113	113	114	114	115	115	116	116	117	117	118	118	119	119	119
40	112	113	113	114	114	114	115	115	116	116	116	117	117	118	118	119	119	119	120	120	121	121
45	116	116	116	116	117	117	117	118	118	118	119	119	120	120	120	121	121	121	122	122	122	123
50	119	119	119	120	120	120	120	121	121	121	121	122	122	122	123	123	123	124	124	125	125	125
55	123	123	123	123	123	123	123	124	124	124	124	125	125	125	125	126	126	126	127	127	127	128
60	127	126	126	126	127	127	127	127	127	127	127	127	128	128	128	128	129	129	129	129	130	130
65	131	131	130	130	130	130	130	130	130	130	131	131	131	131	131	131	132	132	132	132	132	133
70	135	135	135	134	134	134	134	134	134	134	134	134	134	134	134	134	134	135	135	135	135	135
75	140	140	139	139	138	138	138	138	138	138	137	137	137	137	137	137	137	137	137	138	138	138
80	145	144	144	143	143	142	142	142	142	141	141	141	141	141	141	141	141	141	141	141	141	141
85	150	149	149	148	147	147	146	146	146	145	145	145	145	144	144	144	144	144	144	144	144	144
90	155	154	154	153	152	151	151	150	150	149	149	149	148	148	148	148	147	147	147	147	147	147
95	161	160	159	158	157	156	155	155	154	154	153	153	152	152	152	151	151	151	151	150	150	150
100	166	165	164	163	162	161	160	159	159	158	157	157	156	156	155	155	154	154	154	154	154	153
105	172	170	169	168	167	166	165	164	163	162	162	161	160	160	159	159	158	158	158	157	157	157
110	177	176	174	173	172	171	170	169	168	167	166	165	165	164	163	163	162	162	161	161	160	160
115	183	181	180	178	177	176	174	173	172	171	170	170	169	168	167	166	165	165	164	164	164	164
120	188	186	185	183	182	180	179	178	177	176	175	174	173	172	171	170	169	169	168	168	167	167
125	193	192	190	188	187	185	184	183	181	180	179	178	177	176	175	174	173	173	172	171	171	171
130	199	197	195	193	192	190	189	187	186	185	184	183	182	181	180	179	178	177	176	175	174	174
135	204	202	200	198	197	195	194	192	191	189	188	187	186	185	184	183	182	181	180	179	179	178
140	209	207	205	203	202	200	198	197	195	194	193	191	190	189	188	187	186	185	184	183	182	182
145	214	212	210	208	206	205	203	201	200	198	197	196	194	193	192	191	190	189	188	187	186	185
150	219	217	215	213	211	209	208	206	204	203	201	200	199	197	196	195	194	193	192	191	190	189
155	224	222	220	218	216	214	212	211	209	207	206	204	203	202	200	199	198	197	196	195	194	193
160	229	227	225	223	221	219	217	215	213	212	210	209	207	206	204	203	202	201	199	198	197	196
165	234	232	229	227	225	223	221	220	218	216	214	213	211	210	208	207	206	205	203	202	201	200
170	239	236	234	232	230	228	226	224	222	220	219	217	215	214	212	211	210	208	207	206	205	204
175	243	241	239	236	234	232	230	228	226	225	223	221	220	218	217	215	214	212	211	210	209	207
180	248	246	243	241	239	237	235	233	231	229	227	225	224	222	221	219	218	216	215	214	212	211
185	252	250	248	245	243	241	239	237	235	233	231	230	228	226	225	223	221	220	219	217	216	215
190	257	255	252	250	248	245	243	241	239	237	235	234	232	230	228	227	225	224	222	221	220	218
195	261	259	257	254	252	250	248	245	243	241	240	238	236	234	232	231	229	228	226	225	223	222
200	266	263	261	259	256	254	252	250	248	246	244	242	240	238	236	235	233	231	230	228	227	226
205	270	268	265	263	260	258	256	254	252	250	248	246	244	242	240	238	237	235	234	232	231	229
210	274	272	269	267	265	262	260	258	256	254	252	250	248	246	244	242	241	239	237	236	234	233
215	279	276	274	271	269	267	264	262	260	258	256	254	252	250	248	246	244	243	241	239	238	236
220	283	280	278	275	273	271	268	266	264	262	260	257	255	254	252	250	248	246	245	243	241	240
225	287	285	282	279	277	275	272	270	268	266	263	261	259	257	255	254	252	250	248	247	245	243
230	291	289	286	284	281	279	276	274	272	269	267	265	263	261	259	257	255	254	252	250	248	247
235	295	293	290	288	285	283	280	278	276	273	271	269	267	265	263	261	259	257	255	254	252	250
240	299	297	294	292	289	287	284	282	279	277	275	273	271	269	267	265	263	261	259	257	255	254



TABLE 13. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

		MOLE FRACTION OF HELIUM 0.3000																					
T, DEG K	156	158	160	162	164	166	168	170	172	174	176	178	180	182	184	186	188	190	192	194	196	198	
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	112	113	114	115	116	117	119	120	121	122	123	124	125	126	128	129	130	131	132	133	134	135	135
5	112	113	115	116	117	118	119	120	121	123	124	125	126	127	128	129	130	131	132	133	134	135	135
10	113	114	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136
15	114	116	117	118	119	120	121	122	123	124	126	127	128	129	130	131	132	133	134	135	136	137	137
20	116	117	118	119	120	121	122	123	124	125	127	128	129	130	131	132	133	134	135	136	137	138	138
25	117	118	119	120	121	122	123	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
30	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	140
35	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	139	140	141
40	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	139	140	141	142	142
45	124	125	126	127	128	129	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	144
50	126	127	128	129	129	130	131	132	133	134	135	136	137	137	138	139	140	141	142	143	144	145	145
55	128	129	130	131	131	132	133	134	135	135	136	137	138	139	140	141	142	142	143	144	145	146	146
60	131	131	132	133	133	134	135	136	136	137	138	139	140	141	141	142	143	144	145	146	147	147	147
65	133	134	134	135	135	136	137	138	138	139	140	141	142	143	144	145	146	147	148	149	149	150	150
70	136	136	137	137	138	138	139	140	140	141	142	142	143	144	145	146	147	148	149	150	151	152	152
75	138	139	139	139	140	141	141	142	142	143	144	145	146	146	147	148	149	149	150	151	152	153	153
80	141	141	142	142	142	143	143	144	144	145	146	146	147	147	148	149	149	150	151	152	153	154	154
85	144	144	144	145	145	145	146	146	147	147	148	148	149	149	150	151	151	152	153	153	154	155	155
90	147	147	147	147	147	148	148	148	149	149	150	150	151	151	152	152	153	154	154	155	156	156	156
95	150	150	150	150	150	150	150	151	151	151	152	152	153	153	154	154	155	155	156	157	157	158	158
100	153	153	153	153	153	153	153	153	153	154	154	154	155	155	156	156	157	157	158	158	159	160	160
105	156	156	156	156	155	155	156	156	156	156	156	157	157	157	158	158	159	159	160	160	161	161	161
110	160	159	159	158	158	158	158	158	158	158	159	159	159	159	160	160	161	161	161	162	162	163	163
115	163	162	162	161	161	161	161	161	161	161	161	161	161	162	162	162	163	163	163	164	164	165	165
120	166	166	165	165	164	164	164	163	163	163	163	163	164	164	164	165	165	165	166	166	166	167	167
125	170	169	168	168	167	167	166	166	166	166	166	166	166	166	166	167	167	167	168	168	168	168	168
130	173	172	171	171	170	170	169	169	169	168	168	168	168	168	168	169	169	169	170	170	170	170	170
135	177	176	175	174	173	173	172	172	171	171	171	171	171	171	171	171	171	171	171	172	172	172	172
140	180	179	178	177	176	176	175	174	174	174	173	173	173	173	173	173	173	173	173	173	174	174	174
145	184	183	181	180	179	179	178	177	177	176	176	176	175	175	175	175	175	175	175	175	176	176	176
150	187	186	185	184	182	182	181	180	179	179	179	178	178	178	178	177	177	177	177	178	178	178	178
155	191	189	188	187	186	185	184	183	182	182	181	181	180	180	180	180	180	180	180	180	180	180	180
160	195	193	191	190	189	188	187	186	185	184	184	183	183	183	182	182	182	182	182	182	182	182	182
165	198	196	195	193	192	191	190	189	188	187	187	186	185	185	185	184	184	184	184	184	184	184	184
170	202	200	198	197	195	194	193	192	191	190	189	189	188	188	187	187	186	186	186	186	186	186	186
175	205	203	201	200	198	197	196	195	194	193	192	191	191	190	190	189	189	188	188	188	188	188	188
180	209	207	205	203	202	200	199	198	196	195	195	194	193	192	192	191	191	191	190	190	190	190	190
185	212	210	208	206	205	203	202	200	199	198	197	196	195	194	193	192	191	191	190	190	190	190	190
190	216	214	212	210	208	206	205	203	202	201	200	199	198	197	196	195	194	193	193	193	192	192	192
195	219	217	215	213	211	209	208	206	205	204	203	202	201	200	199	197	196	196	195	195	195	194	194
200	223	221	218	216	214	212	211	209	208	207	206	204	203	202	201	199	198	198	197	197	197	196	196
205	226	224	222	219	217	216	214	212	211	209	208	207	206	205	204	204	203	202	202	201	201	200	200
210	230	227	225	223	221	219	217	215	214	212	211	210	209	208	207	206	205	205	204	203	203	203	203
215	233	231	228	226	224	222	220	218	217	215	214	212	211	210	209	208	208	207	206	206	205	205	205
220	237	234	232	229	227	225	223	221	219	218	216	215	214	213	212	211	210	209	209	208	207	207	207
225	240	238	235	232	230	228	226	224	222	221	219	218	217	215	214	213	212	212	211	210	210	209	209
230	244	241	238	236	233	231	229	227	225	224	222	221	219	218	217	215	214	213	212	212	211	210	209
235	247	244	241	239	236	234	232	230	228	226	225	223	222	221	219	218	217	216	215	214	213	212	211
240	251	248	245	242	240	237	235	233	231	229	227	226	224	223	222	221	219	218	217	216	215	214	213





TABLE 13. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

		MOLE FRACTION OF HELIUM 0.3000																					
T, DEG K		200	205	210	215	220	225	230	235	240	245	250	255	260	265	270	275	280	285	290	295	300	305
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	136	139	142	144	147	150	152	155	157	160	162	165	167	170	172	174	177	179	182	184	186	188	
5	137	140	142	145	147	150	153	155	158	160	163	165	168	170	172	175	177	180	182	184	186	188	
10	138	140	143	146	148	151	153	156	158	161	163	166	168	171	173	175	178	180	182	184	186	189	
15	138	141	144	146	149	151	154	156	159	161	164	166	169	171	173	175	178	180	182	185	187	189	
20	139	142	144	147	150	152	155	157	160	162	164	167	169	172	174	176	178	180	183	185	187	190	
25	140	143	145	148	150	153	155	158	160	163	165	168	170	172	174	176	179	181	183	186	188	190	
30	141	144	146	149	151	154	156	159	161	164	166	168	171	173	175	177	179	182	184	186	188	191	
35	142	145	147	150	152	155	157	159	162	164	167	169	171	173	175	178	180	182	184	187	189	191	
40	143	146	148	151	153	156	158	160	163	165	167	169	171	174	176	178	181	183	185	187	189	191	
45	145	147	149	152	154	156	159	161	164	166	168	170	172	174	177	179	181	183	186	188	190	192	
50	146	148	150	153	155	157	160	162	164	167	169	171	173	175	177	180	182	184	186	189	191	193	
55	147	149	152	154	156	158	161	163	165	168	170	172	174	177	179	181	183	185	187	189	191	194	
60	148	151	153	155	157	160	162	164	166	169	171	173	175	177	180	182	184	186	188	190	192	194	
65	150	152	154	156	158	161	163	165	167	169	172	174	176	178	180	183	185	187	189	191	193	195	
70	151	153	155	157	160	162	164	166	168	170	173	175	177	179	181	183	185	187	189	191	193	196	
75	152	154	157	159	161	163	165	167	169	171	174	176	178	180	182	184	186	188	190	192	194	196	
80	154	156	158	160	162	164	166	168	170	172	175	177	179	181	183	185	187	189	191	193	195	197	
85	155	157	159	161	163	165	167	169	171	173	175	178	180	182	184	186	188	190	192	194	196	198	
90	157	159	161	163	164	166	168	170	172	174	176	179	181	183	185	187	189	191	193	195	197	199	
95	159	160	162	164	166	168	170	172	174	176	178	180	182	184	186	188	190	192	194	196	198	200	
100	160	162	164	165	167	169	171	173	175	177	179	181	183	185	187	189	191	193	195	197	199	201	
105	162	163	165	167	168	170	172	174	176	178	180	182	183	185	187	189	191	193	195	197	199	201	
110	164	165	167	168	170	172	173	175	177	179	181	183	184	186	188	190	192	194	196	198	200	202	
115	165	167	168	170	171	173	175	176	178	180	182	184	186	187	189	191	193	195	197	199	201	203	
120	167	168	170	171	173	174	176	178	179	181	183	185	187	188	190	192	194	196	198	200	202	204	
125	169	170	171	173	174	176	177	179	180	182	184	186	188	189	191	193	195	197	199	201	203	204	
130	171	172	173	174	175	177	178	180	182	183	185	187	189	190	192	194	196	198	200	201	203	205	
135	172	173	174	176	177	178	180	181	183	185	186	188	190	191	193	195	197	199	200	202	204	206	
140	174	175	176	177	178	180	181	183	184	186	187	189	191	192	194	196	198	200	201	203	205	207	
145	176	177	178	179	180	181	183	184	185	187	189	190	192	194	196	198	200	201	203	205	207	209	
150	178	179	180	180	182	183	184	185	187	188	190	191	193	195	196	198	200	201	203	205	207	209	
155	180	181	181	182	183	184	185	187	188	190	191	193	194	196	197	199	201	202	204	206	208	209	
160	182	182	183	184	185	186	187	188	189	191	192	194	195	197	198	200	202	203	205	207	209	211	
165	184	184	185	185	186	187	188	189	191	192	193	195	196	198	199	201	203	204	206	208	209	211	
170	186	186	187	187	188	189	190	191	192	193	195	196	198	199	201	202	204	205	207	209	210	212	
175	188	188	188	189	189	190	191	192	193	195	196	197	199	200	202	203	205	206	208	209	211	213	
180	190	190	190	191	191	192	193	194	195	196	197	198	200	201	202	204	205	207	208	210	212	214	
185	192	192	192	192	193	193	194	195	196	197	198	200	201	202	204	205	207	208	210	211	213	215	
190	194	194	194	194	194	195	196	197	198	199	200	201	202	204	205	207	208	210	211	213	215	217	
195	196	196	196	196	196	197	197	198	199	200	201	202	204	205	206	208	209	211	212	214	216	218	
200	198	198	197	198	198	198	199	200	200	201	202	203	205	206	207	209	210	212	213	215	217	219	
205	200	200	199	199	199	200	200	201	202	203	204	205	206	207	208	210	211	213	214	216	218	220	
210	202	202	201	201	201	201	202	203	203	204	205	206	207	208	209	211	212	213	215	217	219	221	
215	204	204	203	203	203	203	204	205	205	206	207	208	209	211	212	213	214	216	217	219	221	223	
220	206	206	205	205	205	205	206	206	207	208	209	210	211	212	213	214	215	217	218	220	222	224	
225	209	208	207	207	206	206	207	207	208	208	209	210	211	212	213	214	215	216	218	219	221	223	
230	211	210	209	208	208	208	208	209	209	210	210	211	212	213	214	215	216	218	219	221	223	225	
235	213	212	211	210	210	210	210	210	210	211	212	212	213	214	215	216	217	219	220	221	223	225	
240	215	214	213	212	212	211	211	212	212	212	213	214	215	215	216	217	219	220	221	222	224	226	



TABLE 13. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

		MOLE FRACTION OF HELIUM 0.3000																					
T, DEG K	P, ATM	310	320	330	340	350	360	370	380	390	400	410	420	430	440	450	460	470	480	490	500	510	520
	1	191	195	200	204	208	212	217	221	225	229	233	237	241	245	248	252	256	259	263	267	270	274
5		191	195	200	204	209	213	217	221	225	229	233	237	241	245	248	252	256	260	263	267	270	274
10		191	196	200	205	209	213	217	221	225	229	233	237	241	245	249	253	256	260	263	267	270	274
15		192	196	201	205	209	213	218	222	226	230	234	238	241	245	249	253	256	260	263	267	271	274
20		192	197	201	205	210	214	218	222	226	230	234	238	242	246	249	253	256	260	264	267	271	274
25		193	197	202	206	210	214	218	223	227	231	234	238	242	246	250	253	257	260	264	268	271	275
30		193	198	202	206	211	215	219	223	227	231	235	239	243	246	250	254	257	261	265	268	272	275
35		194	198	203	207	211	215	219	223	227	231	235	239	243	247	250	254	258	261	265	268	272	275
40		195	199	203	207	212	216	220	224	228	232	236	239	243	247	250	254	258	261	265	268	272	275
45		195	199	204	208	212	216	220	224	228	232	236	239	243	247	251	254	258	262	265	269	272	275
50		196	200	204	208	213	217	221	225	229	233	236	240	244	247	251	255	258	262	266	269	273	276
55		196	201	205	209	213	217	221	225	229	233	237	241	244	248	251	255	259	262	266	269	273	276
60		197	201	205	210	214	218	222	226	230	233	237	241	244	248	252	256	259	263	266	270	273	277
65		198	202	206	210	214	218	222	226	230	233	237	241	245	249	252	256	260	263	267	270	274	277
70		198	203	207	211	215	219	223	227	231	234	238	242	245	249	253	256	260	263	267	270	274	277
75		199	203	207	211	215	219	223	227	231	235	239	242	246	249	253	257	260	264	267	271	274	277
80		200	204	208	212	216	220	224	228	232	235	239	242	246	250	253	257	261	264	268	271	275	278
85		200	204	209	213	216	220	224	228	232	235	239	243	247	250	254	257	261	265	268	272	275	278
90		201	205	209	213	217	221	225	229	233	236	240	243	247	251	254	258	261	265	268	272	275	278
95		202	206	210	214	218	222	225	229	233	236	240	244	247	251	255	258	262	265	269	272	276	279
100		203	207	210	214	218	222	226	230	234	237	241	244	248	252	255	259	262	266	269	273	276	279
105		203	207	211	215	219	223	227	230	234	238	242	245	249	252	256	259	263	266	270	273	276	280
110		204	208	212	216	220	223	227	231	235	238	242	245	249	252	256	260	263	267	270	273	277	280
115		205	209	212	216	220	224	228	231	235	239	243	246	249	253	256	260	263	267	270	274	277	280
120		206	209	213	217	221	225	228	232	236	239	243	247	250	253	257	260	264	267	271	274	278	281
125		206	210	214	218	221	225	229	233	236	240	244	247	251	254	257	261	264	268	271	275	278	281
130		207	211	215	218	222	226	229	233	237	240	244	248	251	254	258	261	265	268	272	275	278	282
135		208	212	215	219	223	226	230	234	237	241	245	248	252	255	259	262	265	269	272	275	279	282
140		209	212	216	220	223	227	231	234	238	242	245	249	252	255	259	262	266	269	272	276	279	282
145		209	213	217	220	224	228	231	235	239	242	246	249	252	256	259	263	266	269	273	276	279	283
150		210	214	217	221	225	228	232	236	239	243	246	250	253	257	260	263	266	270	273	277	280	283
155		211	215	218	222	225	229	233	236	240	243	247	250	254	257	261	264	267	271	274	277	280	283
160		212	215	219	223	226	230	233	237	240	244	247	251	254	258	261	264	267	271	274	277	281	284
165		213	216	220	223	227	230	234	237	241	244	248	251	255	258	261	265	268	272	275	278	281	284
170		214	217	221	224	227	231	234	238	241	245	248	252	255	259	262	265	269	272	275	279	282	285
175		214	218	221	225	228	232	235	239	242	245	249	252	256	259	262	266	269	272	275	279	282	285
180		215	219	222	225	229	232	236	239	243	246	249	253	256	260	263	266	269	272	276	279	282	285
185		216	219	223	226	230	233	236	240	243	247	250	253	257	260	263	266	270	273	276	279	283	286
190		217	220	224	227	230	234	237	240	244	247	251	254	257	261	264	267	270	274	277	280	283	286
195		218	221	224	228	231	234	238	241	244	248	251	254	258	261	264	268	271	274	277	280	283	287
200		219	222	225	228	232	235	238	242	245	248	252	255	258	262	265	268	271	274	277	281	284	287
205		220	223	226	229	232	236	239	242	246	249	252	256	259	262	265	269	272	275	278	281	284	287
210		221	224	227	230	233	236	240	243	246	249	252	256	259	263	266	269	272	275	278	282	285	288
215		222	225	228	231	234	237	240	244	247	250	253	256	259	263	266	269	272	276	279	282	285	288
220		222	225	228	232	235	238	241	244	248	251	254	257	260	263	266	270	273	276	279	282	285	289
225		223	226	229	232	235	239	242	245	248	251	254	258	261	264	267	270	273	276	280	283	286	289
230		224	227	230	233	236	239	242	246	249	252	255	258	261	264	267	271	274	277	280	283	286	290
235		225	228	231	234	237	240	243	246	249	253	256	259	262	265	268	271	274	277	281	284	287	290
240		226	229	232	235	238	241	244	247	250	253	256	259	263	266	269	272	275	278	281	285	288	291



TABLE 13. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICRPOISES

		MOLE FRACTION OF HELIUM 0.3000																					
T, DEG K	530	540	550	560	570	580	590	600	610	620	630	640	650	660	670	680	690	700	710	720	730	740	
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	
1	277	281	284	287	291	294	297	301	304	307	310	314	317	320	323	326	329	332	335	338	341	344	
5	277	281	284	288	291	294	298	301	304	307	311	314	317	320	323	326	329	332	335	338	341	344	
10	278	281	284	288	291	294	298	301	304	308	311	314	317	320	323	326	329	332	335	338	341	344	
15	278	281	285	288	291	295	298	301	304	308	311	314	317	320	323	326	330	333	336	339	342	345	
20	278	282	285	288	292	295	298	301	305	308	311	314	317	320	323	326	330	333	336	339	342	345	
25	278	282	285	289	292	295	298	302	305	308	311	314	317	321	324	327	330	333	336	339	342	345	
30	279	282	285	289	292	295	299	302	305	308	312	315	318	321	324	327	330	333	336	339	342	345	
35	279	282	286	289	292	296	299	302	305	309	312	315	318	321	324	327	330	333	336	339	342	345	
40	279	283	286	289	293	296	299	302	306	309	312	315	318	321	324	328	331	334	337	340	343	345	
45	280	283	286	290	293	296	299	303	306	309	312	315	318	321	324	328	331	334	337	340	343	346	
50	280	283	287	290	293	297	300	303	306	309	313	316	319	322	325	328	331	334	337	340	343	346	
55	280	284	287	290	294	297	300	303	306	310	313	316	319	322	325	328	331	334	337	340	343	346	
60	280	284	287	291	294	297	300	304	307	310	313	316	319	322	325	328	331	334	337	340	343	346	
65	281	284	287	291	294	297	301	304	307	310	313	316	319	322	325	328	331	334	337	340	343	346	
70	281	284	288	291	294	298	301	304	307	310	313	316	319	322	325	328	331	334	337	340	343	346	
75	281	285	288	291	295	298	301	304	308	311	314	317	320	323	326	329	332	335	338	341	344	347	
80	282	285	288	292	295	298	301	305	308	311	314	317	320	323	326	329	332	335	338	341	344	347	
85	282	285	289	292	295	299	302	305	308	311	314	317	320	323	326	329	332	335	338	341	344	347	
90	282	286	289	292	296	299	302	305	308	312	315	318	321	324	327	330	333	336	339	342	345	348	
95	283	286	289	293	296	299	302	306	309	312	315	318	321	324	327	330	333	336	339	342	345	348	
100	283	286	290	293	296	299	303	306	309	312	315	318	321	324	327	330	333	336	339	342	345	348	
105	283	287	290	293	297	300	303	306	309	312	315	319	322	325	328	331	334	337	340	342	345	348	
110	284	287	290	294	297	300	303	306	310	313	316	319	322	325	328	331	334	337	340	342	345	348	
115	284	287	291	294	297	300	304	307	310	313	316	319	322	325	328	331	334	337	340	343	346	349	
120	285	288	291	294	298	301	304	307	310	313	316	319	322	325	328	331	334	337	340	343	346	349	
125	285	288	291	295	298	301	304	307	310	313	316	319	322	325	328	331	334	337	340	343	346	349	
130	285	289	292	295	298	301	305	308	311	314	317	320	323	326	329	332	335	338	341	343	346	349	
135	286	289	292	295	299	302	305	308	311	314	317	320	323	326	329	332	335	338	341	344	347	349	
140	286	289	292	296	299	302	305	308	311	314	317	321	324	327	330	333	335	338	341	344	347	350	
145	286	290	293	296	299	302	305	309	312	315	318	321	324	327	330	333	335	338	341	344	347	350	
150	287	290	293	296	300	303	306	309	312	315	318	321	324	327	330	333	336	339	342	345	348	350	
155	287	290	294	297	300	303	306	309	312	315	318	321	324	327	330	333	336	339	342	345	348	351	
160	287	291	294	297	300	303	306	310	313	316	319	322	325	328	331	334	337	339	342	345	348	351	
165	288	291	294	297	301	304	307	310	313	316	319	322	325	328	331	334	337	340	343	345	348	351	
170	288	291	295	298	301	304	307	310	313	316	319	322	325	328	331	334	337	340	343	345	348	351	
175	289	292	295	298	301	304	307	311	314	317	320	323	326	329	331	334	337	340	343	346	349	351	
180	289	292	295	298	302	305	308	311	314	317	320	323	326	329	331	334	337	340	343	346	349	352	
185	289	293	296	299	302	305	308	311	314	317	320	323	326	329	332	335	338	341	343	346	349	352	
190	290	293	296	299	302	305	308	312	315	318	321	324	326	329	332	335	338	341	344	347	349	352	
195	290	293	296	300	303	306	309	312	315	318	321	324	326	329	332	335	338	341	344	347	350	352	
200	291	294	297	300	303	306	309	312	315	318	321	324	327	330	333	336	339	342	344	347	350	353	
205	291	294	297	300	303	306	309	313	316	319	321	324	327	330	333	336	339	342	344	347	350	353	
210	291	295	298	301	304	307	310	313	316	319	322	325	328	331	334	336	339	342	345	348	350	353	
215	292	295	298	301	304	307	310	313	316	319	322	325	328	331	334	336	339	342	345	348	351	353	
220	292	295	298	301	304	308	311	314	317	319	322	325	328	331	334	337	340	342	345	348	351	354	
225	293	296	299	302	305	308	311	314	317	320	323	326	329	332	334	337	340	343	346	348	351	354	
230	293	296	299	302	305	308	311	314	317	320	323	326	329	332	334	337	340	343	346	349	351	354	
235	293	296	300	303	306	309	312	315	318	320	323	326	329	332	335	338	340	343	346	349	352	355	
240	294	297	300	303	306	309	312	315	318	321	324	327	330	332	335	338	341	344	346	349	352	355	



TABLE 14. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

MOLE FRACTION OF HELIUM 0.2500

T, DEG K	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	96	97	98	98	99	99	100	101	101	102	102	103	104	104	105	105	106	107	107	108	108	109
5	97	98	98	99	100	100	101	101	102	103	103	104	104	105	106	106	107	107	108	109	109	110
10	99	99	100	100	101	102	102	103	103	104	105	105	106	106	107	107	108	109	109	110	110	111
15	100	101	102	102	103	103	104	104	105	105	106	107	107	108	108	109	109	110	111	111	112	112
20	102	103	103	104	105	105	106	106	107	107	108	108	109	109	110	110	111	112	112	113	113	114
25	105	105	106	106	107	107	108	108	109	109	110	110	111	111	112	112	113	113	114	114	115	115
30	107	108	108	109	109	110	110	110	111	111	112	112	113	113	114	114	115	115	116	116	117	117
35	110	111	111	111	112	112	113	113	113	114	114	115	115	116	116	117	117	118	118	119	119	119
40	114	114	114	115	115	115	116	116	116	117	117	117	118	118	118	119	119	120	120	121	121	121
45	117	118	118	118	118	118	119	119	119	120	120	120	120	121	121	121	122	122	123	123	123	124
50	122	122	122	122	122	122	122	122	123	123	123	123	124	124	124	124	125	125	125	126	126	126
55	126	126	126	126	126	126	126	126	126	126	126	127	127	127	127	127	128	128	128	128	129	129
60	132	131	131	131	131	130	130	130	130	130	130	130	130	130	131	131	131	131	131	132	132	132
65	137	137	136	136	135	135	135	135	134	134	134	134	134	134	134	134	134	134	134	135	135	135
70	143	142	142	141	140	140	139	139	139	138	138	138	138	138	138	138	138	138	138	138	138	138
75	149	148	147	147	146	145	144	144	143	143	143	142	142	142	142	142	142	141	141	141	141	141
80	156	155	154	152	152	151	150	149	148	148	147	147	146	146	146	146	145	145	145	145	145	145
85	163	161	160	159	157	156	155	155	154	153	152	152	151	151	150	150	149	149	149	149	149	148
90	169	168	166	165	163	162	161	160	159	158	158	157	156	155	155	154	154	153	153	153	153	152
95	176	174	173	171	170	168	167	166	165	164	163	162	161	160	160	159	158	158	157	157	156	156
100	183	181	179	177	176	174	173	171	170	169	168	167	166	165	164	164	163	162	162	161	161	160
105	190	187	186	184	182	180	179	177	176	174	173	172	171	170	169	168	167	167	166	165	165	164
110	196	194	192	190	188	186	184	183	181	180	179	177	176	175	174	173	172	171	170	169	168	168
115	203	200	198	196	194	192	190	189	187	185	184	183	181	180	179	178	177	176	175	174	173	173
120	209	207	204	202	200	198	196	194	192	191	189	188	186	185	184	183	182	180	179	179	178	177
125	215	213	210	208	206	204	202	200	198	196	195	193	192	190	189	187	186	185	184	183	182	181
130	221	219	216	214	212	210	207	205	203	202	200	198	197	195	194	192	191	190	189	188	186	185
135	227	225	222	220	217	215	213	211	209	207	205	203	202	200	199	197	196	194	193	192	191	190
140	233	231	228	226	223	221	218	216	214	212	210	209	207	205	203	202	200	199	198	196	195	194
145	239	236	234	231	229	226	224	222	220	217	215	214	212	210	208	207	205	204	202	201	200	198
150	245	242	239	237	234	232	229	227	225	223	221	219	217	215	213	211	210	208	207	205	204	203
155	250	247	245	242	239	237	234	232	230	228	226	224	222	220	218	216	214	213	211	210	208	207
160	256	253	250	247	245	242	240	237	235	233	231	228	226	224	223	221	219	217	216	214	213	211
165	261	258	255	253	250	247	245	242	240	238	235	233	231	229	227	225	224	222	220	219	217	216
170	266	263	260	258	255	252	250	247	245	243	240	238	236	234	232	230	228	226	225	223	221	220
175	271	268	266	263	260	257	255	252	250	247	245	243	241	239	237	235	233	231	229	227	226	224
180	276	273	271	268	265	262	260	257	255	252	250	248	245	243	241	239	237	235	233	232	230	228
185	281	278	275	273	270	267	264	262	259	257	254	252	250	248	246	243	242	240	238	236	234	232
190	286	283	280	277	275	272	269	267	264	262	259	257	254	252	250	248	246	244	242	240	238	237
195	291	288	285	282	279	277	274	271	269	266	264	261	259	257	254	252	250	248	246	244	242	241
200	296	293	290	287	284	281	279	276	273	271	268	266	263	261	259	257	254	252	250	248	247	245
205	301	298	295	292	289	286	283	280	278	275	273	270	268	265	263	261	259	257	255	253	251	249
210	306	302	299	296	293	290	288	285	282	280	277	275	272	270	267	265	263	261	259	257	255	253
215	310	307	304	301	298	295	292	289	287	284	281	279	276	274	272	269	267	265	263	261	259	257
220	314	311	308	305	302	299	297	294	291	288	286	283	281	278	276	273	271	269	267	265	263	261
225	319	316	313	310	307	304	301	298	295	293	290	287	285	282	280	278	275	273	271	269	267	265
230	323	320	317	314	311	308	305	302	300	297	294	292	289	287	284	282	279	277	275	273	271	269
235	328	325	322	318	315	313	310	307	304	301	298	296	293	291	288	286	283	281	279	277	275	272
240	332	329	326	323	320	317	314	311	308	305	303	300	297	295	292	290	287	285	283	281	278	276





TABLE 14. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

		MOLE FRACTION OF HELIUM 0.2500																					
T, DEG K		156	158	160	162	164	166	168	170	172	174	176	178	180	182	184	186	188	190	192	194	196	198
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	110	111	112	114	115	116	117	118	119	121	122	123	124	125	126	127	128	130	131	132	133	134	
5	111	112	113	114	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134
10	112	113	114	115	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135
15	113	114	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136
20	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137
25	116	117	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139
30	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
35	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142
40	122	123	124	125	126	127	128	129	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143
45	124	125	126	127	128	129	130	130	131	132	133	134	135	136	137	138	139	139	140	141	142	143	144
50	127	128	128	129	130	131	131	132	133	134	135	136	137	137	138	139	140	141	142	143	144	145	146
55	129	130	131	131	132	133	134	134	135	136	137	138	138	139	140	141	142	143	143	144	145	146	147
60	132	133	133	134	134	135	136	136	137	138	139	139	140	141	142	143	143	144	145	146	147	148	149
65	135	136	136	136	137	138	138	139	139	140	141	141	142	143	144	145	146	147	148	149	150	151	152
70	138	138	139	139	140	140	141	141	142	142	143	143	144	145	145	146	147	148	149	150	151	152	153
75	141	142	142	142	142	143	143	144	144	145	145	146	146	147	147	148	149	150	151	152	153	154	155
80	145	145	145	145	145	146	146	146	147	147	148	148	149	150	150	151	151	152	153	154	155	156	157
85	148	148	148	148	148	148	148	149	149	149	150	150	151	151	152	152	153	153	154	155	156	157	158
90	152	151	151	151	151	151	151	151	152	152	153	153	153	154	154	155	155	156	157	158	159	160	161
95	156	155	155	154	154	154	154	154	154	155	155	155	156	156	156	157	157	158	158	159	160	161	162
100	159	159	158	158	157	157	157	157	157	157	157	158	158	158	159	159	159	160	160	161	161	162	163
105	163	162	162	161	161	160	160	160	160	160	160	160	160	160	161	161	161	162	162	162	163	163	164
110	167	166	165	165	164	164	163	163	163	163	163	163	163	163	163	164	164	164	165	165	165	166	167
115	171	170	169	168	168	167	167	166	166	166	166	165	165	165	166	166	166	166	167	167	167	168	169
120	175	174	173	172	171	170	170	169	169	169	168	168	168	168	168	168	168	169	169	169	170	171	172
125	180	178	177	176	175	174	173	172	172	172	171	171	171	171	171	171	171	171	171	171	171	172	173
130	184	182	181	179	178	177	176	176	175	175	174	174	173	173	173	173	173	173	173	173	173	174	175
135	188	186	184	183	182	181	180	179	178	178	177	177	176	176	176	176	176	176	176	176	176	177	178
140	192	190	188	187	185	184	183	182	181	181	180	180	179	179	178	178	178	178	178	178	178	179	180
145	196	194	192	191	189	188	187	186	185	184	183	182	182	181	181	181	181	181	181	181	181	182	183
150	200	198	196	194	193	191	190	189	188	187	186	185	185	184	184	183	183	183	183	183	183	184	185
155	205	202	200	198	196	195	193	192	191	190	189	188	188	187	186	186	186	185	185	185	185	185	186
160	209	206	204	202	200	198	197	196	194	193	192	191	191	190	189	189	188	188	188	187	187	187	188
165	213	210	208	206	204	202	200	199	198	196	195	194	193	193	192	191	191	190	190	190	189	189	190
170	217	214	212	210	208	206	204	202	201	200	198	197	196	196	195	194	194	193	193	192	192	192	193
175	221	218	216	213	211	209	207	206	204	203	202	200	199	198	198	197	196	196	195	195	194	194	195
180	225	222	220	217	215	213	211	209	207	206	205	203	202	201	200	200	199	198	198	197	197	197	198
185	229	226	224	221	219	216	214	212	211	209	208	206	205	204	203	202	202	201	200	200	199	199	200
190	233	230	227	225	222	220	218	216	214	212	211	210	208	207	206	205	204	203	203	202	202	202	203
195	237	234	231	228	226	223	221	219	217	216	214	213	211	210	209	208	207	206	205	205	204	204	205
200	241	238	235	232	230	227	225	223	221	219	217	216	214	213	212	211	210	209	208	207	206	206	207
205	245	242	239	236	233	231	228	226	224	222	220	219	217	216	215	213	212	211	210	210	209	208	209
210	249	246	243	240	237	234	232	229	227	225	223	222	220	219	217	216	215	214	213	212	211	211	212
215	253	250	246	243	240	238	235	233	231	228	227	225	223	222	220	219	218	217	216	215	214	214	215
220	257	253	250	247	244	241	238	236	234	232	230	228	226	225	223	222	220	219	218	217	216	216	217
225	261	257	254	250	247	245	242	239	237	235	233	231	229	227	226	224	223	222	221	220	219	219	220
230	265	261	257	254	251	248	245	243	240	238	236	234	232	230	229	227	226	225	224	223	222	222	223
235	268	265	261	258	254	251	249	246	244	241	239	237	235	233	232	230	229	227	226	225	224	224	225
240	272	268	265	261	258	255	252	249	247	244	242	240	238	236	234	233	232	230	229	227	226	226	227



TABLE 14. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

		MOLE FRACTION OF HELIUM 0.2500																					
T, DEG K		200	205	210	215	220	225	230	235	240	245	250	255	260	265	270	275	280	285	290	295	300	305
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	135	138	140	143	146	148	151	153	156	158	161	163	166	168	171	173	175	178	180	182	185	187	
5	136	138	141	144	146	149	151	154	156	159	161	164	166	169	171	173	175	178	180	182	185	187	
10	136	139	142	144	147	149	152	154	157	159	162	164	167	169	172	174	176	179	181	183	185	187	
15	137	140	142	145	148	150	153	155	158	160	163	165	167	169	172	174	176	179	181	183	185	187	
20	138	141	143	146	149	151	154	156	158	161	163	166	168	171	173	175	178	180	182	184	186	188	
25	139	142	144	147	149	152	154	157	159	162	164	166	169	171	174	176	178	180	182	184	187	189	
30	140	143	145	148	150	153	155	158	160	163	165	167	170	172	174	177	179	181	183	185	187	190	
35	142	144	147	149	151	154	156	159	161	163	166	168	170	173	175	177	180	182	184	186	188	190	
40	143	145	148	150	152	155	157	160	162	164	167	169	171	174	176	178	180	183	185	187	189	191	
45	144	146	149	151	154	156	158	161	163	165	167	169	171	174	176	178	180	183	185	187	189	191	
50	146	148	150	152	155	157	159	162	164	166	168	171	173	175	177	179	181	183	186	188	190	192	
55	147	149	151	154	156	158	160	163	165	167	169	172	174	176	178	180	183	185	187	189	191	193	
60	148	151	153	155	157	159	161	164	166	168	170	173	175	177	179	181	183	186	188	189	191	193	
65	150	152	154	156	158	160	163	165	167	169	171	174	176	178	180	182	184	186	188	190	192	194	
70	151	153	155	158	160	162	164	166	168	170	172	175	177	179	181	183	185	187	189	191	193	195	
75	153	155	157	159	161	163	165	167	169	171	173	176	178	180	182	184	186	188	190	192	194	196	
80	155	157	158	160	162	164	166	168	170	172	174	177	179	181	183	185	187	189	191	193	195	197	
85	156	158	160	162	164	166	168	170	172	174	176	178	180	182	184	186	188	190	192	194	196	198	
90	158	160	162	163	165	167	169	171	173	175	177	179	181	183	185	187	189	191	193	195	197	199	
95	160	162	163	165	167	168	170	172	174	176	178	180	182	184	186	188	190	192	194	196	198	200	
100	162	163	165	166	168	170	172	173	175	177	179	181	183	185	187	189	191	193	195	197	198	200	
105	164	165	167	168	170	171	173	175	177	178	180	182	184	186	188	190	192	194	195	197	199	201	
110	166	167	168	170	171	173	174	176	177	179	181	183	185	187	189	191	193	194	196	198	200	202	
115	168	169	170	171	173	174	176	177	179	181	183	184	186	188	190	192	194	195	197	199	201	203	
120	170	171	172	173	174	176	177	179	180	182	183	184	186	187	189	191	193	195	196	198	200	202	
125	172	173	174	175	176	177	179	180	182	183	185	187	188	190	192	194	196	197	199	201	203	205	
130	174	175	175	177	178	179	181	182	183	185	186	188	189	191	193	194	196	198	200	202	204	206	
135	176	177	177	178	179	181	182	183	185	186	188	189	191	193	194	196	198	199	201	203	205	207	
140	178	179	179	180	181	182	183	185	186	187	189	190	192	194	195	197	199	200	202	204	206	208	
145	180	181	181	182	183	184	185	186	187	189	190	192	193	195	196	198	200	201	203	205	207	209	
150	182	183	183	184	185	185	187	188	189	190	192	193	195	196	198	199	201	202	204	206	208	210	
155	185	185	185	186	186	187	188	189	190	192	193	194	196	197	199	200	202	204	205	207	209	211	
160	187	187	187	187	188	189	190	191	192	193	194	196	197	198	200	201	203	205	206	208	209	211	
165	189	189	189	189	190	191	191	192	193	194	196	197	198	200	201	203	204	206	207	209	210	212	
170	191	191	191	191	192	192	193	194	195	196	197	198	200	201	202	204	205	207	208	210	211	213	
175	194	193	193	193	194	194	195	195	196	197	198	200	201	202	204	205	206	208	209	211	212	214	
180	196	195	195	195	195	196	196	197	198	199	200	201	202	204	205	206	208	209	210	212	213	215	
185	198	198	197	197	197	198	198	199	199	200	201	202	203	205	206	208	209	210	212	213	214	216	
190	201	200	199	199	199	199	200	200	201	202	203	204	205	206	207	209	210	211	213	214	215	217	
195	203	202	201	201	201	201	202	202	203	203	204	205	206	207	208	210	211	213	214	215	217	219	
200	205	204	204	203	203	203	203	204	204	205	206	207	208	209	210	211	212	214	215	217	218	220	
205	208	206	206	205	205	205	205	205	206	206	207	208	209	210	211	212	213	215	216	217	219	221	
210	210	209	208	207	207	207	207	207	208	208	209	209	210	211	212	213	215	216	217	218	220	222	
215	212	211	210	209	209	208	208	209	209	209	210	211	212	213	214	215	216	217	218	219	221	223	
220	215	213	212	211	211	210	210	210	211	211	212	212	213	214	215	216	217	218	219	220	222	224	
225	217	216	214	213	213	212	212	212	212	213	213	214	214	215	216	217	218	219	220	222	223	225	
230	220	218	216	215	215	214	214	214	214	214	215	215	216	217	217	218	219	220	222	223	224	226	
235	222	220	219	217	217	216	216	215	216	216	216	217	217	218	219	220	221	222	223	224	225	227	
240	224	222	221	219	219	218	217	217	217	217	218	218	219	219	220	221	222	223	224	225	226	228	



TABLE 14. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

		MOLE FRACTION OF HELIUM 0.2500																					
T, DEG K		310	320	330	340	350	360	370	380	390	400	410	420	430	440	450	460	470	480	490	500	510	520
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	189	194	198	203	207	211	215	219	223	227	231	235	239	243	247	250	254	258	261	265	269	272	275
5	190	194	198	203	207	211	215	220	224	228	232	236	239	243	247	251	254	258	262	265	269	272	275
10	190	195	199	203	208	212	216	220	224	228	232	236	240	244	247	251	255	258	262	265	269	272	275
15	191	195	199	204	208	212	216	220	224	228	232	236	240	244	248	251	255	259	262	266	269	273	276
20	191	196	200	204	208	213	217	221	225	229	233	237	240	244	248	251	255	259	262	266	269	273	276
25	192	196	200	205	209	213	217	221	225	229	233	237	241	245	248	252	255	259	263	266	270	273	276
30	192	197	201	205	209	214	218	222	226	230	234	237	241	245	248	252	256	259	263	266	270	273	276
35	193	197	202	206	210	214	218	222	226	230	234	238	242	245	249	253	256	260	263	267	270	274	277
40	194	198	202	206	211	215	219	223	227	231	234	238	242	245	249	253	256	260	264	267	271	274	277
45	194	199	203	207	211	215	219	223	227	231	234	238	242	246	249	253	257	260	264	267	271	274	277
50	195	199	203	208	212	216	220	224	228	232	235	239	242	246	250	254	257	261	264	268	271	275	278
55	196	200	204	208	212	216	220	224	228	232	236	240	243	247	251	254	258	262	265	269	272	275	278
60	196	200	205	209	213	217	221	225	229	233	236	240	244	248	251	255	258	262	265	269	272	275	278
65	197	201	205	209	213	217	221	225	229	233	237	241	244	248	251	255	259	262	265	269	272	275	278
70	198	202	206	210	214	218	222	226	230	234	237	241	244	248	252	255	259	262	266	269	273	276	279
75	198	203	207	211	215	219	223	226	230	234	237	241	245	248	252	256	259	263	266	270	273	276	279
80	199	203	207	211	215	219	223	227	231	235	238	242	245	249	252	256	260	263	267	270	273	277	280
85	200	204	208	212	216	220	224	228	231	235	239	243	246	249	253	256	260	264	267	270	274	277	280
90	201	205	209	213	217	220	224	228	232	236	239	243	246	250	253	257	260	264	267	271	274	278	281
95	202	206	209	213	217	221	225	229	232	236	239	243	247	250	254	257	261	264	268	271	275	278	281
100	202	206	210	214	218	222	226	229	233	237	240	244	248	251	255	258	262	265	268	272	275	278	281
105	203	207	211	215	219	222	226	230	234	237	241	245	248	252	255	259	262	266	269	272	275	278	281
110	204	208	212	215	219	223	227	231	234	238	241	245	249	252	256	259	263	266	269	272	275	278	281
115	205	209	212	216	220	224	227	231	235	238	242	246	249	253	256	260	263	267	270	273	276	279	282
120	206	209	213	217	221	224	228	232	235	239	243	246	250	253	257	260	264	267	270	274	277	280	283
125	207	210	214	218	221	225	229	232	236	240	243	247	250	254	257	261	264	267	270	274	277	280	283
130	207	211	215	218	222	226	229	233	237	240	244	247	251	254	258	261	264	267	271	274	277	281	284
135	208	212	216	219	223	226	230	234	237	241	244	248	251	255	258	261	265	268	271	275	278	281	284
140	209	213	216	220	224	227	231	234	238	241	245	248	252	255	259	262	265	268	272	275	278	282	285
145	210	214	217	221	224	228	231	235	238	242	245	249	252	255	259	262	265	269	272	275	279	282	285
150	211	214	218	221	225	229	232	236	239	243	246	249	253	256	259	263	266	269	273	276	279	282	285
155	212	215	219	222	226	229	233	236	240	243	247	250	253	257	260	264	267	270	274	277	280	283	286
160	213	216	220	223	227	230	233	237	240	244	247	251	254	257	261	264	267	271	274	277	280	283	286
165	214	217	220	224	227	231	234	238	241	244	248	251	255	258	261	265	268	271	274	278	281	284	287
170	215	218	221	225	228	231	235	238	242	245	248	252	255	258	262	265	268	272	275	278	281	284	287
175	216	219	222	225	229	232	236	239	242	246	249	252	256	259	262	266	269	272	275	278	281	284	287
180	217	220	223	226	230	233	236	240	243	246	250	253	256	259	262	266	269	272	275	279	282	285	288
185	218	221	224	227	230	234	237	240	244	247	250	254	257	260	263	266	269	273	276	279	282	285	288
190	218	222	225	228	231	234	238	241	244	248	251	254	257	260	263	267	270	273	276	280	283	286	289
195	219	222	226	229	232	235	238	242	245	248	251	255	258	261	264	267	270	274	277	280	283	286	289
200	220	223	226	230	233	236	239	242	246	249	252	255	259	262	265	268	271	274	277	280	284	287	290
205	221	224	227	230	234	237	240	243	246	250	253	256	259	262	266	269	272	275	278	281	284	287	290
210	222	225	228	231	234	237	241	244	247	250	253	257	260	263	266	269	272	275	278	281	284	287	290
215	223	226	229	232	235	238	241	244	248	251	254	257	260	264	267	270	273	276	279	282	285	288	291
220	224	227	230	233	236	239	242	245	248	251	255	258	261	264	267	270	273	277	280	283	286	289	292
225	225	228	231	234	237	240	243	246	249	252	255	258	262	265	268	271	274	277	280	283	286	289	292
230	226	229	232	235	238	241	244	247	250	253	256	259	262	265	268	271	274	277	280	283	286	289	292
235	227	230	233	236	238	241	244	247	250	253	256	259	262	265	268	271	275	278	281	284	287	290	293
240	228	231	234	236	239	242	245	248	251	254	257	260	263	266	269	272	275	278	281	284	287	290	293



TABLE 14. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

		MOLE FRACTION OF HELIUM 0.2500																					
T, DEG K		530	540	550	560	570	580	590	600	610	620	630	640	650	660	670	680	690	700	710	720	730	740
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	276	279	282	286	289	292	296	299	302	305	308	312	315	318	321	324	327	330	333	336	339	342	
5	276	279	283	286	289	293	296	299	302	305	309	312	315	318	321	324	327	330	333	336	339	342	
10	276	279	283	286	289	293	296	299	302	306	309	312	315	318	321	324	327	330	333	336	339	342	
15	276	280	283	286	290	293	296	300	303	306	309	312	315	318	321	324	327	330	333	336	339	342	
20	277	280	283	287	290	293	297	300	303	306	309	312	316	319	322	325	328	331	334	337	340	342	
25	277	280	284	287	290	294	297	300	303	306	310	313	316	319	322	325	328	331	334	337	340	343	
30	277	281	284	287	291	294	297	300	303	307	310	313	316	319	322	325	328	331	334	337	340	343	
35	277	281	284	288	291	294	297	301	304	307	310	313	316	319	322	325	328	331	334	337	340	343	
40	278	281	285	288	291	294	298	301	304	307	310	313	316	319	322	325	328	331	334	337	340	343	
45	278	281	285	288	291	295	298	301	304	307	311	314	317	320	323	326	329	332	335	338	341	343	
50	278	282	285	288	292	295	298	301	305	308	311	314	317	320	323	326	329	332	335	338	341	344	
55	279	282	285	289	292	295	299	302	305	308	311	314	317	320	323	326	329	332	335	338	341	344	
60	279	282	286	289	292	296	299	302	305	308	311	315	318	321	324	327	330	333	336	339	341	344	
65	279	283	286	289	293	296	299	302	305	309	312	315	318	321	324	327	330	333	336	339	341	344	
70	280	283	286	290	293	296	299	303	306	309	312	315	318	321	324	327	330	333	336	339	342	345	
75	280	284	287	290	293	297	300	303	306	309	312	315	318	321	324	327	330	333	336	339	342	345	
80	281	284	287	290	294	297	300	303	306	309	312	315	318	321	325	328	330	333	336	339	342	345	
85	281	284	288	291	294	297	300	304	307	310	313	316	319	322	325	328	331	334	337	340	342	345	
90	281	285	288	291	294	298	301	304	307	310	313	316	319	322	325	328	331	334	337	340	343	346	
95	282	285	288	291	295	298	301	304	307	310	313	316	319	322	325	328	331	334	337	340	343	346	
100	282	285	289	292	295	298	301	305	308	311	314	317	320	323	326	329	332	335	337	340	343	346	
105	282	286	289	292	295	299	302	305	308	311	314	317	320	323	326	329	332	335	338	341	343	346	
110	283	286	289	293	296	299	302	305	308	311	314	317	320	323	326	329	332	335	338	341	344	347	
115	283	286	290	293	296	299	302	306	309	312	315	318	321	324	327	330	333	336	338	341	344	347	
120	284	287	290	293	296	300	303	306	309	312	315	318	321	324	327	330	333	336	338	341	344	347	
125	284	287	290	294	297	300	303	306	309	312	315	318	321	324	327	330	333	336	339	342	345	347	
130	284	288	291	294	297	300	303	307	310	313	316	319	322	325	328	331	334	336	339	342	345	348	
135	285	288	291	294	298	301	304	307	310	313	316	319	322	325	328	331	334	336	339	342	345	348	
140	285	288	292	295	298	301	304	307	310	313	316	319	322	325	328	331	334	337	340	342	345	348	
145	286	289	292	295	298	301	305	308	311	314	317	320	323	325	328	331	334	337	340	343	346	348	
150	286	289	292	296	299	302	305	308	311	314	317	320	323	326	329	331	334	337	340	343	346	349	
155	286	290	293	296	299	302	305	308	311	314	317	320	323	326	329	332	335	338	340	343	346	349	
160	287	290	293	296	299	303	306	309	312	315	318	321	324	327	329	332	335	338	341	344	346	349	
165	287	290	294	297	300	303	306	309	312	315	318	321	324	327	329	332	335	338	341	344	347	350	
170	288	291	294	297	300	303	306	309	312	315	318	321	324	327	330	333	336	338	341	344	347	350	
175	288	291	294	297	301	304	307	310	313	316	319	322	325	327	330	333	336	339	342	344	347	350	
180	289	292	295	298	301	304	307	310	313	316	319	322	325	328	331	334	336	339	342	345	348	350	
185	289	292	295	298	301	304	307	310	313	316	319	322	325	328	331	334	336	339	342	345	348	351	
190	289	293	296	299	302	305	308	311	314	317	320	323	325	328	331	334	337	340	342	345	348	351	
195	290	293	296	299	302	305	308	311	314	317	320	323	326	328	331	334	337	340	343	346	348	351	
200	290	293	296	299	303	306	309	312	314	317	320	323	326	329	332	335	337	340	343	346	349	351	
205	291	294	297	300	303	306	309	312	315	318	321	324	327	329	332	335	338	341	343	346	349	352	
210	291	294	297	300	303	306	309	312	315	318	321	324	327	329	332	335	338	341	344	346	349	352	
215	292	295	298	301	304	307	310	313	316	318	321	324	327	330	333	335	338	341	344	347	350	352	
220	292	295	298	301	304	307	310	313	316	319	322	324	327	330	333	336	339	341	344	347	350	353	
225	292	295	299	302	305	307	310	313	316	319	322	325	328	330	333	336	339	342	345	347	350	353	
230	293	296	299	302	305	308	311	314	317	320	322	325	328	331	334	336	339	342	345	348	350	353	
235	293	296	299	302	305	308	311	314	317	320	322	325	328	331	334	337	340	342	345	348	351	353	
240	294	297	300	303	306	309	312	315	317	320	323	326	329	331	334	337	340	343	345	348	351	354	





TABLE 15. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

		MOLE FRACTION OF HELIUM 0.2000																				
T, DEG K	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	95	96	96	97	97	98	99	99	100	100	101	102	102	103	103	104	105	105	106	106	107	108
5	96	97	97	98	98	99	100	100	101	101	102	103	103	104	104	105	106	106	107	107	108	109
10	98	98	99	99	100	101	101	102	102	103	103	104	105	105	106	106	107	108	108	109	109	110
15	100	100	101	101	102	102	103	104	104	105	105	106	106	107	107	108	109	109	110	110	111	111
20	102	102	103	103	104	105	105	106	106	107	107	108	108	109	109	110	110	111	111	112	112	113
25	105	105	106	106	106	107	107	108	108	109	109	110	110	111	111	112	112	113	113	114	114	115
30	108	108	109	109	109	110	110	111	111	111	112	112	113	113	114	114	115	115	116	116	116	117
35	111	112	112	112	113	113	113	114	114	114	115	115	116	116	116	117	117	118	118	118	119	119
40	116	116	116	116	116	117	117	117	117	118	118	118	119	119	119	120	120	120	121	121	121	122
45	120	120	120	120	120	121	121	121	121	121	121	122	122	122	122	123	123	123	124	124	124	125
50	126	126	125	125	125	125	125	125	125	125	125	125	126	126	126	126	126	126	127	127	127	127
55	132	132	131	131	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130	131
60	139	138	138	137	136	136	135	135	135	134	134	134	134	134	134	134	134	134	134	134	134	134
65	147	146	144	144	143	142	141	141	140	140	139	139	139	138	138	138	138	138	138	138	138	138
70	155	153	152	151	150	149	148	147	146	145	145	144	144	143	143	143	142	142	142	142	142	142
75	163	162	160	158	157	156	154	153	152	151	151	150	149	149	148	148	147	147	147	146	146	146
80	172	170	168	166	164	163	161	160	159	158	157	156	155	154	153	153	152	152	151	151	150	150
85	181	178	176	174	172	170	168	167	165	164	163	162	161	160	159	158	157	157	156	156	155	155
90	190	187	184	182	180	178	176	174	172	171	169	168	167	166	165	164	163	162	161	161	160	159
95	198	195	192	190	187	185	183	181	179	177	176	174	173	172	170	169	168	167	166	166	165	164
100	206	203	200	198	195	193	190	188	186	184	182	181	179	178	176	175	174	173	172	171	170	169
105	214	211	208	205	202	200	197	195	193	191	189	187	185	184	182	181	180	178	177	176	175	174
110	222	219	216	213	210	207	205	202	200	198	196	194	192	190	188	187	185	184	183	181	180	179
115	229	226	223	220	217	214	211	209	206	204	202	200	198	196	194	193	191	190	188	187	185	184
120	236	233	230	227	224	221	218	216	213	211	208	206	204	202	200	198	197	195	194	192	191	189
125	243	240	237	234	231	228	225	222	220	217	215	212	210	208	206	204	202	201	199	197	196	195
130	250	247	244	240	237	234	231	229	226	223	221	218	216	214	212	210	208	206	204	203	201	200
135	257	253	250	247	244	241	238	235	232	229	227	224	222	220	218	216	214	212	210	208	206	205
140	263	260	256	253	250	247	244	241	238	235	233	230	228	226	223	221	219	217	215	213	212	210
145	270	266	263	259	256	253	250	247	244	241	239	236	234	231	229	227	224	222	220	219	217	215
150	276	272	269	265	262	259	256	253	250	247	244	242	239	237	234	232	230	228	226	224	222	220
155	282	278	275	271	268	265	262	259	256	253	250	247	245	242	240	237	235	233	231	229	227	225
160	287	284	281	277	274	271	267	264	261	258	256	253	250	248	245	243	240	238	236	234	232	230
165	293	290	286	283	279	276	273	270	267	264	261	258	256	253	250	248	246	243	241	239	237	235
170	299	295	292	288	285	282	279	275	272	269	266	264	261	258	256	253	251	248	246	244	242	240
175	304	301	297	294	290	287	284	281	278	275	272	269	266	263	261	258	256	253	251	249	246	244
180	310	306	303	299	296	293	289	286	283	280	277	274	271	268	266	263	261	258	256	253	251	249
185	315	312	308	305	301	298	295	291	288	285	282	279	276	273	271	268	266	263	261	258	256	254
190	320	317	313	310	306	303	300	296	293	290	287	284	281	278	276	273	270	268	265	263	261	258
195	326	322	318	315	311	308	305	301	298	295	292	289	286	283	281	278	275	273	270	268	265	263
200	331	327	323	320	317	313	310	306	303	300	297	294	291	288	285	283	280	277	275	272	270	268
205	336	332	328	325	322	318	315	311	308	305	302	299	296	293	290	287	285	282	279	277	274	272
210	341	337	333	330	326	323	320	316	313	310	307	304	301	298	295	292	289	286	284	281	279	276
215	346	342	338	335	331	328	324	321	318	315	311	308	305	302	299	297	294	291	288	286	283	281
220	350	347	343	340	336	333	329	326	323	319	316	313	310	307	304	301	298	296	293	290	288	285
225	355	352	348	344	341	337	334	331	327	324	321	318	314	311	309	306	303	300	297	295	292	290
230	360	356	353	349	346	342	339	335	332	329	325	322	319	316	313	310	307	304	302	299	296	294
235	365	361	357	354	350	347	343	340	336	333	330	327	324	320	317	314	312	309	306	303	301	298
240	369	366	362	358	355	351	348	344	341	338	334	331	328	325	322	319	316	313	310	308	305	302



TABLE 15. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

		MOLE FRACTION OF HELIUM 0.2000																					
T, DEG K	156	158	160	162	164	166	168	170	172	174	176	178	180	182	184	186	188	190	192	194	196	198	
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	
1	109	110	111	112	113	115	116	117	118	119	120	121	123	124	125	126	127	128	129	130	131	133	
5	110	111	112	113	114	115	117	118	119	120	121	122	123	124	126	127	128	129	130	131	132	133	
10	111	112	113	114	115	117	118	119	120	121	122	123	124	125	127	128	129	130	131	132	133	134	
15	112	114	115	116	117	118	119	120	121	122	123	124	126	127	128	129	130	131	132	133	134	135	
20	114	115	116	117	118	119	120	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	
25	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	
30	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	
35	120	121	122	123	124	125	126	127	128	128	129	130	131	132	133	134	135	136	137	138	139	140	
40	123	123	124	125	126	127	128	129	129	130	131	132	133	134	135	136	137	138	139	140	141	141	
45	125	126	127	127	128	129	130	131	131	132	133	134	135	136	137	138	138	139	140	141	142	143	
50	128	129	129	130	131	131	132	133	134	134	135	136	137	138	138	139	140	141	142	143	144	145	
55	131	132	132	133	133	134	135	135	136	137	137	138	139	140	140	141	142	143	144	144	145	146	
60	134	135	135	136	136	137	137	138	138	139	140	140	141	142	142	143	144	145	146	146	147	148	
65	138	138	138	139	139	139	140	140	141	141	142	143	143	144	145	145	146	147	147	148	149	150	
70	142	142	142	142	142	142	143	143	143	144	144	145	146	146	147	147	148	149	149	150	151	151	
75	146	145	145	145	145	145	146	146	146	147	147	148	148	149	150	150	151	151	152	153	153	153	
80	150	149	149	149	149	149	149	149	149	149	150	150	150	151	151	152	152	153	153	154	155	155	
85	154	153	153	153	152	152	152	152	152	153	153	153	153	154	154	155	155	156	156	157	157	157	
90	158	158	157	156	156	156	155	155	155	155	155	156	156	156	156	157	157	158	158	159	159	159	
95	163	162	161	160	160	159	159	159	159	158	158	158	159	159	159	159	159	160	160	161	161	161	
100	168	166	165	164	164	163	162	162	162	162	161	161	161	161	162	162	162	162	163	163	163	164	
105	172	171	170	169	168	167	166	166	165	165	165	164	164	164	164	164	165	165	165	165	166	166	
110	177	176	174	173	172	171	170	169	169	168	168	168	167	167	167	167	167	167	168	168	168	168	
115	182	180	179	177	176	175	174	173	172	172	171	171	170	170	170	170	170	170	170	170	171	171	
120	187	185	183	181	180	179	178	177	176	175	174	174	174	173	173	173	173	173	173	173	173	173	
125	192	190	188	186	184	183	181	180	179	178	177	177	176	176	176	175	175	175	175	175	175	175	
130	197	194	192	190	188	187	185	184	183	182	181	181	180	179	179	179	178	178	178	178	178	178	
135	202	199	197	195	193	191	189	188	187	186	185	184	183	183	182	182	181	181	181	180	180	180	
140	207	204	201	199	197	195	193	192	191	189	188	187	186	186	185	184	184	184	183	183	183	183	
145	212	209	206	204	201	199	197	196	194	193	192	191	190	189	188	188	187	186	186	186	186	185	
150	217	213	211	208	206	203	201	200	198	197	195	194	193	192	191	191	190	189	189	188	188	188	
155	221	218	215	212	210	208	206	204	202	200	199	198	196	195	194	194	193	192	192	191	191	190	
160	226	223	220	217	214	212	210	207	206	204	202	201	200	199	198	197	196	195	195	194	194	193	
165	231	227	224	221	218	216	214	211	209	208	206	205	203	202	201	200	199	198	197	197	196	196	
170	236	232	229	226	223	220	218	215	213	211	210	208	207	205	204	203	202	201	200	199	199	198	
175	240	237	233	230	227	224	222	219	217	215	213	211	210	209	207	206	205	204	203	202	202	201	
180	245	241	238	234	231	228	226	223	221	219	217	215	213	212	210	209	208	207	206	205	204	204	
185	250	246	242	238	235	232	230	227	225	222	220	218	217	215	214	212	211	210	209	208	207	206	
190	254	250	246	243	239	236	233	231	228	226	224	222	220	218	217	215	214	213	212	211	210	209	
195	259	254	251	247	244	240	237	235	232	230	227	225	224	222	220	219	217	216	215	214	213	212	
200	263	259	255	251	248	244	241	238	236	233	231	229	227	225	223	222	220	219	218	217	216	215	
205	267	263	259	255	252	248	245	242	240	237	235	232	230	228	227	225	223	222	221	220	218	217	
210	272	267	263	259	256	252	249	246	243	241	238	236	234	232	230	228	226	225	224	222	221	220	
215	276	272	267	263	260	256	253	250	247	244	242	239	237	235	233	231	230	228	227	225	224	223	
220	280	276	272	268	264	260	257	254	251	248	245	243	240	238	236	234	233	231	230	228	227	226	
225	285	280	276	272	268	264	261	257	254	251	248	245	243	240	238	236	234	233	231	230	228	226	
230	289	284	280	276	272	268	264	261	257	254	251	248	246	244	242	239	236	236	234	232	231	230	
235	293	288	284	280	276	272	268	265	261	258	255	252	250	247	245	243	241	239	237	235	234	231	
240	297	292	288	284	279	276	272	268	265	262	259	256	253	250	248	246	244	242	240	238	237	234	



TABLE 15. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROROISES

		MOLE FRACTION OF HELIUM 0.2000																					
T, DEG K	200	205	210	215	220	225	230	235	240	245	250	255	260	265	270	275	280	285	290	295	300	305	
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	134	136	139	142	144	147	149	152	155	157	160	162	164	167	169	172	174	176	179	181	183	186	
5	134	137	140	142	145	147	150	152	155	158	160	162	165	167	170	172	174	177	179	181	184	186	
10	135	138	140	143	146	148	151	153	156	158	161	163	166	168	170	173	175	177	180	182	184	187	
15	136	139	141	144	147	149	152	154	157	159	161	164	166	169	171	173	176	178	180	183	185	187	
20	137	140	142	145	147	150	152	155	157	160	162	165	167	169	172	174	176	179	181	183	186	188	
25	138	141	143	146	148	151	153	156	158	161	163	165	168	170	173	175	177	179	182	184	186	188	
30	140	142	145	147	150	152	154	157	159	162	164	166	169	171	173	176	178	180	182	185	187	189	
35	141	143	146	148	151	153	155	158	160	163	165	167	170	172	174	176	179	181	183	185	188	190	
40	142	145	147	149	152	154	157	159	161	164	166	168	170	173	175	177	179	182	184	186	188	190	
45	144	146	148	151	153	155	158	160	162	165	167	169	171	174	176	178	180	183	185	187	189	191	
50	145	148	150	152	154	157	159	161	163	166	168	170	172	175	177	179	181	183	186	188	190	192	
55	147	149	151	153	156	158	160	162	164	167	169	171	173	176	178	180	182	184	186	189	191	193	
60	149	151	153	155	157	159	161	163	166	168	170	172	174	176	179	181	183	185	187	189	191	194	
65	150	152	154	156	158	161	163	165	167	169	171	173	175	178	180	182	184	186	188	190	192	194	
70	152	154	156	158	160	162	164	166	168	170	172	174	176	179	181	183	185	187	189	191	193	195	
75	154	156	158	159	161	163	165	167	169	171	173	175	178	180	182	184	186	188	190	192	194	196	
80	156	158	159	161	163	164	166	168	170	172	174	176	178	180	182	184	186	188	190	192	194	196	
85	158	159	161	163	164	166	168	170	172	174	176	178	180	182	184	186	188	190	192	194	196	197	
90	160	161	163	164	166	168	170	171	173	175	177	179	181	183	185	187	189	191	193	195	197	199	
95	162	163	165	166	168	169	171	173	175	177	178	180	182	184	186	188	190	192	194	196	198	200	
100	164	165	167	168	169	171	173	174	176	178	180	181	183	185	187	189	191	193	195	197	199	200	
105	166	167	168	170	171	173	174	176	178	179	181	183	185	186	188	190	192	194	196	198	199	201	
110	168	169	170	172	173	174	176	177	179	181	182	184	186	188	189	191	193	195	197	199	200	202	
115	171	172	172	174	175	176	177	179	180	182	184	185	187	188	189	191	192	194	196	198	200	202	
120	173	174	174	175	177	178	179	180	182	183	185	187	188	190	192	193	195	197	199	201	202	203	
125	175	176	177	177	178	180	181	182	183	185	186	188	190	191	193	195	196	198	200	202	203	204	
130	178	178	179	179	180	181	182	184	185	186	188	189	191	193	194	196	197	199	201	203	204	205	
135	180	180	181	181	182	183	184	185	187	188	189	191	192	194	195	197	199	201	203	204	205	206	
140	183	183	183	183	184	185	186	187	188	189	191	192	194	195	197	199	200	202	204	205	206	207	
145	185	185	185	186	186	187	188	189	190	191	192	194	195	196	198	199	201	203	204	205	206	208	
150	188	187	187	188	188	189	189	190	191	193	194	195	196	198	199	201	203	204	206	208	209	209	
155	190	190	190	190	190	191	191	192	193	194	195	196	198	199	200	202	203	205	206	208	210	211	
160	193	192	192	192	192	193	193	194	195	196	197	198	199	200	202	203	205	206	208	209	211	212	
165	195	195	194	194	194	194	195	196	196	197	198	199	201	202	203	204	206	207	209	210	212	213	
170	198	197	196	196	196	196	197	197	198	199	200	201	202	203	204	206	207	208	210	211	213	214	
175	201	199	199	198	198	198	199	199	200	201	201	202	203	205	206	207	208	210	211	213	214	215	
180	203	202	201	201	200	200	201	201	202	202	203	204	205	206	207	208	210	211	212	214	215	217	
185	206	204	203	203	203	202	203	203	203	204	205	205	206	207	209	210	211	212	213	215	216	218	
190	208	207	206	205	205	204	204	205	205	206	206	207	208	209	210	211	212	213	215	216	217	219	
195	211	209	208	207	207	206	206	207	207	207	208	209	209	210	211	212	213	215	216	217	218	220	
200	214	212	211	210	209	209	208	208	209	209	209	210	211	212	213	214	215	216	217	218	220	221	
205	216	215	213	212	211	211	210	210	210	211	211	212	212	213	214	215	216	217	218	220	221	222	
210	219	217	215	214	213	213	212	212	212	212	213	213	214	215	215	216	217	218	220	221	222	223	
215	222	220	218	216	215	215	214	214	214	214	215	215	216	217	218	219	220	221	222	223	224	225	
220	225	222	220	219	218	217	216	216	216	216	216	217	218	219	220	221	222	223	224	225	226	227	
225	227	225	223	221	220	219	218	218	218	218	218	219	219	220	221	222	223	224	225	226	227	228	
230	230	227	225	223	222	221	220	220	220	219	219	219	220	220	221	221	222	223	224	225	226	227	
235	233	230	228	226	224	223	222	222	222	221	221	221	221	222	222	223	224	225	226	227	228	229	
240	235	232	230	228	226	225	224	224	224	223	223	223	223	224	224	225	225	226	227	228	229	230	



TABLE 15. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

		MOLE FRACTION OF HELIUM 0.2000																					
T, DEG K		310	320	330	340	350	360	370	380	390	400	410	420	430	440	450	460	470	480	490	500	510	520
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	188	192	197	201	205	210	214	218	222	226	230	234	238	241	245	249	253	256	260	263	267	270	
5	188	193	197	201	206	210	214	218	222	226	230	234	238	242	245	249	253	256	260	264	267	271	
10	189	193	198	202	206	210	215	219	223	227	231	234	238	242	246	250	253	257	260	264	267	271	
15	189	194	198	202	207	211	215	219	223	227	231	235	239	242	246	250	254	257	261	264	268	271	
20	190	194	199	203	207	211	215	220	224	228	231	235	239	243	247	250	254	258	261	265	268	271	
25	191	195	199	204	208	212	216	220	224	228	232	236	240	243	247	251	254	258	261	265	268	272	
30	191	196	200	204	208	212	217	221	225	228	232	236	240	244	247	251	255	258	262	265	269	272	
35	192	196	201	205	209	213	217	221	225	229	233	237	240	244	248	252	255	259	262	266	269	273	
40	193	197	201	205	210	214	218	222	226	229	233	237	241	245	248	252	256	259	263	266	270	273	
45	193	198	202	206	210	214	218	222	226	230	234	238	241	245	249	252	256	260	263	266	270	273	
50	194	198	203	207	211	215	219	223	227	231	234	238	241	245	249	252	256	260	263	267	270	273	
55	195	199	203	207	211	215	219	223	227	231	235	239	242	246	250	253	257	260	264	267	271	274	
60	196	200	204	208	212	216	220	224	228	232	235	239	243	246	250	254	257	261	264	268	271	274	
65	196	201	205	209	213	217	221	224	228	232	236	240	243	247	251	254	258	261	265	268	272	275	
70	197	201	205	209	213	217	221	225	229	233	236	240	244	247	251	254	258	262	265	269	272	275	
75	198	202	206	210	214	218	222	226	230	233	237	241	244	248	252	255	259	262	266	269	272	275	
80	199	203	207	211	215	219	222	226	230	234	238	241	245	248	252	256	259	263	266	269	272	276	
85	200	204	208	212	215	219	223	227	231	234	238	242	245	249	253	256	260	263	266	270	273	277	
90	201	205	208	212	216	220	224	228	231	235	239	242	246	250	253	257	260	263	266	270	273	277	
95	201	205	209	213	217	221	224	228	232	236	239	243	246	250	254	257	261	264	267	270	274	277	
100	202	206	210	214	218	221	225	229	233	236	240	243	247	251	254	258	261	264	268	271	274	277	
105	203	207	211	215	218	222	226	230	233	237	240	244	248	251	255	258	261	265	268	272	275	278	
110	204	208	212	215	219	223	227	230	234	237	241	245	248	252	255	259	262	265	269	272	275	278	
115	205	209	213	216	220	224	227	231	234	238	242	245	249	252	256	259	262	266	269	273	276	279	
120	206	210	213	217	221	224	228	232	235	239	242	246	249	253	256	260	263	266	270	273	276	279	
125	207	211	214	218	221	225	229	232	236	239	243	246	250	253	257	260	264	267	270	273	277	280	
130	208	211	215	219	222	226	229	233	236	240	243	247	250	254	257	261	264	267	271	274	277	280	
135	209	212	216	219	223	227	230	234	237	241	244	248	251	254	258	261	265	268	271	274	278	281	
140	210	213	217	220	224	227	231	234	238	241	245	248	252	255	258	262	265	268	272	275	278	281	
145	211	214	218	221	225	228	232	235	238	242	245	249	252	256	259	262	266	269	272	275	279	282	
150	212	215	219	222	225	229	232	236	239	243	246	249	253	256	259	263	266	269	273	276	279	282	
155	213	216	219	223	226	230	233	236	240	243	247	250	253	257	260	263	267	270	273	276	280	283	
160	214	217	220	224	227	230	234	237	241	244	247	251	254	257	261	264	267	270	274	277	280	283	
165	215	218	221	225	228	231	235	238	241	245	248	251	255	258	261	264	268	271	274	277	281	284	
170	216	219	222	225	229	232	235	239	242	245	249	252	255	258	262	265	268	271	275	278	281	284	
175	217	220	223	226	230	233	236	239	243	246	249	253	256	259	262	266	269	272	275	278	281	284	
180	218	221	224	227	230	234	237	240	243	247	250	253	256	260	263	266	269	273	276	279	282	285	
185	219	222	225	228	231	234	238	241	244	247	251	254	257	260	263	267	270	273	276	279	282	285	
190	220	223	226	229	232	235	238	242	245	248	251	254	258	261	264	267	270	274	277	280	283	286	
195	221	224	227	230	233	236	239	242	246	249	252	255	258	262	265	268	271	274	277	280	283	286	
200	222	225	228	231	234	237	240	243	246	249	253	256	259	262	265	268	272	275	278	281	284	287	
205	223	226	229	232	235	238	241	244	247	250	253	256	260	263	266	269	272	275	278	281	284	287	
210	224	227	230	233	236	239	242	245	248	251	254	257	260	263	266	270	273	276	279	282	285	288	
215	226	228	231	234	237	240	243	246	249	252	255	258	261	264	267	270	273	276	279	282	285	288	
220	227	229	232	235	237	240	243	246	249	252	255	258	262	265	268	271	274	277	280	283	286	289	
225	228	230	233	236	238	241	244	247	250	253	256	259	262	265	268	271	274	277	280	283	286	289	
230	229	231	234	237	239	242	245	248	251	254	257	260	263	266	269	272	275	278	281	284	287	290	
235	230	232	235	237	240	243	246	249	252	255	258	261	264	267	270	273	276	279	282	285	287	290	
240	231	233	236	238	241	244	247	249	252	255	258	261	264	267	270	273	276	279	282	285	288	291	





TABLE 15. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

		MOLE FRACTION OF HELIUM 0.2000																				
T, DEG K	530	540	550	560	570	580	590	600	610	620	630	640	650	660	670	680	690	700	710	720	730	740
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	274	277	281	284	287	291	294	297	300	303	307	310	313	316	319	322	325	328	331	334	337	340
5	274	277	281	284	288	291	294	297	300	304	307	310	313	316	319	322	325	328	331	334	337	340
10	274	278	281	284	288	291	294	298	301	304	307	310	313	316	319	322	325	328	331	334	337	340
15	275	278	281	285	288	291	295	298	301	304	307	310	313	316	319	322	325	328	331	334	337	340
20	275	278	282	285	288	292	295	298	301	304	308	311	314	317	320	323	326	329	332	335	338	341
25	275	279	282	285	289	292	295	298	302	305	308	311	314	317	320	323	326	329	332	335	338	341
30	276	279	282	286	289	292	295	299	302	305	308	311	314	317	320	323	326	329	332	335	338	341
35	276	279	283	286	289	293	296	299	302	305	308	312	315	318	321	324	327	330	333	336	339	342
40	276	280	283	286	290	293	296	299	302	306	309	312	315	318	321	324	327	330	333	336	339	342
45	277	280	283	287	290	293	296	299	302	306	309	312	315	318	321	324	327	330	333	336	339	342
50	277	280	284	287	290	294	297	300	303	306	309	312	315	318	321	324	327	330	333	336	339	342
55	277	281	284	287	291	294	297	300	303	307	310	313	316	319	322	325	328	331	334	337	339	342
60	278	281	285	288	291	294	297	301	304	307	310	313	316	319	322	325	328	331	334	337	339	342
65	278	282	285	288	291	295	298	301	304	307	310	313	316	319	322	325	328	331	334	337	340	343
70	279	282	285	288	292	295	298	301	304	307	311	314	317	320	323	326	329	332	334	337	340	343
75	279	282	286	289	292	295	298	302	305	308	311	314	317	320	323	326	329	332	334	337	340	343
80	279	283	286	289	292	296	299	302	305	308	311	314	317	320	323	326	329	332	335	338	340	343
85	280	283	286	290	293	296	299	302	305	308	312	315	318	321	324	327	329	332	335	338	341	344
90	280	284	287	290	293	296	299	302	306	309	312	315	318	321	324	327	330	333	336	338	341	344
95	281	284	287	290	294	297	300	303	306	309	312	315	318	321	324	327	330	333	336	338	341	344
100	281	284	288	291	294	297	300	303	306	309	313	316	319	322	324	327	330	333	336	339	342	344
105	282	285	288	291	294	297	301	304	307	310	313	316	319	322	324	327	330	333	336	339	342	345
110	282	285	288	292	295	298	301	304	307	310	313	316	319	322	325	328	331	334	336	339	342	345
115	282	286	289	292	295	298	301	304	307	311	314	317	320	322	325	328	331	334	337	340	342	345
120	283	286	289	292	295	299	302	305	308	311	314	317	320	322	325	328	331	334	337	340	343	346
125	283	286	290	293	296	299	302	305	308	311	314	317	320	323	326	329	332	334	337	340	343	346
130	284	287	290	293	296	299	302	306	309	312	315	318	321	323	326	329	332	335	338	340	343	346
135	284	287	290	294	297	300	303	306	309	312	315	318	321	323	326	329	332	335	338	341	344	346
140	285	288	291	294	297	300	303	306	309	312	315	318	321	324	327	330	333	335	338	341	344	347
145	285	288	291	294	297	301	304	307	310	313	316	319	322	324	327	330	333	336	339	341	344	347
150	285	289	292	295	298	301	304	307	310	313	316	319	322	324	327	330	333	336	339	342	344	347
155	286	289	292	295	298	301	304	307	310	313	316	319	322	325	328	331	333	336	339	342	345	348
160	286	289	293	296	299	302	305	308	311	314	317	320	323	325	328	331	334	337	339	342	345	348
165	287	290	293	296	299	302	305	308	311	314	317	320	323	325	328	331	334	337	340	343	345	348
170	287	290	293	297	300	303	306	309	312	315	317	320	323	326	329	332	334	337	340	343	346	348
175	288	291	294	297	300	303	306	309	312	315	318	321	324	326	329	332	335	338	340	343	346	349
180	288	291	294	297	300	303	306	309	312	315	318	321	324	327	329	332	335	338	341	343	346	349
185	289	292	295	298	301	304	307	310	313	316	319	321	324	327	330	333	335	338	341	344	347	349
190	289	292	295	298	301	304	307	310	313	316	319	321	324	327	330	333	336	339	341	344	347	349
195	290	293	296	299	302	305	308	311	313	316	319	322	325	328	330	333	336	339	342	344	347	350
200	290	293	296	299	302	305	308	311	314	317	320	323	325	328	331	334	336	339	342	345	348	350
205	291	294	297	300	303	306	309	311	314	317	320	323	325	328	331	334	337	340	342	345	348	351
210	291	294	297	300	303	306	309	312	315	318	320	323	326	329	331	334	337	340	343	345	348	351
215	291	294	297	300	303	306	309	312	315	318	321	324	326	329	332	335	338	340	343	346	349	351
220	292	295	298	301	304	307	310	313	315	318	321	324	327	330	332	335	338	341	344	346	349	352
225	292	295	298	301	304	307	310	313	315	318	321	324	327	330	332	335	338	341	344	346	349	352
230	293	296	299	302	305	308	310	313	316	319	322	324	327	330	333	336	338	341	344	347	349	352
235	293	296	299	302	305	308	311	314	317	319	322	325	328	330	333	336	339	341	344	347	350	352
240	294	297	300	303	306	308	311	314	317	320	323	326	328	331	334	337	339	342	345	348	350	353



TABLE 16. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICRPOISES

		MOLE FRACTION OF HELIUM 0.1500																				
T, DEG K	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	94	94	95	96	96	97	97	98	99	99	100	100	101	102	102	103	103	104	105	105	106	106
5	95	96	96	97	97	98	99	99	100	100	101	101	102	103	103	104	104	105	106	106	107	107
10	97	97	98	98	99	100	100	101	101	102	102	103	104	104	105	105	106	106	107	108	108	109
15	99	99	100	101	101	102	102	103	103	104	104	105	106	106	107	107	108	108	109	109	110	110
20	102	102	103	103	104	104	105	105	106	106	107	107	108	108	109	109	110	110	111	111	112	112
25	105	105	106	106	106	107	107	108	108	109	109	110	110	111	111	112	112	113	113	113	114	114
30	108	109	109	109	110	110	111	111	111	112	112	113	113	113	114	114	115	115	116	116	116	117
35	113	113	113	114	114	114	114	115	115	115	115	116	116	116	117	117	118	118	118	119	119	120
40	118	118	118	118	118	118	119	119	119	119	120	120	120	120	121	121	121	121	121	122	122	122
45	125	124	124	124	124	124	124	124	124	124	124	124	124	124	124	124	125	125	125	125	125	126
50	132	132	131	130	130	130	129	129	129	129	129	128	128	128	128	129	129	129	129	129	129	129
55	141	140	139	138	137	136	136	135	135	134	134	134	134	133	133	133	133	133	133	133	133	133
60	152	150	148	147	145	144	143	142	142	141	140	140	139	139	139	138	138	138	138	138	137	137
65	163	160	158	156	154	153	151	150	149	148	147	146	145	145	144	143	143	143	143	142	142	142
70	175	172	169	166	164	162	160	158	157	155	154	153	152	151	150	150	149	149	148	148	147	147
75	186	183	180	177	174	171	169	167	165	164	162	161	159	158	157	156	155	154	154	153	153	152
80	198	194	190	187	184	181	179	176	174	172	170	168	167	165	164	163	162	161	160	159	158	157
85	209	205	201	197	194	191	188	185	183	180	178	176	174	173	171	170	168	167	166	165	164	163
90	219	215	211	207	204	200	197	194	191	189	186	184	182	180	178	177	175	174	172	171	170	169
95	229	224	220	217	213	209	206	203	200	197	195	192	190	188	186	184	182	181	179	178	176	175
100	238	234	230	226	222	218	215	212	208	206	203	200	198	195	193	191	189	187	186	184	183	181
105	247	242	238	234	230	227	223	220	217	214	211	208	205	203	200	198	196	194	192	191	189	187
110	255	251	247	243	239	235	231	228	225	222	218	216	213	210	208	205	203	201	199	197	195	194
115	263	259	255	251	247	243	239	236	232	229	226	223	220	217	215	212	210	208	206	204	202	200
120	271	267	263	258	255	251	247	243	240	237	233	230	227	225	222	219	217	214	212	210	208	206
125	278	274	270	266	262	258	254	251	247	244	241	237	234	231	229	226	223	221	219	216	214	212
130	286	281	277	273	269	265	262	258	254	251	248	244	241	238	235	233	230	227	225	223	220	218
135	293	289	284	280	276	272	269	265	261	258	254	251	248	245	242	239	236	234	231	229	226	224
140	300	295	291	287	283	279	275	272	268	264	261	258	254	251	248	245	243	240	237	235	232	230
145	306	302	298	294	290	286	282	278	275	271	267	264	261	258	255	252	249	246	243	241	238	236
150	313	308	304	300	296	292	288	285	281	277	274	270	267	264	261	258	255	252	249	247	244	242
155	319	315	311	307	303	299	295	291	287	284	280	277	273	270	267	264	261	258	255	252	250	247
160	325	321	317	313	309	305	301	297	293	290	286	283	279	276	273	270	267	264	261	258	255	253
165	331	327	323	319	315	311	307	303	299	296	292	289	285	282	279	275	272	269	266	264	261	258
170	337	333	329	325	321	317	313	309	305	301	298	294	291	288	284	281	278	275	272	269	266	264
175	343	339	335	331	327	323	319	315	311	307	304	300	297	293	290	287	284	280	277	275	272	269
180	349	345	340	336	332	328	324	320	317	313	309	306	302	299	295	292	289	286	283	280	277	274
185	354	350	346	342	338	334	330	326	322	318	315	311	308	304	301	298	294	291	288	285	282	279
190	360	356	352	348	343	339	335	332	328	324	320	317	313	310	306	303	300	296	293	290	287	285
195	365	361	357	353	349	345	341	337	333	329	326	322	318	315	311	308	305	302	299	296	293	290
200	371	367	362	358	354	350	346	342	338	335	331	327	324	320	317	313	310	307	304	301	298	295
205	376	372	368	364	360	356	352	348	344	340	336	333	329	325	322	318	315	312	309	306	303	300
210	381	377	373	369	365	361	357	353	349	345	341	338	334	330	327	324	320	317	314	310	307	304
215	387	382	378	374	370	366	362	358	354	350	346	343	339	335	332	328	325	322	319	315	312	309
220	392	387	383	379	375	371	367	363	359	355	351	348	344	340	337	333	330	327	323	320	317	314
225	397	393	388	384	380	376	372	368	364	360	356	353	349	345	342	338	335	332	328	325	322	319
230	402	398	393	389	385	381	377	373	369	365	361	358	354	350	347	343	340	336	333	330	327	323
235	407	402	398	394	390	386	382	378	374	370	366	362	359	355	351	348	344	341	338	334	331	328
240	412	407	403	399	395	391	387	383	379	375	371	367	364	360	356	353	349	346	342	339	336	333



TABLE 16. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

		MOLE FRACTION OF HELIUM 0.1500																					
T, DEG K		156	158	160	162	164	166	168	170	172	174	176	178	180	182	184	186	188	190	192	194	196	198
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	108	109	110	111	112	113	114	116	117	118	119	120	121	122	124	125	126	127	128	129	130	131	131
5	108	110	111	112	113	114	115	116	118	119	120	121	122	123	124	125	126	128	129	130	131	131	132
10	110	111	112	113	114	116	117	118	119	120	121	122	123	124	125	127	128	129	130	131	132	132	133
15	112	113	114	115	116	117	118	119	120	121	122	123	125	126	127	128	129	130	131	132	133	133	134
20	113	114	115	117	118	119	120	121	122	123	124	126	127	128	129	130	131	132	133	134	135	135	136
25	115	116	117	118	119	120	121	122	123	124	126	127	128	129	130	131	132	133	134	135	136	137	137
30	118	119	120	121	122	122	123	124	125	126	127	128	129	130	131	132	133	133	134	135	136	137	138
35	120	121	122	123	124	125	126	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141
40	123	124	125	125	126	127	128	129	129	130	131	132	133	134	135	136	137	137	138	139	140	141	141
45	126	127	127	128	129	130	130	131	132	133	133	134	135	136	137	138	138	139	140	141	142	142	143
50	130	130	131	131	132	132	133	134	134	135	136	136	137	138	139	140	140	141	142	143	144	144	145
55	133	134	134	134	135	135	136	136	137	138	138	139	140	140	141	142	142	143	144	145	146	146	146
60	137	137	138	138	138	138	139	139	140	140	141	141	142	143	143	144	145	145	146	147	148	148	148
65	142	141	141	141	142	142	142	142	143	143	144	144	145	145	146	146	147	148	148	149	150	150	150
70	146	146	146	145	145	145	145	146	146	146	147	147	147	148	148	149	149	150	151	151	152	152	152
75	151	150	150	150	149	149	149	149	149	150	150	150	151	151	151	152	152	153	153	154	155	155	155
80	156	155	155	154	153	153	153	153	153	153	153	153	153	153	154	154	154	155	155	156	156	157	157
85	162	160	159	158	158	157	157	156	156	156	156	156	156	156	156	157	157	157	158	158	159	159	159
90	167	166	164	163	162	161	161	160	160	160	160	160	159	159	159	160	160	160	160	161	161	161	161
95	173	171	169	168	167	166	165	164	164	163	163	163	163	163	163	163	163	163	163	163	164	164	164
100	179	177	175	173	172	170	169	169	168	167	167	166	166	166	166	166	166	166	166	166	166	166	166
105	185	182	180	178	176	175	174	173	172	171	170	170	170	169	169	169	169	169	169	169	169	169	169
110	191	188	185	183	181	180	178	177	176	175	174	174	173	173	172	172	172	172	172	172	172	172	172
115	197	194	191	189	186	185	183	181	180	179	178	177	177	176	176	175	175	175	175	174	174	174	174
120	202	199	196	194	191	189	188	186	185	183	182	181	180	180	179	179	178	178	178	177	177	177	177
125	208	205	202	199	196	194	192	190	189	187	186	185	184	183	183	182	181	181	181	180	180	180	180
130	214	211	207	204	202	199	197	195	193	192	190	189	188	187	186	185	185	184	184	183	183	183	183
135	220	216	213	209	207	204	202	199	198	196	194	193	192	191	190	189	188	187	187	186	186	186	186
140	226	222	218	215	212	209	206	204	202	200	198	197	196	194	193	192	191	191	190	189	189	189	189
145	231	227	223	220	217	214	211	209	206	204	203	201	199	198	197	196	195	194	193	193	192	191	191
150	237	233	229	225	222	219	216	213	211	209	207	205	203	202	200	199	198	197	196	196	195	194	194
155	242	238	234	230	227	223	220	218	215	213	211	209	207	206	204	203	202	201	200	199	198	197	197
160	248	243	239	235	232	228	225	222	220	217	215	213	211	209	208	206	205	204	203	202	201	200	200
165	253	249	244	240	236	233	230	227	224	221	219	217	215	213	212	210	209	207	206	205	204	204	204
170	259	254	249	245	241	238	234	231	228	226	223	221	219	217	215	214	212	211	210	208	207	207	207
175	264	259	254	250	246	242	239	236	233	230	227	225	223	221	219	217	216	214	213	212	211	210	210
180	269	264	259	255	251	247	243	240	237	234	231	229	227	225	223	221	219	218	216	215	214	213	213
185	274	269	264	260	256	252	248	244	241	238	235	233	231	228	226	224	223	221	220	218	217	216	216
190	279	274	269	264	260	256	252	249	246	242	240	237	234	232	230	228	226	224	223	221	220	219	219
195	284	279	274	269	265	261	257	253	250	247	244	241	238	236	234	232	230	228	226	225	223	222	222
200	289	284	279	274	269	265	261	257	254	251	248	245	242	240	237	235	233	231	230	228	226	225	225
205	294	288	283	278	274	270	266	262	258	255	252	249	246	243	241	239	237	235	233	231	230	228	228
210	299	293	288	283	278	274	270	266	262	259	256	253	250	247	245	242	240	238	236	234	233	231	231
215	303	298	293	288	283	278	274	270	266	263	260	256	254	251	248	246	244	241	239	238	236	234	234
220	308	302	297	292	287	283	278	274	270	267	263	260	257	254	252	249	247	245	243	241	239	237	237
225	313	307	302	297	292	287	283	278	274	271	267	263	260	257	254	252	249	247	245	243	241	239	237
230	317	312	306	301	296	291	287	283	279	275	271	267	264	261	258	255	253	250	248	246	244	242	241
235	322	316	311	305	300	295	291	287	283	279	275	271	268	265	262	259	256	254	252	249	247	245	244
240	326	321	315	310	305	300	295	291	287	283	279	275	272	268	265	263	260	257	255	253	251	249	247



TABLE 16. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

		MOLE FRACTION OF HELIUM 0.1500																					
T, DEG K		200	205	210	215	220	225	230	235	240	245	250	255	260	265	270	275	280	285	290	295	300	305
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	132	135	138	140	143	146	148	151	153	156	158	161	163	166	168	170	173	175	177	180	182	184	
5	133	136	138	141	144	146	149	151	154	156	159	161	164	166	168	171	173	175	178	180	182	185	
10	134	137	139	142	144	147	150	152	155	157	159	162	164	167	169	171	174	176	178	181	183	185	
15	135	138	140	143	145	148	150	153	155	158	160	163	165	167	170	172	175	177	179	181	184	186	
20	136	139	141	144	146	149	151	154	156	159	161	164	166	168	171	173	175	178	180	182	184	187	
25	138	140	143	145	148	150	152	155	157	160	162	164	167	169	171	174	176	178	181	183	185	187	
30	139	141	144	146	149	151	154	156	158	161	163	165	168	170	172	175	177	179	181	184	186	188	
35	140	143	145	148	150	152	155	157	159	162	164	166	169	171	173	176	178	180	182	184	187	189	
40	142	144	147	149	151	154	156	158	161	163	165	167	170	172	174	176	179	181	183	185	187	190	
45	144	146	148	150	153	155	157	159	162	164	166	168	171	173	175	177	180	182	184	186	188	190	
50	145	148	150	152	154	156	159	161	163	165	167	170	172	174	176	178	181	183	185	187	189	191	
55	147	149	151	153	156	158	160	162	164	166	169	171	173	175	177	179	182	184	186	188	190	192	
60	149	151	153	155	157	159	161	163	165	168	170	172	174	176	178	180	182	185	187	189	191	193	
65	151	153	155	157	159	161	163	165	167	169	171	173	175	177	179	181	184	186	188	190	192	194	
70	153	155	157	158	160	162	164	166	168	170	172	174	176	178	180	182	185	187	189	191	193	195	
75	155	157	158	160	162	164	166	168	170	172	174	176	178	180	182	184	186	188	190	192	194	196	
80	157	159	160	162	164	165	167	169	171	173	175	177	179	181	183	185	187	189	191	193	195	197	
85	160	161	162	164	165	167	169	171	172	174	176	178	180	182	184	186	188	190	192	194	196	198	
90	162	163	164	166	167	169	171	172	174	176	178	179	181	183	185	187	189	191	193	195	197	199	
95	164	165	166	168	169	171	172	174	176	177	179	181	183	184	186	188	190	192	194	196	198	200	
100	167	168	169	170	171	172	174	176	177	179	180	182	184	186	188	189	191	193	195	197	199	201	
105	169	170	171	172	173	174	176	177	179	180	182	184	185	187	189	191	192	194	196	198	200	202	
110	172	172	173	174	175	176	178	179	180	182	183	185	187	188	190	192	194	195	197	199	201	203	
115	174	175	175	176	177	178	179	181	182	183	185	187	188	190	191	193	195	197	198	200	202	204	
120	177	177	178	178	179	180	181	182	184	185	187	188	190	191	193	194	196	198	199	201	203	205	
125	180	180	180	181	181	182	183	184	185	187	188	190	191	193	194	196	197	199	201	202	204	206	
130	183	182	182	183	183	184	185	186	187	188	190	191	192	194	195	197	199	200	202	203	205	207	
135	185	185	185	185	186	186	187	188	189	190	191	193	194	195	197	198	200	201	203	205	206	208	
140	188	188	187	187	188	188	189	190	191	192	193	194	195	197	198	200	201	203	204	206	207	209	
145	191	190	190	190	190	191	191	192	193	194	195	196	197	198	200	201	203	204	206	207	209	210	
150	194	193	192	192	192	193	193	194	194	195	196	197	199	200	201	202	204	205	207	208	210	211	
155	197	196	195	195	195	195	195	196	196	197	198	199	200	201	202	204	205	207	208	209	211	212	
160	200	199	198	197	197	197	197	198	198	199	200	201	202	203	204	205	206	208	209	211	212	214	
165	203	201	200	200	199	199	199	199	200	201	201	202	203	204	205	207	208	209	211	212	213	215	
170	206	204	203	202	202	201	201	202	202	202	203	204	205	206	207	208	209	210	212	213	215	216	
175	209	207	205	205	204	204	203	204	204	204	205	206	206	207	208	209	211	212	213	214	216	217	
180	212	210	208	207	206	206	206	206	206	206	207	207	208	209	210	211	212	213	214	216	217	218	
185	215	213	211	210	209	208	208	208	208	208	208	209	210	211	211	212	213	215	216	217	218	220	
190	218	215	214	212	211	210	210	210	210	210	210	211	211	212	213	214	215	216	217	218	219	221	
195	221	218	216	215	213	213	212	212	212	212	212	212	213	214	214	215	216	217	218	219	221	222	
200	224	221	219	217	216	215	214	214	214	214	214	214	215	215	216	217	218	219	220	221	222	223	
205	227	224	222	220	218	217	216	216	216	216	216	216	216	217	218	218	219	220	221	222	223	224	
210	230	227	224	222	221	220	219	218	218	218	218	218	218	219	219	220	221	222	222	223	225	226	
215	233	230	227	225	223	222	221	220	220	220	219	219	220	220	221	221	222	223	224	225	226	227	
220	236	233	230	228	226	224	223	222	222	221	221	221	222	222	222	223	224	224	225	226	227	228	
225	239	235	233	230	228	227	225	224	224	223	223	223	223	224	224	224	225	226	227	227	228	229	
230	242	238	235	233	231	229	228	227	226	225	225	225	225	225	226	226	227	227	228	229	230	231	
235	245	241	238	235	233	231	230	229	228	227	227	227	227	227	227	228	228	229	229	230	231	232	
240	248	244	241	238	236	234	232	231	230	229	229	229	229	229	229	230	230	231	232	232	233	233	





TABLE 16. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

		MOLE FRACTION OF HELIUM 0.1500																					
T, DEG K		310	320	330	340	350	360	370	380	390	400	410	420	430	440	450	460	470	480	490	500	510	520
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	187	191	195	200	204	208	212	216	221	225	228	232	236	240	244	247	251	255	258	262	265	269	
5	187	191	196	200	204	209	213	217	221	225	229	233	237	240	244	248	251	255	259	262	266	269	
10	188	192	196	201	205	209	213	217	221	225	229	233	237	241	244	248	252	255	259	262	266	269	
15	188	193	197	201	205	210	214	218	222	226	230	234	237	241	245	249	252	256	259	263	266	270	
20	189	193	198	202	206	210	214	218	222	226	230	234	238	242	245	249	253	256	260	263	267	270	
25	190	194	198	202	207	211	215	219	223	227	231	234	238	242	246	249	253	257	260	264	267	270	
30	190	195	199	203	207	211	215	219	223	227	231	235	239	242	246	250	253	257	261	264	267	271	
35	191	195	200	204	208	212	216	220	224	228	232	235	239	243	247	250	254	257	261	264	268	271	
40	192	196	200	204	209	213	217	221	225	228	232	236	240	243	247	251	254	258	261	265	268	272	
45	193	197	201	205	209	213	217	221	225	229	233	237	240	244	248	251	255	258	262	265	269	272	
50	193	198	202	206	210	214	218	222	226	230	233	237	241	244	248	252	255	259	262	266	269	272	
55	194	198	202	207	211	215	219	222	226	230	234	238	241	245	249	252	256	259	263	266	270	273	
60	195	199	203	207	211	215	219	223	227	231	234	238	242	246	249	253	256	260	263	267	270	273	
65	196	200	204	208	212	216	220	224	228	231	235	239	242	246	250	253	257	260	264	267	270	274	
70	197	201	205	209	213	217	221	224	228	232	236	239	243	247	250	254	257	261	264	267	271	274	
75	198	202	206	210	214	217	221	225	229	233	236	240	244	247	251	254	258	261	265	268	271	275	
80	199	203	207	210	214	218	222	226	229	233	237	240	244	248	251	255	258	262	265	268	271	275	
85	200	203	207	211	215	219	223	226	230	234	237	241	245	248	252	255	259	262	266	269	272	276	
90	200	204	208	212	216	220	223	227	231	234	238	242	245	249	252	256	259	263	266	269	273	276	
95	201	205	209	213	217	220	224	228	231	235	239	242	246	249	253	256	260	263	267	270	273	276	
100	202	206	210	214	217	221	225	229	232	236	239	243	246	250	253	257	260	264	267	270	274	277	
105	203	207	211	215	218	222	226	229	233	236	240	244	247	251	254	257	261	264	268	271	274	277	
110	204	208	212	215	219	223	226	230	234	237	241	244	248	251	255	258	261	265	268	271	275	278	
115	205	209	213	216	220	224	227	231	234	238	241	245	248	252	255	259	262	265	269	272	275	278	
120	206	210	214	217	221	224	228	231	235	238	242	245	249	252	256	259	262	266	269	272	276	279	
125	208	211	215	218	222	225	229	232	236	239	243	246	250	253	256	260	263	266	270	273	276	279	
130	209	212	215	219	222	226	229	233	236	240	243	247	250	254	257	260	264	267	270	273	277	280	
135	210	213	216	220	223	227	230	234	237	241	244	247	251	254	257	261	264	267	271	274	277	280	
140	211	214	217	221	224	228	231	234	238	241	245	248	251	255	258	261	265	268	271	274	278	281	
145	212	215	218	222	225	228	232	235	239	242	245	249	252	255	259	262	265	268	272	275	278	281	
150	213	216	219	223	226	229	233	236	239	243	246	249	253	256	259	263	266	269	272	275	279	282	
155	214	217	220	224	227	230	233	237	240	243	247	250	253	257	260	263	266	270	273	276	279	282	
160	215	218	221	225	228	231	234	238	241	244	247	251	254	257	261	264	267	270	273	277	280	283	
165	216	219	222	226	229	232	235	238	242	245	248	251	255	258	261	264	268	271	274	277	280	283	
170	217	220	223	226	230	233	236	239	242	246	249	252	255	259	262	265	268	271	274	278	281	284	
175	219	221	224	227	231	234	237	240	243	246	250	253	256	259	262	266	269	272	275	278	281	284	
180	220	223	225	228	231	235	238	241	244	247	250	254	257	260	263	266	269	272	276	279	282	285	
185	221	224	226	229	232	235	239	242	245	248	251	254	257	261	264	267	270	273	276	279	282	285	
190	222	225	228	230	233	236	239	243	246	249	252	255	258	261	264	267	271	274	277	280	283	286	
195	223	226	229	231	234	237	240	243	246	249	253	256	259	262	265	268	271	274	277	280	283	286	
200	224	227	230	232	235	238	241	244	247	250	253	256	259	263	266	269	272	275	278	281	284	287	
205	226	228	231	233	236	239	242	245	248	251	254	257	260	263	266	269	272	275	278	281	284	287	
210	227	229	232	234	237	240	243	246	249	252	255	258	261	264	267	270	273	276	279	282	285	288	
215	228	230	233	235	238	241	244	247	250	253	256	259	262	265	268	271	274	277	280	283	286	288	
220	229	232	234	237	239	242	245	248	250	253	256	259	262	265	268	271	274	277	280	283	286	289	
225	230	233	235	238	240	243	246	248	251	254	257	260	263	266	269	272	275	278	281	284	287	290	
230	232	234	236	239	241	244	247	249	252	255	258	261	264	267	270	273	275	278	281	284	287	290	
235	233	235	237	240	242	245	247	250	253	256	259	262	264	267	270	273	275	278	281	284	287	290	
240	234	236	238	241	243	246	248	251	254	257	259	262	265	268	271	274	277	280	283	285	288	291	



TABLE 16. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

		MOLE FRACTION OF HELIUM 0.1500																					
T, DEG K	530	540	550	560	570	580	590	600	610	620	630	640	650	660	670	680	690	700	710	720	730	740	
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	
1	272	276	279	282	286	289	292	295	299	302	305	308	311	314	317	320	323	326	329	332	335	338	
5	272	276	279	283	286	289	292	296	299	302	305	308	311	314	317	320	323	326	329	332	335	338	
10	273	276	280	283	286	289	293	296	299	302	305	308	311	315	318	321	324	327	329	332	335	338	
15	273	277	280	283	286	290	293	296	299	302	306	309	312	315	318	321	324	327	330	333	336	338	
20	274	277	280	284	287	290	293	296	300	303	306	309	312	315	318	321	324	327	330	333	336	338	
25	274	277	281	284	287	290	294	297	300	303	306	309	312	315	318	321	324	327	330	333	336	339	
30	274	278	281	284	287	291	294	297	300	303	306	310	313	316	319	322	325	328	330	333	336	339	
35	275	278	281	285	288	291	294	297	301	304	307	310	313	316	319	322	325	328	330	333	336	339	
40	275	278	282	285	288	291	295	298	301	304	307	310	313	316	319	322	325	328	331	334	337	339	
45	275	279	282	285	289	292	295	298	301	304	307	311	314	317	320	323	325	328	331	334	337	340	
50	276	279	282	286	289	292	295	298	302	305	308	311	314	317	320	323	325	328	331	334	337	340	
55	276	280	283	286	289	293	296	299	302	305	308	311	314	317	320	323	326	329	332	335	338	341	
60	277	280	283	286	290	293	296	299	302	305	308	311	315	318	320	323	326	329	332	335	338	341	
65	277	280	284	287	290	293	296	300	303	306	309	312	315	318	321	324	327	330	333	335	338	341	
70	278	281	284	287	290	294	297	300	303	306	309	312	315	318	321	324	327	330	333	335	338	341	
75	278	281	284	288	291	294	297	300	303	306	309	313	316	318	321	324	327	330	333	336	339	341	
80	278	282	285	288	291	294	298	301	304	307	310	313	316	319	322	325	328	331	333	336	339	342	
85	279	282	285	288	292	295	298	301	304	307	310	313	316	319	322	325	328	331	333	336	339	342	
90	279	283	286	289	292	295	298	301	304	308	311	314	317	319	322	325	328	331	334	337	339	342	
95	280	283	286	289	292	296	299	302	305	308	311	314	317	319	322	325	328	331	334	337	340	343	
100	280	283	287	290	293	296	299	302	305	308	311	314	317	320	323	326	329	331	334	337	340	343	
105	281	284	287	290	293	296	300	303	306	309	312	315	318	321	323	326	329	332	335	338	341	343	
110	281	284	287	291	294	297	300	303	306	309	312	315	318	321	323	326	329	332	335	338	341	343	
115	282	285	288	291	294	297	300	303	306	309	312	315	318	321	324	327	330	332	335	338	341	344	
120	282	285	288	291	295	298	301	304	307	310	313	316	319	322	324	327	330	333	336	338	341	344	
125	282	286	289	292	295	298	301	304	307	310	313	316	319	322	324	327	330	333	336	339	342	344	
130	283	286	289	292	295	298	302	305	308	311	314	316	319	322	325	328	331	333	336	339	342	345	
135	283	287	290	293	296	299	302	305	308	311	314	316	319	322	325	328	331	334	337	339	342	345	
140	284	287	290	293	296	299	302	305	308	311	314	317	320	323	326	328	331	334	337	340	343	345	
145	284	288	291	294	297	300	303	306	309	312	315	318	320	323	326	329	332	334	337	340	343	346	
150	285	288	291	294	297	300	303	306	309	312	315	318	321	324	327	329	332	335	338	341	343	346	
155	285	288	292	295	298	301	304	307	310	313	315	318	321	324	327	330	333	335	338	341	344	347	
160	286	289	292	295	298	301	304	307	310	313	316	319	322	324	327	330	333	335	338	341	344	347	
165	286	289	292	296	299	302	304	307	310	313	316	319	322	325	328	331	333	336	339	341	344	347	
170	287	290	293	296	299	302	305	308	311	314	317	320	322	325	328	331	333	336	339	342	344	347	
175	287	290	293	296	299	302	305	308	311	314	317	320	323	326	328	331	334	336	339	342	345	348	
180	288	291	294	297	300	303	306	309	312	315	317	320	323	326	329	332	334	337	340	342	345	348	
185	288	291	294	297	300	303	306	309	312	315	317	320	323	326	329	332	334	337	340	343	345	348	
190	289	292	295	298	301	304	307	310	312	315	318	321	324	326	329	332	335	338	340	343	346	348	
195	289	292	295	298	301	304	307	310	312	315	318	321	324	327	330	332	335	338	341	343	346	349	
200	290	293	296	299	302	305	308	310	313	316	319	321	324	327	330	333	335	338	341	344	346	349	
205	290	293	296	299	302	305	308	311	314	317	319	322	325	328	331	333	336	339	341	344	347	349	
210	291	294	297	300	303	306	308	311	314	317	319	322	325	328	331	333	336	339	342	344	347	350	
215	291	294	297	300	303	306	309	312	315	317	320	323	325	328	331	334	337	339	342	345	347	350	
220	292	295	298	301	304	306	309	312	315	318	321	323	326	329	331	334	337	340	342	345	348	350	
225	292	295	298	301	304	307	310	313	315	318	321	323	326	329	332	335	337	340	343	345	348	351	
230	293	296	299	302	305	307	310	313	316	319	322	324	327	329	332	335	338	340	343	346	348	351	
235	294	296	299	302	305	308	311	314	316	319	322	324	327	330	333	335	338	341	343	346	349	351	
240	294	297	300	303	306	308	311	314	317	320	322	325	328	331	333	336	338	341	344	346	349	352	



TABLE 17. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

		MOLE FRACTION OF HELIUM 0.1000																					
T, DEG K		133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	93	93	94	94	95	96	96	97	97	98	99	99	100	100	101	102	102	103	103	104	104	105	105
5	94	94	95	96	96	97	97	98	99	99	100	100	101	102	102	103	103	104	104	105	106	106	106
10	96	96	97	98	98	99	99	100	100	101	102	102	103	103	104	104	105	106	106	107	107	107	108
15	98	99	99	100	100	101	102	102	103	103	104	104	105	105	106	106	107	107	108	109	109	109	110
20	101	102	102	103	103	104	104	105	105	106	106	107	107	108	108	109	109	110	110	111	111	111	112
25	105	105	106	106	107	107	107	108	108	109	109	110	110	110	111	111	112	112	113	113	114	114	114
30	110	110	110	110	111	111	111	112	112	112	113	113	113	114	114	114	115	115	116	116	116	116	117
35	115	115	115	115	116	116	116	116	116	116	117	117	117	117	118	118	118	119	119	119	120	120	120
40	123	122	122	122	121	121	121	121	121	121	121	121	121	122	122	122	122	122	123	123	123	123	123
45	132	131	130	129	129	128	128	128	128	127	127	127	127	127	127	127	127	127	127	127	127	127	127
50	144	142	140	139	138	137	136	135	134	134	133	133	133	132	132	132	132	132	132	132	132	132	132
55	159	156	153	151	148	147	145	144	143	142	141	140	139	139	138	138	138	137	137	137	137	137	137
60	176	171	167	164	161	158	156	154	152	151	149	148	147	146	145	145	144	143	143	143	142	142	142
65	193	187	183	178	175	171	168	165	163	161	159	157	156	154	153	152	151	150	150	149	148	148	148
70	208	203	198	193	188	184	181	177	174	172	169	167	165	163	162	160	159	158	157	156	155	154	154
75	223	217	212	207	202	197	193	189	186	183	180	177	175	173	171	169	167	166	164	163	162	161	161
80	236	230	225	220	215	210	205	201	198	194	191	188	185	182	180	178	176	174	172	171	169	168	168
85	248	242	237	232	226	222	217	213	209	205	201	198	195	192	189	187	184	182	180	179	177	175	175
90	259	253	248	243	238	233	228	224	220	215	212	208	205	202	199	196	193	191	189	187	185	183	183
95	269	264	258	253	248	243	239	234	230	226	222	218	214	211	208	205	202	199	197	195	193	190	190
100	279	274	268	263	258	253	248	244	240	235	231	227	224	220	217	214	211	208	205	203	200	198	198
105	288	283	278	273	268	263	258	253	249	245	240	237	233	229	226	222	219	216	213	211	208	206	206
110	297	292	287	281	276	272	267	262	258	253	249	245	241	238	234	231	227	224	221	219	216	213	213
115	305	300	295	290	285	280	275	271	266	262	258	254	250	246	242	239	235	232	229	226	223	221	221
120	314	308	303	298	293	288	284	279	275	270	266	262	258	254	250	247	243	240	237	234	231	228	228
125	321	316	311	306	301	296	292	287	283	278	274	270	266	262	258	254	251	248	244	241	238	235	235
130	329	324	319	314	309	304	299	295	290	286	282	277	273	269	266	262	258	255	251	248	245	242	242
135	336	331	326	321	316	312	307	302	298	293	289	285	281	277	273	269	265	262	259	255	252	249	249
140	343	338	333	328	324	319	314	309	305	301	296	292	288	284	280	276	272	269	265	262	259	256	256
145	350	345	340	335	331	326	321	317	312	308	303	299	295	291	287	283	279	276	272	269	266	262	262
150	357	352	347	342	337	333	328	323	319	314	310	306	302	298	294	290	286	282	279	275	272	269	269
155	364	359	354	349	344	339	335	330	326	321	317	313	308	304	300	296	293	289	285	282	278	275	275
160	370	365	360	356	351	346	341	337	332	328	323	319	315	311	307	303	299	295	292	288	285	281	281
165	377	372	367	362	357	352	348	343	339	334	330	325	321	317	313	309	305	302	298	294	291	287	287
170	383	378	373	368	363	359	354	349	345	340	336	332	327	323	319	315	311	308	304	300	297	293	293
175	389	384	379	374	370	365	360	356	351	347	342	338	334	329	325	321	317	314	310	306	303	299	299
180	395	390	385	380	376	371	366	362	357	353	348	344	340	335	331	327	323	320	316	312	309	305	305
185	401	396	391	386	382	377	372	368	363	359	354	350	346	341	337	333	329	325	322	318	314	311	311
190	407	402	397	392	388	383	378	374	369	364	360	356	351	347	343	339	335	331	327	324	320	316	316
195	413	408	403	398	393	389	384	379	375	370	366	361	357	353	349	345	341	337	333	329	326	322	322
200	418	413	409	404	399	394	390	385	380	376	372	367	363	359	354	350	346	342	338	335	331	327	327
205	424	419	414	409	405	400	395	391	386	382	377	373	368	364	360	356	352	348	344	340	336	333	333
210	429	425	420	415	410	406	401	396	392	387	383	378	374	370	365	361	357	353	349	346	342	338	338
215	435	430	425	420	416	411	406	402	397	393	388	384	379	375	371	367	363	359	355	351	347	343	343
220	440	435	431	426	421	416	412	407	403	398	393	389	385	380	376	372	368	364	360	356	352	349	349
225	446	441	436	431	427	422	417	412	408	403	399	394	390	386	381	377	373	369	365	361	357	354	354
230	451	446	441	437	432	427	422	418	413	409	404	400	395	391	387	382	378	374	370	366	363	359	359
235	456	451	447	442	437	432	428	423	418	414	409	405	400	396	392	388	383	379	375	371	368	364	364
240	461	457	452	447	442	438	433	428	424	419	414	410	406	401	397	393	389	384	380	376	373	369	369



TABLE 17. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

		MOLE FRACTION OF HELIUM 0.1000																					
T, DEG K		156	158	160	162	164	166	168	170	172	174	176	178	180	182	184	186	188	190	192	194	196	198
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	106	107	109	110	111	112	113	114	116	117	118	119	120	121	122	123	124	126	127	128	129	130	131
5	107	108	110	111	112	113	114	115	116	118	119	120	121	122	123	124	125	126	127	129	130	131	132
10	109	110	111	112	113	114	116	117	118	119	120	121	122	123	124	125	126	128	129	130	131	132	133
15	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133
20	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135
25	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137
30	118	119	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139
35	121	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142
40	124	125	125	126	127	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144
45	128	128	129	129	130	130	131	132	132	133	134	135	135	136	137	138	139	139	140	141	142	143	144
50	132	132	132	133	133	134	134	135	135	136	137	137	138	139	139	140	141	142	142	143	144	145	146
55	136	136	136	137	137	137	137	138	138	139	139	140	141	141	142	142	143	144	145	145	146	147	148
60	141	141	141	141	141	141	141	142	142	143	143	144	144	145	145	146	146	147	148	148	149	150	151
65	147	146	146	145	145	145	145	145	145	146	146	147	147	148	148	149	149	149	150	151	151	152	153
70	153	152	151	150	150	149	149	149	149	149	149	150	150	151	151	152	152	153	153	154	154	155	156
75	159	158	156	155	155	154	154	153	153	153	153	153	153	153	153	154	154	154	155	155	156	156	157
80	166	164	162	161	160	159	158	158	157	157	157	157	156	157	157	157	157	157	158	158	159	160	161
85	173	170	168	167	165	164	163	162	162	161	161	160	160	160	160	160	160	160	160	161	161	161	162
90	180	177	174	172	171	169	168	167	166	165	165	164	164	164	164	163	163	163	164	164	164	164	165
95	187	184	181	179	176	175	173	172	171	170	169	168	168	167	167	167	167	167	167	167	167	167	168
100	194	191	187	185	182	180	179	177	176	174	173	173	172	171	171	171	170	170	170	170	170	170	171
105	201	198	194	191	188	186	184	182	181	179	178	177	176	175	175	174	174	173	173	173	173	173	174
110	209	204	201	197	194	192	189	187	186	184	183	181	180	179	179	178	177	177	177	176	176	176	177
115	216	211	207	204	200	198	195	193	191	189	187	186	185	184	183	182	181	181	180	180	179	179	180
120	223	218	214	210	207	203	201	198	196	194	192	190	189	188	187	186	185	184	184	183	183	182	183
125	230	225	220	216	213	209	206	203	201	199	197	195	193	192	191	190	189	188	187	187	186	186	187
130	237	232	227	222	219	215	212	209	206	204	202	200	198	196	195	194	193	192	191	190	189	189	190
135	243	238	233	229	225	221	217	214	211	209	206	204	202	201	199	198	197	195	194	194	193	192	193
140	250	244	239	235	230	226	223	220	217	214	211	209	207	205	203	202	201	199	198	197	196	196	197
145	256	251	246	241	236	232	228	225	222	219	216	214	211	209	208	206	205	203	202	201	200	199	200
150	263	257	252	247	242	238	234	230	227	224	221	218	216	214	212	210	209	207	206	204	203	202	203
155	269	263	258	252	248	243	239	235	232	229	226	223	221	218	216	214	213	211	209	208	207	206	207
160	275	269	263	258	253	249	245	241	237	234	231	228	225	223	220	218	217	215	213	212	211	209	210
165	281	275	269	264	259	254	250	246	242	239	235	232	230	227	225	223	221	219	217	216	214	213	214
170	287	281	275	269	264	260	255	251	247	243	240	237	234	231	229	227	225	223	221	219	218	216	217
175	293	286	281	275	270	265	260	256	252	248	245	242	239	236	233	231	229	227	225	223	221	219	220
180	298	292	286	280	275	270	265	261	257	253	249	246	243	240	237	235	233	231	229	227	225	223	224
185	304	298	292	286	280	275	270	266	262	258	254	251	247	244	242	239	237	234	232	230	229	227	228
190	310	303	297	291	286	280	275	271	267	262	259	255	252	249	246	243	241	238	236	234	232	231	232
195	315	308	302	296	291	285	280	276	271	267	263	260	256	253	250	247	245	242	240	238	236	234	235
200	320	314	307	301	296	290	285	281	276	272	268	264	261	257	254	251	249	246	244	242	240	238	239
205	326	319	313	307	301	295	290	285	281	276	272	268	265	261	258	255	253	250	248	245	243	241	242
210	331	324	318	312	306	300	295	290	285	281	277	273	269	266	262	259	256	254	251	249	247	245	246
215	336	329	323	317	311	305	300	295	290	285	281	277	273	270	267	263	260	258	255	253	250	248	249
220	341	334	328	322	316	310	305	299	295	290	286	282	278	274	271	267	264	261	259	256	254	252	253
225	346	339	333	326	320	315	309	304	299	294	290	286	282	278	275	271	268	265	262	260	257	255	256
230	351	344	338	331	325	319	314	309	304	299	294	290	286	282	279	275	272	269	266	264	261	259	260
235	356	349	343	336	330	324	318	313	308	303	299	294	290	286	282	279	275	272	269	266	264	261	262
240	361	354	347	341	335	329	323	318	313	308	303	299	294	290	286	283	279	276	273	270	267	265	266





TABLE 17. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

		MOLE FRACTION OF HELIUM 0.1000																				
T, DEG K	200	205	210	215	220	225	230	235	240	245	250	255	260	265	270	275	280	285	290	295	300	305
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	131	134	136	139	142	144	147	149	152	154	157	159	162	164	167	169	171	174	176	178	181	183
5	132	134	137	140	142	145	147	150	152	155	157	160	162	165	167	170	172	174	177	179	181	183
10	133	135	138	141	143	146	148	151	153	156	158	161	163	166	168	170	173	175	177	180	182	184
15	134	137	139	142	144	147	149	152	154	157	159	162	164	166	169	171	173	176	178	180	183	185
20	135	138	140	143	145	148	150	153	155	158	160	163	165	167	170	172	174	177	179	181	183	186
25	137	139	142	144	147	149	152	154	156	159	161	164	166	168	171	173	175	177	180	182	184	186
30	138	141	143	146	148	150	153	155	158	160	162	165	167	169	171	174	176	178	180	183	185	187
35	140	142	145	147	149	152	154	156	159	161	163	166	168	170	172	175	177	179	181	184	186	188
40	142	144	146	149	151	153	155	158	160	162	164	167	169	171	173	176	178	180	182	184	187	189
45	144	146	148	150	152	155	157	159	161	163	166	168	170	172	175	177	179	181	183	185	188	190
50	145	148	150	152	154	156	158	160	163	165	167	169	171	173	176	178	180	182	184	186	188	191
55	148	149	151	153	156	158	160	162	164	166	168	170	172	175	177	179	181	183	185	187	189	191
60	150	151	153	155	157	159	161	163	165	167	170	172	174	176	178	180	182	184	186	188	190	192
65	152	154	155	157	159	161	163	165	167	169	171	173	175	177	179	181	183	185	187	189	191	193
70	154	156	157	159	161	163	165	166	168	170	172	174	176	178	180	182	184	186	188	190	192	194
75	157	158	159	161	163	164	166	168	170	172	174	176	178	180	182	184	185	187	189	191	193	195
80	159	160	162	163	165	166	168	170	172	174	176	178	180	182	184	185	187	189	191	193	194	196
85	162	163	164	165	167	168	170	171	173	175	177	179	180	182	184	186	188	190	192	194	196	197
90	164	165	166	167	169	170	172	173	175	177	178	180	182	184	185	187	189	191	193	195	197	199
95	167	168	169	170	171	172	174	175	177	178	180	182	183	185	187	189	190	192	194	196	198	200
100	170	170	171	172	173	174	176	177	178	180	181	183	185	186	188	190	192	193	195	197	199	201
105	173	173	174	174	175	176	178	179	180	182	183	185	186	188	190	191	193	195	196	198	200	202
110	176	176	176	177	178	178	180	181	182	183	185	186	188	189	191	193	194	196	198	199	201	203
115	179	179	179	179	180	181	182	183	184	185	186	188	189	191	192	194	196	197	199	201	202	204
120	182	182	182	182	182	183	184	185	186	187	188	190	191	192	194	195	197	199	200	202	204	205
125	185	185	184	184	185	185	186	187	188	189	190	191	193	194	195	197	198	200	202	203	205	206
130	188	188	187	187	187	187	188	189	190	191	192	193	194	196	197	198	200	201	203	204	206	208
135	192	191	190	190	190	190	190	191	192	193	194	195	196	197	198	200	201	203	204	206	207	209
140	195	194	193	192	192	192	193	193	194	194	195	196	198	199	200	201	203	204	206	207	209	210
145	198	197	196	195	195	195	195	195	196	196	197	198	199	200	202	203	204	206	207	208	210	211
150	202	200	199	198	197	197	197	197	198	198	199	200	201	202	203	204	206	207	208	210	211	213
155	205	203	201	200	200	199	199	200	200	200	201	202	203	204	205	206	207	208	210	211	212	214
160	208	206	204	203	202	202	202	202	202	202	203	204	204	205	206	207	209	210	211	212	214	215
165	212	209	207	206	205	204	204	204	204	204	205	206	206	207	208	209	210	211	212	214	215	216
170	215	213	210	209	208	207	206	206	206	206	207	207	208	209	210	211	212	213	214	215	216	218
175	219	216	213	212	210	210	209	209	208	209	209	209	210	211	211	212	213	214	215	217	218	219
180	222	219	217	215	213	212	211	211	211	211	211	211	212	212	213	214	215	216	217	218	219	220
185	225	222	220	217	216	215	214	213	213	213	213	214	214	215	215	216	217	218	219	220	222	223
190	229	225	223	220	219	217	216	216	215	215	215	215	216	216	217	218	219	220	221	222	223	224
195	232	229	226	223	221	220	219	218	217	217	217	217	218	218	219	220	220	221	222	223	224	225
200	236	232	229	226	224	222	221	220	220	219	219	219	219	219	220	220	221	222	223	224	225	226
205	239	235	232	229	227	225	224	223	222	221	221	221	221	221	222	222	223	223	224	225	226	227
210	243	238	235	232	230	228	226	225	224	223	223	223	223	223	224	224	225	226	227	227	228	228
215	246	242	238	235	232	230	229	227	226	226	225	225	225	225	226	226	227	227	228	229	230	231
220	250	245	241	238	235	233	231	230	229	228	227	227	227	227	227	227	228	228	229	230	231	232
225	253	248	244	241	238	236	234	232	231	230	229	229	229	229	229	229	230	230	231	232	233	234
230	256	251	247	244	241	238	236	235	233	232	231	231	231	231	230	230	231	231	232	233	234	235
235	260	255	250	247	244	241	239	237	236	234	234	233	233	232	232	232	233	233	234	235	236	237
240	263	258	253	250	246	244	241	239	238	237	236	235	234	234	234	234	235	235	236	236	236	237



TABLE 17. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

		MOLE FRACTION OF HELIUM 0.1000																					
T, DEG K		310	320	330	340	350	360	370	380	390	400	410	420	430	440	450	460	470	480	490	500	510	520
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	185	190	194	198	203	207	211	215	219	223	227	231	235	239	242	246	250	253	257	260	264	267	
5	186	190	194	199	203	207	211	216	220	224	227	231	235	239	243	246	250	254	257	261	264	268	
10	186	191	195	199	204	208	212	216	220	224	228	232	236	239	243	246	250	254	257	261	264	268	
15	187	191	196	200	204	208	213	217	221	224	228	232	236	240	243	247	251	254	258	261	265	268	
20	188	192	196	201	205	209	213	217	221	225	229	233	237	240	244	248	251	255	258	262	265	269	
25	188	193	197	201	206	210	214	218	222	226	229	233	237	241	244	248	252	255	259	262	266	269	
30	189	194	198	202	206	210	214	218	222	226	230	234	238	241	245	249	252	256	259	263	266	270	
35	190	194	199	203	207	211	215	219	223	227	231	234	238	242	245	249	253	256	259	263	266	270	
40	191	195	199	203	208	212	216	220	223	227	231	235	239	242	246	250	253	256	260	263	267	270	
45	192	196	200	204	208	212	216	220	224	228	232	235	239	243	246	250	254	257	261	264	267	270	
50	193	197	201	205	209	213	217	221	225	229	232	236	240	243	247	251	254	258	261	265	268	271	
55	194	198	202	206	210	214	218	222	225	229	233	237	240	244	248	251	255	258	262	265	268	272	
60	194	199	203	207	211	215	218	222	226	230	234	237	241	245	248	252	255	259	262	265	269	272	
65	195	199	203	207	211	215	219	223	227	231	234	238	242	245	249	252	256	259	263	266	269	272	
70	196	200	204	208	212	216	220	224	227	231	235	239	242	246	249	253	256	260	263	266	270	273	
75	197	201	205	209	213	217	221	224	228	232	236	239	243	246	250	253	257	260	264	267	270	274	
80	198	202	206	210	214	218	221	225	229	233	236	240	243	246	250	253	257	260	264	267	270	274	
85	199	203	207	211	215	218	222	226	230	233	237	240	243	247	250	254	257	261	264	267	271	274	
90	200	204	208	212	216	219	223	227	230	234	238	241	245	248	252	255	258	262	265	268	271	275	
95	201	205	209	213	216	220	224	227	231	235	238	242	245	249	252	256	259	262	266	269	272	275	
100	203	206	210	214	217	221	225	228	232	235	239	242	246	249	253	256	260	263	266	270	273	276	
105	204	207	211	215	218	222	225	229	233	236	240	243	247	250	253	257	260	263	267	270	273	277	
110	205	208	212	215	219	223	226	230	233	237	240	244	247	251	254	257	261	264	267	271	274	277	
115	206	209	213	216	220	224	227	231	234	238	241	244	248	251	255	258	261	265	268	271	274	278	
120	207	210	214	217	221	224	228	231	235	238	242	245	249	252	255	259	262	265	268	272	275	278	
125	208	212	215	218	222	225	229	232	236	239	242	246	249	253	256	259	263	266	269	272	275	279	
130	209	213	216	219	223	226	230	233	236	240	243	247	250	253	257	260	263	266	270	273	276	279	
135	210	214	217	220	224	227	230	234	237	241	244	247	251	254	257	260	264	267	270	273	277	280	
140	212	215	218	221	225	228	231	235	238	241	245	248	251	255	258	261	264	267	270	273	277	280	
145	213	216	219	222	226	229	232	236	239	242	245	249	252	255	259	262	265	268	271	274	277	280	
150	214	217	220	223	227	230	233	236	240	243	246	249	253	256	259	262	266	269	272	275	278	281	
155	215	218	221	224	228	231	234	237	240	244	247	250	253	257	260	263	266	269	273	276	279	282	
160	217	219	222	225	229	232	235	238	241	245	248	251	254	257	261	264	267	270	273	276	279	282	
165	218	221	224	227	230	233	236	239	242	245	249	252	255	258	261	264	267	271	274	277	280	283	
170	219	222	225	228	231	234	237	240	243	246	249	252	256	259	262	265	268	271	274	277	280	283	
175	220	223	226	229	232	235	238	241	244	247	250	253	256	259	263	266	269	272	275	278	281	284	
180	222	224	227	230	233	236	239	242	245	248	251	254	257	260	263	266	269	272	275	278	281	284	
185	223	225	228	231	234	237	240	243	246	249	252	255	258	261	264	267	270	273	276	279	282	285	
190	224	227	229	232	235	238	240	243	246	249	252	255	259	262	265	268	271	274	277	280	283	286	
195	225	228	230	233	236	239	241	244	247	250	253	256	259	262	265	268	271	274	277	280	283	286	
200	227	229	232	234	237	240	242	245	248	251	254	257	260	263	266	269	272	275	278	281	284	287	
205	228	230	233	235	238	241	243	246	249	252	255	258	261	264	267	270	273	276	279	282	284	287	
210	229	232	234	236	239	242	244	247	250	253	256	259	262	264	267	270	273	276	279	282	284	287	
215	231	233	235	237	240	243	245	248	251	254	257	259	262	265	268	271	274	277	280	283	286	289	
220	232	234	236	239	241	244	246	249	252	255	257	260	263	266	269	272	275	278	280	283	286	289	
225	233	235	237	240	242	245	247	250	253	255	258	261	264	267	270	272	275	278	281	284	287	290	
230	235	237	239	241	243	246	248	251	254	256	259	262	265	267	270	272	275	278	281	284	287	290	
235	236	238	240	242	244	247	249	252	254	257	260	263	265	267	270	273	276	279	282	285	287	290	
240	238	239	241	243	245	248	250	253	255	258	261	263	266	269	272	275	277	280	283	286	289	291	



TABLE 17. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

		MOLE FRACTION OF HELIUM 0.1000																					
T, DEG K	530	540	550	560	570	580	590	600	610	620	630	640	650	660	670	680	690	700	710	720	730	740	
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	271	274	277	281	284	287	290	294	297	300	303	306	309	312	315	318	321	324	327	330	333	336	
5	271	274	278	281	284	288	291	294	297	300	303	306	309	312	315	318	321	324	327	330	333	336	
10	271	275	278	281	285	288	291	294	297	300	304	307	310	313	316	319	322	325	328	330	333	336	
15	272	275	278	282	285	288	291	295	298	301	304	307	310	313	316	319	322	325	328	330	333	336	
20	272	275	279	282	285	289	292	295	298	301	304	307	310	313	316	319	322	325	328	331	334	337	
25	272	276	279	282	286	289	292	295	298	301	305	308	311	314	317	320	323	326	328	331	334	337	
30	273	276	280	283	286	289	292	296	299	302	305	308	311	314	317	320	323	326	329	332	334	337	
35	273	277	280	283	286	290	293	296	299	302	305	308	311	314	317	320	323	326	329	332	334	337	
40	274	277	280	284	287	290	293	296	299	302	305	308	311	314	317	320	323	326	329	332	335	338	
45	274	277	281	284	287	290	294	297	300	303	306	309	312	315	318	321	323	326	329	332	335	338	
50	275	278	281	284	288	291	294	297	300	303	306	309	312	315	318	321	324	327	330	332	335	338	
55	275	278	282	285	288	291	294	297	301	304	307	310	313	316	319	322	324	327	330	333	336	338	
60	275	279	282	285	288	292	295	298	301	304	307	310	313	316	319	322	324	327	330	333	336	339	
65	276	279	282	286	289	292	295	298	301	304	307	310	313	316	319	322	325	328	331	333	336	339	
70	276	280	283	286	289	292	296	299	302	305	308	311	314	317	320	323	325	328	331	334	337	339	
75	277	280	283	287	290	293	296	299	302	305	308	311	314	317	320	323	326	329	332	334	337	340	
80	277	281	284	287	290	293	296	299	302	305	308	311	314	317	320	323	326	329	332	335	338	341	
85	278	281	284	287	291	294	297	300	303	306	309	312	315	318	321	324	326	329	332	335	338	341	
90	278	281	285	288	291	294	297	300	303	306	309	312	315	318	321	324	326	329	332	335	338	341	
95	279	282	285	288	291	295	298	301	304	307	310	313	316	318	321	324	327	330	333	335	338	341	
100	279	282	286	289	292	295	298	301	304	307	310	313	316	319	322	325	328	330	333	336	338	341	
105	280	283	286	289	292	295	298	301	304	307	310	313	316	319	322	325	328	330	333	336	339	342	
110	280	283	287	290	293	296	299	302	305	308	311	314	317	320	323	325	328	331	334	336	339	342	
115	281	284	287	290	293	296	299	302	305	308	311	314	317	320	323	325	328	331	334	337	339	342	
120	281	284	288	291	294	297	300	303	306	309	312	315	317	320	323	326	329	331	334	337	340	343	
125	282	285	288	291	294	297	300	303	306	309	312	315	318	321	324	326	329	332	335	337	340	343	
130	282	285	288	292	295	298	301	304	307	310	312	315	318	321	324	327	330	332	335	338	340	343	
135	283	286	289	292	295	298	301	304	307	310	312	315	318	321	324	327	330	332	335	338	341	344	
140	283	286	289	293	296	299	302	305	307	310	313	316	319	322	324	327	330	333	336	338	341	344	
145	284	287	290	293	296	299	302	305	308	311	314	317	319	322	325	328	330	333	336	339	342	344	
150	284	287	290	293	296	299	302	305	308	311	314	317	319	322	325	328	331	334	336	339	342	345	
155	285	288	291	294	297	300	303	306	309	312	315	317	320	323	326	329	332	334	337	340	343	345	
160	285	288	291	294	297	300	303	306	309	312	315	317	320	323	326	329	332	334	337	340	343	345	
165	286	289	292	295	298	301	304	307	310	313	315	318	321	324	327	330	332	335	338	341	343	346	
170	286	290	292	295	298	301	304	307	310	313	316	319	321	324	327	330	332	335	338	341	343	346	
175	287	290	293	296	299	302	305	308	311	313	316	319	322	324	327	330	333	335	338	341	344	346	
180	288	291	294	296	299	302	305	308	311	313	316	319	322	325	328	330	333	336	339	341	344	346	
185	288	291	294	297	300	303	306	309	311	314	317	320	322	325	328	331	333	336	339	342	344	347	
190	289	292	295	297	300	303	306	309	311	314	317	320	323	326	328	331	334	337	339	342	345	347	
195	289	292	295	298	301	304	307	310	312	315	318	320	323	326	329	331	334	337	340	342	345	348	
200	290	293	296	299	301	304	307	310	313	316	318	321	324	327	330	332	335	337	340	343	345	348	
205	290	293	296	299	302	305	308	310	313	316	319	322	324	327	330	332	335	338	340	343	346	348	
210	291	294	297	300	302	305	308	311	314	317	319	322	324	327	330	333	335	338	341	343	346	349	
215	291	294	297	300	303	306	309	311	314	317	320	323	325	328	330	333	336	338	341	344	346	349	
220	292	295	298	301	303	306	309	312	315	317	320	323	326	328	331	333	336	339	342	344	347	350	
225	293	295	298	301	304	307	310	312	315	318	321	323	326	329	332	334	337	339	342	345	347	350	
230	293	296	299	302	304	307	310	313	316	318	321	323	326	329	332	334	337	340	342	345	348	350	
235	294	297	299	302	305	308	311	313	316	319	322	324	327	329	332	335	337	340	343	345	348	351	
240	294	297	300	303	305	308	311	314	317	319	322	324	327	330	332	335	338	340	343	346	348	351	



TABLE 18. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

MOLE FRACTION OF HELIUM 0.0500

T, DEG K	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	91	92	93	93	94	94	95	96	96	97	97	98	99	99	100	100	101	102	102	103	103	104
5	93	93	94	95	95	96	96	97	98	98	99	99	100	100	101	102	102	103	103	104	104	105
10	95	96	96	97	97	98	98	99	99	100	101	101	102	102	103	103	104	105	105	106	106	107
15	98	98	99	99	100	100	101	101	102	102	103	103	104	105	105	106	106	107	107	108	108	109
20	101	102	102	103	103	103	104	104	105	105	106	106	107	107	108	108	109	109	110	110	111	111
25	106	106	106	107	107	107	108	108	108	109	109	110	110	110	111	111	112	112	113	113	113	114
30	111	111	112	112	112	112	112	112	113	113	113	114	114	114	114	115	115	115	116	116	117	117
35	119	119	119	118	118	118	118	118	118	118	118	118	118	119	119	119	119	119	120	120	120	121
40	130	129	128	127	126	126	125	125	125	124	124	124	124	124	124	124	124	124	124	124	125	125
45	148	144	141	139	138	136	135	134	133	132	132	131	131	130	130	130	130	130	130	130	130	130
50	173	166	161	156	153	150	147	145	144	142	141	140	139	138	138	137	136	136	136	135	135	135
55	201	192	185	178	172	167	163	160	157	154	152	150	149	147	146	145	144	144	143	142	142	141
60	225	216	208	200	193	187	181	176	172	169	165	163	160	158	156	155	153	152	151	150	149	148
65	244	236	228	220	213	206	200	194	189	184	180	176	173	170	168	165	163	162	160	159	157	156
70	260	252	245	237	230	223	217	211	205	200	195	191	187	183	180	177	174	172	170	168	166	165
75	275	267	260	253	246	239	232	226	220	215	210	205	200	196	193	189	186	183	180	178	176	174
80	288	280	273	266	260	253	247	240	234	229	223	218	214	209	205	201	198	194	191	189	186	184
85	299	292	286	279	272	266	259	253	247	242	236	231	226	222	217	213	209	205	202	199	196	193
90	310	304	297	290	284	278	271	265	259	254	248	243	238	233	229	224	220	216	213	209	206	203
95	321	314	308	301	295	289	283	277	271	265	260	254	249	244	240	235	231	227	223	220	216	213
100	331	324	318	311	305	299	293	287	281	276	270	265	260	255	250	246	241	237	233	229	226	222
105	340	334	327	321	315	309	303	297	291	286	280	275	270	265	260	256	251	247	243	239	235	232
110	349	343	337	330	324	318	312	307	301	295	290	285	280	275	270	265	261	256	252	248	244	241
115	358	352	345	339	333	327	321	316	310	305	299	294	289	284	279	274	270	265	261	257	253	249
120	366	360	354	348	342	336	330	324	319	313	308	303	298	293	288	283	278	274	270	266	262	258
125	374	368	362	356	350	344	339	333	327	322	317	311	306	301	296	292	287	282	278	274	270	266
130	382	376	370	364	358	352	347	341	336	330	325	319	314	309	304	300	295	291	286	282	278	274
135	390	384	378	372	366	360	355	349	343	338	333	327	322	317	312	308	303	298	294	290	286	282
140	397	391	385	379	374	368	362	357	351	346	340	335	330	325	320	315	311	306	302	297	293	289
145	404	399	393	387	381	375	370	364	359	353	348	343	338	333	328	323	318	314	309	305	301	296
150	411	406	400	394	388	383	377	372	366	361	355	350	345	340	335	330	326	321	316	312	308	304
155	418	413	407	401	395	390	384	379	373	368	363	357	352	347	342	337	333	328	324	319	315	311
160	425	420	414	408	402	397	391	386	380	375	370	364	359	354	349	344	340	335	330	326	322	317
165	432	426	421	415	409	404	398	393	387	382	376	371	366	361	356	351	346	342	337	333	328	324
170	439	433	427	422	416	410	405	399	394	388	383	378	373	368	363	358	353	348	344	339	335	331
175	445	439	434	428	423	417	411	406	400	395	390	385	379	374	369	365	360	355	350	346	342	337
180	452	446	440	435	429	423	418	412	407	402	396	391	386	381	376	371	366	362	357	352	348	344
185	458	452	447	441	435	430	424	419	413	408	403	398	392	387	382	377	373	368	363	359	354	350
190	464	458	453	447	442	436	431	425	420	414	409	404	399	394	389	384	379	374	369	365	360	356
195	470	465	459	453	448	442	437	431	426	421	415	410	405	400	395	390	385	380	376	371	366	362
200	476	471	465	459	454	448	443	437	432	427	421	416	411	406	401	396	391	386	382	377	372	368
205	482	477	471	466	460	454	449	444	438	433	427	422	417	412	407	402	397	392	388	383	378	374
210	488	483	477	471	466	460	455	449	444	439	433	428	423	418	413	408	403	398	393	389	384	380
215	494	488	483	477	472	466	461	455	450	445	439	434	429	424	419	414	409	404	399	395	390	385
220	500	494	489	483	478	472	467	461	456	450	445	440	435	430	424	420	415	410	405	400	396	391
225	505	500	494	489	483	478	472	467	462	456	451	446	440	435	430	425	420	415	411	406	401	397
230	511	506	500	495	489	484	478	473	467	462	457	451	446	441	436	431	426	421	416	412	407	402
235	517	511	506	500	495	489	484	478	473	468	462	457	452	447	441	436	431	427	422	417	412	408
240	522	517	511	506	500	495	489	484	479	473	468	463	457	452	447	442	437	432	427	423	418	413





TABLE 18. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICRPOISES

		MOLE FRACTION OF HELIUM 0.0500																					
T, DEG K		156	158	160	162	164	166	168	170	172	174	176	178	180	182	184	186	188	190	192	194	196	198
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	105	106	107	109	110	111	112	113	114	115	117	118	119	120	121	122	123	124	125	127	128	129	
5	106	107	108	110	111	112	113	114	115	116	117	119	120	121	122	123	124	125	126	127	128	129	
10	108	109	110	111	112	113	115	116	117	118	119	120	121	122	123	124	125	126	128	129	130	131	
15	110	111	112	113	114	115	116	117	118	119	120	122	123	124	125	126	127	128	129	130	131	132	133
20	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134
25	115	116	117	118	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136
30	118	119	119	120	121	122	123	124	125	126	126	127	128	129	130	131	132	133	134	135	136	137	138
35	121	122	123	123	124	125	126	126	127	128	129	130	131	131	132	133	134	135	136	137	138	139	140
40	125	126	126	127	127	128	129	129	130	131	132	132	133	134	135	135	136	137	138	139	140	141	142
45	130	130	130	131	131	131	132	133	133	134	134	135	136	136	137	138	139	139	140	141	142	143	144
50	135	135	135	135	135	135	136	136	136	137	138	138	139	139	140	141	141	142	143	143	144	145	146
55	141	140	140	140	140	140	140	140	140	140	141	141	142	142	143	143	144	145	145	146	147	147	148
60	147	146	145	145	144	144	144	144	144	144	145	145	145	146	146	146	147	147	148	149	149	150	151
65	154	153	152	151	150	149	149	149	148	148	148	149	149	149	149	150	150	150	151	151	152	152	153
70	162	160	158	157	156	155	154	153	153	153	153	153	152	153	153	153	153	153	154	154	155	155	156
75	171	168	165	163	162	161	159	158	157	157	157	156	156	156	156	156	157	157	157	157	158	158	159
80	179	176	173	171	168	167	165	164	163	162	162	161	161	160	160	160	160	160	160	160	161	161	162
85	189	184	181	178	175	173	171	170	169	167	167	166	165	165	164	164	164	164	164	164	164	164	165
90	198	193	189	186	183	180	178	176	174	173	172	171	170	169	169	168	168	168	168	167	167	167	168
95	207	202	197	193	190	187	184	182	180	178	177	176	175	174	173	172	172	171	171	171	171	171	172
100	216	210	206	201	197	194	191	188	186	184	182	181	180	178	177	177	176	175	175	175	174	174	175
105	225	219	214	209	205	201	198	195	192	190	188	186	185	183	182	181	180	179	179	178	178	178	179
110	234	227	222	217	212	208	204	201	198	196	193	191	190	188	187	186	185	184	183	182	182	181	182
115	242	236	230	224	220	215	211	208	205	202	199	197	195	193	192	190	189	188	187	186	186	185	186
120	250	244	238	232	227	222	218	214	211	208	205	202	200	198	197	195	194	192	191	190	189	189	190
125	258	252	245	239	234	229	225	221	217	214	211	208	206	203	201	200	198	197	195	194	193	193	194
130	266	259	253	247	241	236	231	227	223	220	216	214	211	209	206	203	201	198	197	195	194	193	194
135	274	267	260	254	248	243	238	233	229	226	222	219	216	214	211	209	206	203	201	200	199	197	196
140	281	274	267	261	255	249	244	240	235	232	228	225	222	219	216	214	212	210	208	207	206	204	203
145	289	281	274	268	262	256	251	246	242	237	234	230	227	224	221	219	217	215	213	211	210	208	207
150	296	288	281	274	268	262	257	252	248	243	239	236	232	229	226	224	221	219	217	216	214	212	211
155	303	295	288	281	275	269	263	258	253	249	245	241	238	234	231	229	226	224	222	220	218	216	215
160	309	302	294	288	281	275	269	264	259	255	250	247	243	240	236	234	231	228	226	224	222	220	218
165	316	308	301	294	287	281	275	270	265	260	256	252	248	245	241	238	236	233	231	228	226	224	222
170	323	315	307	300	294	287	281	276	271	266	261	257	253	250	246	243	240	238	235	233	231	229	227
175	329	321	313	306	300	293	287	282	276	271	267	262	258	255	251	248	245	242	239	237	235	233	231
180	335	327	320	312	306	299	293	287	282	277	272	268	264	260	256	253	250	247	244	241	239	237	235
185	341	333	326	318	312	305	299	293	287	282	277	273	269	265	261	257	254	251	248	246	243	241	239
190	348	339	332	324	317	311	304	299	293	288	283	278	274	270	266	262	259	256	253	250	247	245	243
195	354	345	338	330	323	316	310	304	298	293	288	283	279	274	270	266	263	260	257	254	251	249	247
200	359	351	343	336	329	322	315	309	304	298	293	288	283	279	274	270	267	263	260	257	254	251	249
205	365	357	349	342	334	327	321	315	309	303	298	293	288	284	279	275	271	268	264	261	258	256	253
210	371	363	355	347	340	333	326	320	314	308	303	298	293	289	285	280	276	272	269	266	263	260	257
215	377	368	360	353	345	338	332	325	319	313	308	303	298	293	289	285	281	277	273	270	267	264	261
220	382	374	366	358	351	344	337	330	324	318	313	308	303	298	293	289	285	281	278	274	271	268	265
225	388	379	371	363	356	349	342	336	329	323	318	313	308	303	298	294	290	286	282	278	275	272	269
230	393	385	377	369	361	354	347	341	334	328	323	317	312	307	303	298	294	290	286	283	279	276	273
235	399	390	382	374	366	359	352	346	339	333	328	322	317	312	307	303	298	294	290	287	283	280	277
240	404	396	387	379	372	364	357	351	344	338	332	327	321	316	312	307	303	299	295	291	287	284	281
																							285



TABLE 18. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROROISES

		MOLE FRACTION OF HELIUM 0.0500																				
T, DEG K	200	205	210	215	220	225	230	235	240	245	250	255	260	265	270	275	280	285	290	295	300	305
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	130	132	135	138	140	143	146	148	151	153	156	158	161	163	165	168	170	172	175	177	179	182
5	131	133	136	138	141	144	146	149	151	154	156	159	161	164	166	168	171	173	175	178	180	182
10	132	134	137	140	142	145	147	150	152	155	157	160	162	164	167	169	171	174	176	178	181	183
15	133	136	138	141	143	146	148	151	153	156	158	160	162	164	167	169	171	174	176	178	181	183
20	134	137	140	142	145	147	149	152	154	157	159	161	163	165	168	170	172	175	177	179	181	184
25	136	139	141	143	146	148	151	153	155	158	160	163	165	166	169	171	173	175	178	180	182	184
30	138	140	142	145	147	150	152	154	157	159	161	164	166	167	169	172	174	176	179	181	183	185
35	140	142	144	146	149	151	153	156	158	160	163	165	166	168	171	173	175	177	179	181	183	186
40	141	144	146	148	150	153	155	157	159	162	164	166	167	169	172	174	176	178	180	183	185	187
45	143	146	148	150	152	154	156	159	161	163	165	167	168	170	173	175	177	179	181	184	186	188
50	146	148	150	152	154	156	158	160	162	164	166	169	171	173	175	177	179	181	184	186	188	189
55	148	150	152	154	156	158	160	162	164	166	168	170	172	174	176	178	180	183	185	187	189	190
60	150	152	154	156	157	159	161	163	165	167	169	171	173	175	178	180	182	184	186	188	190	191
65	153	154	156	158	159	161	163	165	167	169	171	173	175	177	179	181	183	185	187	189	191	192
70	156	157	158	160	161	163	165	167	169	170	172	174	176	178	180	182	184	186	188	189	191	193
75	158	159	161	162	164	165	167	169	170	172	174	176	178	180	182	183	185	187	189	190	192	194
80	161	162	163	164	166	167	169	170	172	174	176	177	179	181	183	185	187	189	190	192	193	195
85	164	165	166	167	168	169	171	172	174	176	177	179	181	183	184	186	188	189	190	192	194	196
90	167	168	169	169	170	172	173	174	176	178	179	181	182	184	186	188	189	191	193	195	197	199
95	171	171	171	172	173	174	175	176	178	179	181	182	184	186	188	189	191	193	195	197	199	200
100	174	174	174	175	176	177	178	180	181	183	184	186	187	189	190	192	194	196	197	199	200	201
105	177	177	177	177	178	179	180	181	182	183	184	186	187	189	190	192	194	195	197	199	200	202
110	181	180	180	180	181	181	182	183	184	185	186	188	189	190	192	194	195	197	198	200	202	203
115	184	184	183	183	183	184	184	185	186	187	188	189	191	192	194	195	197	198	200	201	203	205
120	188	187	186	186	186	186	187	187	188	189	190	191	193	194	195	197	198	200	201	203	204	206
125	192	190	189	189	189	189	189	190	190	191	192	193	194	196	197	198	200	201	203	204	206	207
130	196	194	193	192	191	191	192	192	193	193	194	195	196	197	199	200	201	203	204	206	207	209
135	199	197	196	195	194	194	194	194	195	195	196	197	198	199	200	202	203	204	206	207	208	210
140	203	201	199	198	197	197	197	197	197	198	198	199	200	201	202	203	204	206	207	208	210	211
145	207	205	203	201	200	200	199	199	199	199	200	200	201	202	203	204	206	207	208	210	211	213
150	211	208	206	204	203	202	202	202	202	202	203	204	205	206	207	208	209	210	211	213	214	214
155	215	212	209	208	206	205	205	204	204	204	205	205	206	206	207	208	209	210	212	213	214	215
160	219	215	213	211	209	208	207	207	207	207	207	208	208	209	210	211	212	213	214	216	217	217
165	223	219	216	214	212	211	210	209	209	209	209	210	210	211	212	213	214	215	216	217	218	218
170	227	223	220	217	215	214	213	212	211	211	211	211	212	212	213	214	214	215	216	217	218	220
175	231	227	223	221	218	217	215	215	214	214	213	214	214	214	215	215	216	217	218	219	220	221
180	235	230	227	224	221	220	218	217	216	216	216	216	216	216	217	217	218	219	220	220	221	223
185	239	234	230	227	225	223	221	220	219	218	218	218	218	218	219	219	220	220	221	222	223	224
190	243	238	234	230	228	226	224	222	221	221	220	220	220	220	221	221	222	223	224	225	225	225
195	247	242	237	234	231	228	227	225	224	223	223	222	222	222	222	223	223	224	224	225	226	227
200	251	245	241	237	234	231	229	228	226	226	225	224	224	224	224	225	225	225	226	227	228	228
205	255	249	244	240	237	234	232	230	229	228	227	227	226	226	226	227	227	228	228	229	230	232
210	258	253	248	244	240	237	235	233	232	230	230	229	228	228	228	229	229	229	230	231	232	233
215	262	256	251	247	243	240	238	236	234	233	232	231	231	230	230	230	231	231	232	232	233	233
220	266	260	255	250	247	243	241	239	237	235	234	233	233	232	232	232	233	233	233	234	235	235
225	270	264	258	254	250	246	244	241	239	238	237	236	235	234	234	234	234	234	235	235	236	236
230	274	267	262	257	253	249	246	244	242	240	239	238	237	237	236	236	236	236	237	237	238	238
235	278	271	265	260	256	252	249	247	245	243	241	240	239	239	238	238	238	238	238	239	239	239
240	282	275	269	264	259	255	252	249	247	245	244	242	241	241	240	240	240	240	240	240	240	241



TABLE 18. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

T, DEG K	MOLE FRACTION OF HELIUM 0.0500																					
	310	320	330	340	350	360	370	380	390	400	410	420	430	440	450	460	470	480	490	500	510	520
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	184	188	193	197	201	206	210	214	218	222	226	230	233	237	241	245	248	252	255	259	262	266
5	184	189	193	198	202	206	210	214	218	222	226	230	234	238	241	245	249	252	256	259	263	266
10	185	190	194	198	202	207	211	215	219	223	227	230	234	238	242	245	249	253	256	260	263	266
15	186	190	195	199	203	207	211	215	219	223	227	231	235	238	242	246	249	253	257	260	263	266
20	187	191	195	200	204	208	212	216	220	224	228	231	235	239	243	246	250	253	257	260	263	267
25	187	192	196	200	204	208	213	217	220	224	228	232	236	240	243	247	250	254	257	261	264	267
30	188	193	197	201	205	209	213	217	221	225	229	233	236	240	244	247	251	254	258	261	265	268
35	189	193	198	202	206	210	214	218	222	226	229	233	237	241	244	248	251	255	258	262	265	269
40	190	194	198	203	207	211	215	219	222	226	230	234	238	241	245	248	252	255	259	262	266	269
45	191	195	199	203	207	211	215	219	223	227	231	234	238	241	245	248	252	255	259	262	266	269
50	192	196	200	204	208	212	216	220	224	228	231	235	239	242	246	249	253	256	259	263	266	270
55	193	197	201	205	209	213	217	221	224	228	232	236	239	243	247	250	254	257	260	264	267	270
60	194	198	202	206	210	214	218	221	225	229	233	236	239	243	247	251	254	258	261	264	268	271
65	195	199	203	207	211	215	218	222	226	230	233	237	241	244	248	251	255	258	261	265	268	271
70	196	200	204	208	212	215	219	223	227	230	234	238	241	245	248	252	255	259	262	265	269	272
75	197	201	205	209	212	216	220	224	227	231	235	238	242	245	249	252	256	259	263	266	269	272
80	198	202	206	210	213	217	221	225	228	232	235	239	243	246	250	253	256	260	263	266	270	273
85	199	203	207	211	214	218	222	225	229	233	236	240	243	247	250	254	257	260	264	267	270	274
90	200	204	208	211	215	219	223	226	230	233	237	240	244	247	251	254	258	261	264	268	271	274
95	202	205	209	212	216	220	223	227	231	234	238	241	245	248	251	255	258	262	265	268	271	275
100	203	206	210	213	217	221	224	228	231	235	238	242	245	249	252	255	259	262	265	269	272	275
105	204	207	211	214	218	222	225	229	232	236	239	243	246	249	253	256	259	263	266	269	272	275
110	205	209	212	216	219	223	226	230	233	236	239	243	246	249	253	256	259	263	266	269	272	276
115	206	210	213	217	220	223	227	230	234	237	241	244	247	251	254	257	260	263	267	270	273	276
120	208	211	214	218	221	224	228	231	235	238	241	245	248	252	255	258	261	264	267	270	274	277
125	209	212	215	219	222	225	229	232	236	239	242	246	249	252	255	259	262	265	268	271	274	277
130	210	213	216	220	223	226	230	233	236	240	243	246	250	253	256	259	263	266	269	272	275	278
135	211	214	218	221	224	227	231	234	237	241	244	247	250	254	257	260	263	266	269	272	275	278
140	213	216	219	222	225	228	232	235	238	241	245	248	251	254	258	261	264	267	270	273	276	279
145	214	217	220	223	226	229	233	236	239	242	245	249	252	255	258	261	264	267	270	273	277	280
150	215	218	221	224	227	230	234	237	240	243	246	249	253	256	259	262	265	268	271	274	277	280
155	217	219	222	225	228	231	235	238	241	244	247	250	253	257	260	263	266	269	272	275	278	281
160	218	221	224	226	229	232	236	239	242	245	248	251	254	257	260	264	267	270	273	276	279	282
165	219	222	225	228	231	234	237	240	243	246	249	252	255	258	261	264	267	270	273	276	279	282
170	221	223	226	229	232	235	238	241	244	247	250	253	256	259	262	265	268	271	274	277	280	283
175	222	225	227	230	233	236	239	241	244	247	251	254	257	260	263	266	269	272	275	278	281	284
180	224	226	229	231	234	237	240	242	245	248	251	254	257	260	263	266	269	272	275	278	281	284
185	225	227	230	232	235	238	241	243	246	249	252	255	258	261	264	267	270	273	276	279	282	285
190	226	229	231	234	236	239	242	244	247	250	253	256	259	262	265	268	271	274	277	280	283	286
195	228	230	232	235	237	240	243	245	248	251	254	257	260	263	266	269	272	274	277	280	283	286
200	229	231	234	236	238	241	244	246	249	252	255	258	261	264	266	269	272	274	277	280	283	286
205	231	233	235	237	240	242	245	247	250	253	256	259	261	264	267	270	273	276	279	282	285	287
210	232	234	236	238	241	243	246	248	251	254	257	259	262	265	268	271	274	277	279	282	285	287
215	234	236	238	240	242	244	247	249	252	255	258	260	263	266	269	272	274	277	280	283	286	289
220	235	237	239	241	243	246	248	251	253	256	258	261	264	267	270	272	275	278	281	284	287	290
225	237	238	240	242	244	247	249	252	254	257	259	262	265	268	270	273	276	279	281	284	287	290
230	238	240	242	243	246	248	250	253	255	258	260	263	266	268	271	274	277	279	282	285	288	291
235	240	241	243	245	247	249	251	254	256	259	261	264	267	269	272	275	277	280	283	286	288	291
240	241	243	244	246	248	250	252	255	257	260	262	265	267	270	273	275	278	281	284	286	289	292



TABLE 18. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

		MOLE FRACTION OF HELIUM 0.0500																					
T, DEG K	P, ATM	530	540	550	560	570	580	590	600	610	620	630	640	650	660	670	680	690	700	710	720	730	740
		VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1		269	273	276	279	282	286	289	292	295	298	301	304	308	311	314	317	319	322	325	328	331	334
5		269	273	276	279	283	286	289	292	295	299	302	305	308	311	314	317	320	323	325	328	331	334
10		270	273	276	280	283	286	289	293	296	299	302	305	308	311	314	317	320	323	325	328	331	334
15		270	274	277	280	283	287	290	293	296	299	302	305	308	311	314	317	320	323	326	329	332	334
20		271	274	277	281	284	287	290	293	296	300	303	306	309	312	315	318	321	323	326	329	332	335
25		271	274	278	281	284	287	291	294	297	300	303	306	309	312	315	318	321	323	326	329	332	335
30		271	275	278	281	285	288	291	294	297	300	303	306	309	312	315	318	321	324	327	330	332	335
35		272	275	279	282	285	288	291	294	298	301	304	307	310	313	316	319	321	324	327	330	333	335
40		272	276	279	282	285	289	292	295	298	301	304	307	310	313	316	319	321	324	327	330	333	336
45		273	276	279	283	286	289	292	295	298	301	304	307	310	313	316	319	322	325	328	330	333	336
50		273	277	280	283	286	289	293	296	299	302	305	308	311	314	317	320	322	325	328	331	334	336
55		274	277	280	283	287	290	293	296	299	302	305	308	311	314	317	320	323	326	329	331	334	337
60		274	278	281	284	287	290	293	296	299	303	306	309	312	314	317	320	323	326	329	331	334	337
65		275	278	281	284	288	291	294	297	300	303	306	309	312	314	317	320	323	326	329	332	335	337
70		275	278	282	285	288	291	294	297	300	303	306	309	312	315	318	321	324	326	329	332	335	337
75		276	279	282	285	288	292	295	298	301	304	307	310	313	316	318	321	324	327	330	332	335	338
80		276	279	283	286	289	292	295	298	301	304	307	310	313	316	318	321	324	327	330	333	336	338
85		277	280	283	286	289	292	296	299	302	305	308	311	313	316	319	322	325	327	330	333	336	339
90		277	280	284	287	290	293	296	299	302	305	308	311	313	316	319	322	325	328	331	333	336	339
95		278	281	284	287	290	293	296	299	302	305	308	311	314	317	320	323	325	328	331	333	336	339
100		278	281	285	288	291	294	297	300	303	306	309	312	315	318	320	323	326	329	331	334	337	340
105		279	282	285	288	291	294	297	300	303	306	309	312	315	318	321	324	326	329	332	335	337	340
110		279	283	286	289	292	295	298	301	304	307	310	313	315	318	321	324	326	329	332	335	338	340
115		280	283	286	289	292	295	298	301	304	307	310	313	316	319	322	324	327	330	332	335	338	341
120		280	284	287	290	293	296	299	302	305	308	311	313	316	319	322	325	328	330	333	336	338	341
125		281	284	287	290	293	296	299	302	305	308	311	313	316	319	322	325	328	330	333	336	339	341
130		282	285	288	291	294	297	300	303	306	308	311	314	317	320	322	325	328	331	334	336	339	341
135		282	285	288	291	294	297	300	303	306	309	312	314	317	320	323	326	328	331	334	337	339	342
140		283	286	289	292	295	298	301	304	307	309	312	315	318	320	323	326	329	332	334	337	340	343
145		283	286	289	292	295	298	301	304	307	310	313	316	318	321	324	326	329	332	335	337	340	343
150		284	287	290	293	296	299	302	305	307	310	313	316	319	322	324	327	330	332	335	338	341	343
155		284	287	290	293	296	299	302	305	308	311	314	316	319	322	325	328	330	333	336	339	341	344
160		285	288	291	294	297	300	303	306	308	311	314	317	320	323	325	328	330	333	336	339	341	344
165		286	288	291	294	297	300	303	306	309	312	315	317	320	323	326	328	331	334	336	339	342	344
170		286	289	292	295	298	301	304	306	309	312	315	318	321	323	326	329	332	334	337	339	342	345
175		287	290	293	295	298	301	304	307	310	313	315	318	321	324	327	329	332	334	337	340	342	345
180		287	290	293	296	299	302	305	307	310	313	315	318	321	324	327	329	332	335	337	340	343	345
185		288	291	294	297	299	302	305	308	311	314	316	319	321	324	327	330	332	335	338	341	343	345
190		288	291	294	297	300	303	306	308	311	314	317	319	322	325	327	330	333	336	338	341	344	346
195		289	292	295	298	301	303	306	309	312	315	317	320	322	325	328	331	333	336	339	341	344	347
200		290	293	295	298	301	304	307	309	312	315	318	321	323	326	328	331	334	336	339	342	344	347
205		290	293	296	299	302	304	307	310	313	316	318	321	324	326	329	332	335	337	340	342	345	347
210		291	294	297	299	302	305	308	310	313	316	319	321	324	326	329	332	335	337	340	342	345	348
215		291	294	297	300	303	305	308	311	314	316	319	322	325	327	330	332	335	338	340	343	346	348
220		292	295	298	300	303	306	309	312	314	317	320	322	325	327	330	333	335	338	341	343	346	349
225		293	295	298	301	304	307	309	312	315	317	320	322	325	328	330	333	336	338	341	344	346	349
230		293	296	299	302	304	307	310	313	315	318	320	323	326	328	331	334	336	339	341	344	347	349
235		294	297	299	302	305	308	310	313	315	318	321	323	326	329	331	334	337	339	342	344	347	349
240		295	297	300	303	305	308	311	314	316	319	322	324	327	330	332	335	337	340	342	345	347	350





TABLE 19. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

		MOLE FRACTION OF HELIUM 0.0000																					
T, DEG K		133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	90	91	92	92	93	93	94	95	95	96	96	97	97	98	99	99	100	100	101	102	102	102	103
5	92	92	93	93	94	95	95	96	96	97	98	98	99	99	100	100	101	102	102	103	103	103	104
10	94	95	95	96	96	97	97	98	98	99	100	100	101	101	102	102	103	104	104	105	105	106	106
15	97	98	98	99	99	100	100	101	101	102	102	103	103	104	104	105	105	106	106	107	107	108	108
20	101	101	102	102	103	103	104	104	105	105	106	106	107	107	108	108	109	109	110	110	110	111	111
25	106	107	107	107	107	108	108	108	109	109	109	110	110	110	111	111	111	112	112	113	113	114	114
30	114	114	114	114	114	114	114	114	114	114	114	114	114	115	115	115	115	116	116	116	117	117	117
35	126	125	124	123	122	122	121	121	121	121	120	120	120	120	120	120	121	121	121	121	121	121	121
40	153	146	141	138	136	134	132	131	130	129	129	128	128	127	127	127	127	127	127	127	127	127	127
45	216	197	180	168	160	154	150	146	144	142	140	139	137	136	136	135	134	134	133	133	133	133	133
50	253	239	225	210	197	186	177	169	164	159	156	153	150	148	147	145	144	143	142	141	140	140	140
55	277	265	254	242	230	219	208	198	190	182	176	171	167	163	160	158	156	154	152	151	150	148	148
60	296	286	275	265	255	244	234	225	215	207	199	193	187	182	177	173	170	167	164	162	160	159	159
65	313	303	293	284	274	265	255	246	238	229	221	214	207	201	195	190	186	182	178	175	172	170	170
70	327	318	309	300	291	282	273	265	256	248	240	233	226	219	213	207	202	197	193	189	186	183	183
75	341	332	323	315	306	298	289	281	273	265	257	250	243	236	230	224	218	213	208	203	199	196	196
80	353	345	336	328	320	312	303	296	288	280	273	265	258	252	245	239	233	228	222	218	213	209	209
85	365	357	348	340	332	324	317	309	301	294	286	279	272	266	259	253	247	241	236	231	226	222	222
90	376	368	360	352	344	336	329	321	314	306	299	292	285	279	272	266	260	255	249	244	239	234	234
95	386	378	371	363	355	348	340	333	325	318	311	304	298	291	285	279	273	267	261	256	251	246	246
100	396	388	381	373	366	358	351	344	336	329	322	316	309	303	296	290	284	278	273	267	262	257	257
105	406	398	391	383	376	368	361	354	347	340	333	326	320	313	307	301	295	289	284	278	273	268	268
110	415	407	400	393	385	378	371	364	357	350	343	337	330	324	318	311	306	300	294	289	283	278	278
115	424	417	409	402	395	388	381	374	367	360	353	347	340	334	328	321	315	310	304	299	293	288	288
120	433	425	418	411	404	397	390	383	376	369	363	356	350	343	337	331	325	319	314	308	303	298	298
125	441	434	427	420	413	406	399	392	385	378	372	365	359	352	346	340	334	329	323	317	312	307	307
130	449	442	435	428	421	414	407	400	394	387	380	374	368	361	355	349	343	338	332	326	321	316	316
135	457	450	443	436	430	423	416	409	402	396	389	383	376	370	364	358	352	346	341	335	330	324	324
140	465	458	451	445	438	431	424	417	411	404	397	391	385	378	372	366	360	355	349	343	338	333	333
145	473	466	459	452	446	439	432	425	419	412	406	399	393	387	381	375	369	363	357	352	346	341	341
150	481	474	467	460	453	447	440	433	427	420	414	407	401	395	389	383	377	371	365	360	354	349	349
155	488	481	475	468	461	454	448	441	434	428	421	415	409	402	396	390	384	379	373	367	362	357	357
160	496	489	482	475	469	462	455	448	442	435	429	423	416	410	404	398	392	386	381	375	370	364	364
165	503	496	489	483	476	469	463	456	449	443	436	430	424	418	412	406	400	394	388	383	377	372	372
170	510	503	497	490	483	476	470	463	457	450	444	437	431	425	419	413	407	401	396	390	384	379	379
175	517	510	504	497	490	484	477	470	464	457	451	445	438	432	426	420	414	408	403	397	392	386	386
180	524	517	511	504	497	491	484	478	471	465	458	452	446	439	433	427	421	416	410	404	399	393	393
185	531	524	518	511	504	498	491	485	478	472	465	459	453	446	440	434	428	423	417	411	406	400	400
190	538	531	524	518	511	505	498	491	485	478	472	466	459	453	447	441	435	429	424	418	413	407	407
195	544	538	531	524	518	511	505	498	492	485	479	473	466	460	454	448	442	436	430	425	419	414	414
200	551	544	538	531	525	518	511	505	498	492	486	479	473	467	461	455	449	443	437	431	426	420	420
205	557	551	544	538	531	525	518	512	505	499	492	486	480	474	467	461	455	450	444	438	432	427	427
210	564	557	551	544	538	531	525	518	512	505	499	493	486	480	474	468	462	456	450	445	439	433	433
215	570	564	557	551	544	538	531	525	518	512	505	499	493	487	480	474	468	463	457	451	445	440	440
220	577	570	564	557	551	544	538	531	525	518	512	505	499	493	487	481	475	469	463	457	452	446	446
225	583	576	570	563	557	550	544	537	531	525	518	512	506	499	493	487	481	475	469	464	458	452	452
230	589	583	576	570	563	557	550	544	537	531	524	518	512	506	499	493	487	481	476	470	464	459	459
235	595	589	582	576	569	563	556	550	544	537	531	524	518	512	506	500	494	488	482	476	470	465	465
240	601	595	589	582	576	569	563	556	550	543	537	531	524	518	512	506	500	494	488	482	476	471	471



TABLE 19. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

MOLE FRACTION OF HELIUM 0.0000

T, DEG K	156	158	160	162	164	166	168	170	172	174	176	178	180	182	184	186	188	190	192	194	196	198	
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	104	105	106	107	109	110	111	112	113	114	115	116	118	119	120	121	122	123	124	125	126	127	
5	105	106	107	108	110	111	112	113	114	115	116	117	119	120	121	122	123	124	125	126	127	128	
10	107	108	109	110	111	112	113	115	116	117	118	119	120	121	122	123	124	125	126	127	128	130	
15	109	110	111	112	113	114	115	116	117	118	119	121	122	123	124	125	126	127	128	129	131	132	133
20	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	131	132	133	
25	114	115	116	117	118	119	120	121	122	123	124	125	126	126	127	128	129	130	131	132	133	134	
30	118	119	119	120	121	122	123	123	124	125	126	127	128	129	130	131	131	132	133	134	135	136	
35	122	122	123	124	124	125	126	126	127	128	129	130	130	131	132	133	134	135	135	136	137	138	
40	127	127	127	128	128	129	129	130	130	131	132	132	133	134	135	135	136	137	138	139	140	140	
45	132	132	132	132	133	133	133	134	134	135	135	136	136	137	138	138	139	140	140	141	142	143	
50	139	138	138	138	137	137	138	138	138	138	139	139	140	140	141	141	142	142	143	144	144	145	
55	147	145	144	144	143	143	143	142	142	143	143	143	143	144	144	144	145	145	146	147	147	148	
60	156	154	152	150	149	149	148	148	147	147	147	147	147	147	148	148	148	149	149	150	150	151	
65	166	163	160	158	156	155	154	153	153	152	152	152	152	152	152	152	152	152	152	153	153	154	
70	177	173	169	167	164	162	161	159	158	158	157	157	156	156	156	156	156	156	156	156	157	157	
75	189	184	179	176	173	170	168	166	165	163	163	162	161	161	160	160	160	160	160	160	160	160	
80	201	195	190	185	181	178	175	173	171	170	168	167	166	166	165	165	164	164	164	164	164	164	
85	214	206	200	195	191	187	183	181	178	176	175	173	172	171	170	169	169	168	168	168	167	167	
90	225	218	211	205	200	196	192	188	186	183	181	179	178	176	175	174	173	173	172	172	171	171	
95	237	229	221	215	209	204	200	196	193	190	188	185	184	182	181	179	178	177	177	176	176	175	
100	248	239	232	225	219	213	209	204	201	197	194	192	190	188	186	185	183	182	181	181	180	179	
105	258	250	242	235	228	222	217	212	208	205	201	199	196	194	192	190	189	187	186	185	184	184	
110	269	260	252	244	237	231	225	220	216	212	208	205	202	200	198	196	194	192	191	190	189	188	
115	278	269	261	253	246	240	234	228	224	219	215	212	209	206	204	201	199	198	196	195	193	192	
120	288	279	270	262	255	248	242	236	231	227	222	219	215	212	209	207	205	203	201	199	198	197	
125	297	288	279	271	263	256	250	244	239	234	229	225	222	218	215	213	210	208	206	204	203	201	
130	306	296	288	279	272	264	258	252	246	241	236	232	228	225	222	219	216	214	211	209	208	206	
135	314	305	296	288	280	272	266	259	254	248	243	239	235	231	228	224	222	219	217	214	213	211	
140	323	313	304	296	288	280	273	267	261	255	250	245	241	237	234	230	227	224	222	220	217	215	
145	331	321	312	303	295	288	281	274	268	262	257	252	247	243	239	236	233	230	227	225	222	220	
150	339	329	320	311	303	295	288	281	275	269	264	258	254	249	245	242	238	235	232	230	227	225	
155	346	337	327	319	310	302	295	288	282	276	270	265	260	256	251	247	244	241	238	235	232	230	
160	354	344	335	326	318	310	302	295	289	282	277	271	266	262	257	253	249	246	243	240	237	235	
165	361	352	342	333	325	317	309	302	295	289	283	277	272	267	263	259	255	251	248	245	242	239	
170	369	359	349	340	332	323	316	309	302	295	289	284	278	273	269	264	260	257	253	250	247	244	
175	376	366	356	347	338	330	322	315	308	302	295	290	284	279	274	270	266	262	258	255	252	249	
180	383	373	363	354	345	337	329	322	315	308	302	296	290	285	280	276	271	267	264	260	257	254	
185	390	380	370	361	352	343	336	328	321	314	308	302	296	291	286	281	277	272	269	265	262	258	
190	396	386	377	367	358	350	342	334	327	320	314	308	302	296	291	286	282	278	274	270	266	263	
195	403	393	383	374	365	356	348	340	333	326	320	313	307	302	297	292	287	283	279	275	271	268	
200	410	400	390	380	371	363	354	347	339	332	325	319	313	307	302	297	292	288	284	280	276	273	
205	416	406	396	387	377	369	361	353	345	338	331	325	319	313	308	302	298	293	289	285	281	277	
210	423	412	402	393	384	375	367	359	351	344	337	330	324	318	313	308	303	298	294	289	286	282	
215	429	419	409	399	390	381	373	365	357	350	343	336	330	324	318	313	308	303	299	294	290	286	
220	435	425	415	405	396	387	378	370	363	355	348	341	335	329	323	318	313	308	303	299	295	291	
225	441	431	421	411	402	393	384	376	368	361	354	347	341	334	329	323	318	313	308	304	300	296	
230	448	437	427	417	408	399	390	382	374	366	359	352	346	340	334	328	323	318	313	309	304	300	
235	454	443	433	423	414	405	396	387	380	372	365	358	351	345	339	333	328	323	318	313	309	305	
240	460	449	439	429	419	410	401	393	385	377	370	363	356	350	344	338	333	327	323	318	313	309	



TABLE 19. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

		MOLE FRACTION OF HELIUM 0.0000																					
T, DEG K		200	205	210	215	220	225	230	235	240	245	250	255	260	265	270	275	280	285	290	295	300	305
P, ATM		VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1		129	131	134	137	139	142	144	147	149	152	154	157	159	162	164	166	169	171	174	176	178	180
5		129	132	135	137	140	142	145	148	150	153	155	157	160	162	165	167	169	172	174	176	179	181
10		131	133	136	138	141	143	146	149	151	153	156	158	161	163	166	168	170	173	175	177	179	182
15		132	135	137	140	142	145	147	150	152	155	157	159	162	164	166	169	171	173	176	178	180	182
20		134	136	139	141	143	146	148	151	153	156	158	160	163	165	167	170	172	174	177	179	181	183
25		135	138	140	142	145	147	150	152	154	157	159	161	164	166	168	171	173	175	177	180	182	184
30		137	139	142	144	146	149	151	153	156	158	160	163	165	167	170	172	174	176	178	181	183	185
35		139	141	143	146	148	150	153	155	157	159	162	164	166	168	171	173	175	177	179	182	184	186
40		141	143	145	148	150	152	154	156	159	161	163	165	167	170	172	174	176	178	181	183	185	187
45		143	145	147	149	152	154	156	158	160	162	164	167	169	171	173	175	177	179	182	184	186	188
50		146	148	150	151	153	156	158	160	162	164	166	168	170	172	174	176	179	181	183	185	187	189
55		148	150	152	154	156	157	159	161	163	165	167	169	172	174	176	178	180	182	184	186	188	190
60		151	153	154	156	158	159	161	163	165	167	169	171	173	175	177	179	181	183	185	187	189	191
65		154	155	157	158	160	162	163	165	167	169	171	173	175	176	178	180	182	184	186	188	190	192
70		157	158	159	161	162	164	165	167	169	171	172	174	176	178	180	182	184	186	188	190	192	193
75		160	161	162	163	165	166	167	169	171	172	174	176	178	180	181	183	185	187	189	191	193	195
80		164	164	165	166	167	168	170	171	173	174	176	178	179	181	183	185	187	188	190	192	194	196
85		167	168	168	169	170	171	172	173	175	176	178	179	181	183	185	186	188	188	190	192	193	195
90		171	171	171	172	172	173	174	176	177	178	180	181	183	184	186	188	188	190	191	193	195	197
95		175	174	174	175	175	176	177	178	179	180	182	183	185	186	188	189	191	193	194	196	198	200
100		179	178	178	178	178	179	179	180	181	183	184	185	187	188	190	191	193	194	196	198	199	201
105		183	182	181	181	181	181	182	183	184	185	186	187	188	190	191	193	194	196	197	199	201	202
110		187	186	185	184	184	184	185	185	186	187	188	189	190	192	193	194	196	197	199	201	202	204
115		191	189	188	187	187	187	187	188	188	189	190	191	192	194	195	196	198	199	200	202	204	205
120		196	193	192	191	190	190	190	190	191	192	192	193	194	195	197	198	199	201	202	204	205	207
125		200	198	196	194	194	193	193	193	193	194	195	195	196	197	198	200	201	202	204	205	206	208
130		205	202	199	198	197	196	196	196	196	196	197	198	198	199	200	201	203	204	205	207	208	209
135		209	206	203	201	200	199	199	198	198	199	199	200	200	201	202	203	204	206	207	208	210	211
140		214	210	207	205	204	202	202	201	201	201	202	202	203	203	204	205	206	207	209	210	211	212
145		218	214	211	209	207	206	205	204	204	204	204	204	205	205	206	207	208	209	210	211	213	214
150		223	219	215	212	210	209	208	207	206	206	206	207	207	208	208	209	210	211	212	213	214	215
155		228	223	219	216	214	212	211	210	209	209	209	209	209	210	210	211	212	213	214	215	216	217
160		232	227	223	220	217	215	214	213	212	211	211	211	211	212	212	213	214	214	215	216	217	219
165		237	232	227	224	221	219	217	216	215	214	214	214	214	214	214	215	216	216	217	218	219	220
170		242	236	231	228	225	222	220	219	218	217	216	216	216	216	216	217	217	218	219	220	221	222
175		246	240	235	231	228	225	223	222	220	219	219	218	218	218	219	219	219	220	221	222	222	223
180		251	245	240	235	232	229	227	225	223	222	221	221	221	221	221	221	221	222	223	223	224	225
185		256	249	244	239	235	232	230	228	226	225	224	223	223	223	223	223	223	224	224	225	226	227
190		260	253	248	243	239	236	233	231	229	228	227	226	225	225	225	225	225	226	226	227	227	228
195		265	258	252	247	243	239	236	234	232	230	229	228	228	227	227	227	227	228	228	229	229	230
200		269	262	256	251	246	243	239	237	235	233	232	231	230	230	229	229	229	230	230	230	231	232
205		274	266	260	254	250	246	243	240	238	236	235	233	233	232	232	231	231	232	232	232	233	233
210		278	271	264	258	253	249	246	243	241	239	237	236	235	234	234	234	233	234	234	234	234	235
215		283	275	268	262	257	253	249	246	244	242	240	239	237	237	236	236	236	236	236	236	236	237
220		287	279	272	266	261	256	253	249	247	244	243	241	240	239	238	238	238	238	238	238	238	238
225		292	283	276	270	264	260	256	252	250	247	245	244	242	241	241	240	240	240	239	240	240	240
230		296	288	280	274	268	263	259	256	253	250	248	246	245	244	243	242	242	242	241	241	242	242
235		301	292	284	277	272	267	262	259	256	253	251	249	247	246	245	244	244	244	243	243	243	244
240		305	296	288	281	275	270	266	262	259	256	253	251	250	249	247	246	246	246	245	245	245	245



TABLE 19. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

MOLE FRACTION OF HELIUM 0.0000

T, DEG K	310	320	330	340	350	360	370	380	390	400	410	420	430	440	450	460	470	480	490	500	510	520
P, ATM	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
1	183	187	192	196	200	204	208	213	217	221	224	228	232	236	240	243	247	250	254	257	261	264
5	183	188	192	196	201	205	209	213	217	221	225	229	232	236	240	244	247	251	254	258	261	265
10	184	188	193	197	201	205	209	213	217	221	225	229	233	237	240	244	248	251	255	258	262	265
15	185	189	193	198	202	206	210	214	218	222	226	230	233	237	241	244	248	252	255	259	262	265
20	185	190	194	198	202	207	211	215	219	223	226	230	234	238	241	245	249	252	256	259	262	266
25	186	191	195	199	203	207	211	215	219	223	227	231	235	238	242	245	249	253	256	260	263	266
30	187	191	196	200	204	208	212	216	220	224	228	231	235	239	242	246	250	253	257	260	263	267
35	188	192	197	201	205	209	213	217	221	224	228	232	236	239	243	247	250	254	257	260	264	267
40	189	193	197	201	206	210	214	217	221	225	229	233	236	240	244	247	251	254	258	261	264	268
45	190	194	198	202	206	210	214	218	222	226	230	233	237	241	244	248	251	255	258	262	265	268
50	191	195	199	203	207	211	215	219	223	227	230	234	238	241	245	248	252	255	259	262	265	269
55	192	196	200	204	208	212	216	220	223	227	231	235	238	242	245	249	252	256	259	263	266	269
60	193	197	201	205	209	213	217	220	224	228	232	235	239	242	246	249	253	256	260	263	266	270
65	194	198	202	206	210	214	218	221	225	229	232	236	240	243	247	250	254	257	260	264	267	270
70	195	199	203	207	211	215	218	222	226	229	233	237	240	244	247	251	254	258	261	264	268	271
75	197	200	204	208	212	216	219	223	227	230	234	237	241	244	248	251	255	258	261	265	268	271
80	198	202	205	209	213	216	220	224	227	231	235	238	242	245	249	252	255	259	262	265	269	272
85	199	203	206	210	214	217	221	225	228	232	235	239	242	246	249	253	256	259	263	266	269	272
90	200	204	207	211	215	218	222	226	229	233	236	240	243	247	250	253	257	260	263	267	270	273
95	201	205	209	212	216	219	223	226	230	233	237	240	244	247	251	254	257	261	264	267	270	274
100	203	206	210	213	217	220	224	227	231	234	238	241	245	248	251	255	258	261	265	268	271	274
105	204	207	211	214	218	221	225	228	232	235	239	242	245	249	252	255	259	262	265	268	272	275
110	205	209	212	215	219	222	226	229	233	236	239	243	246	249	253	256	259	263	266	269	272	275
115	207	210	213	217	220	223	227	230	233	237	240	244	247	250	253	257	260	263	266	270	273	276
120	208	211	214	218	221	224	228	231	234	238	241	244	248	251	254	257	261	264	267	270	273	276
125	209	213	216	219	222	225	229	232	235	239	242	245	248	252	255	258	261	265	268	271	274	277
130	211	214	217	220	223	227	230	233	236	240	243	246	249	252	256	259	262	265	268	271	275	278
135	212	215	218	221	224	228	231	234	237	240	244	247	250	253	256	260	263	266	269	272	275	278
140	214	217	219	223	226	229	232	235	238	241	245	248	251	254	257	260	263	267	270	273	276	279
145	215	218	221	224	227	230	233	236	239	242	245	249	252	255	258	261	264	267	270	273	276	280
150	217	219	222	225	228	231	234	237	240	243	246	249	253	256	259	262	265	268	271	274	277	280
155	218	221	223	226	229	232	235	238	241	244	247	250	253	256	260	263	266	269	272	275	278	281
160	220	222	225	227	230	233	236	239	242	245	248	251	254	257	260	263	266	269	272	275	278	281
165	221	224	226	229	231	234	237	240	243	246	249	252	255	258	261	264	267	270	273	276	279	282
170	223	225	227	230	233	235	238	241	244	247	250	253	256	259	262	265	268	271	274	277	280	283
175	224	227	229	231	234	237	239	242	245	248	251	254	257	260	263	266	269	272	275	277	280	283
180	226	228	230	233	235	238	241	243	246	249	252	255	258	261	264	266	269	272	275	278	281	284
185	227	229	232	234	236	239	242	244	247	250	253	256	259	261	264	267	270	273	276	279	282	285
190	229	231	233	235	238	240	243	245	248	251	254	257	259	262	265	268	271	274	277	280	282	285
195	231	232	234	237	239	241	244	247	249	252	255	257	260	263	266	269	272	275	277	280	283	286
200	232	234	236	238	240	243	245	248	250	253	256	258	261	264	267	270	272	275	278	281	284	287
205	234	236	237	239	242	244	246	249	251	254	257	259	262	265	268	270	273	276	279	282	284	287
210	236	237	239	241	243	245	247	250	252	255	258	260	263	266	268	271	274	277	280	282	285	288
215	237	239	240	242	244	246	249	251	253	256	259	261	264	267	269	272	275	278	280	283	286	289
220	239	240	242	243	245	248	250	252	255	257	260	262	265	267	270	273	276	278	281	284	287	289
225	241	242	243	245	247	249	251	253	256	258	261	263	266	268	271	274	276	279	282	285	287	290
230	242	243	245	246	248	250	252	254	257	259	262	264	267	269	272	275	277	280	283	285	288	291
235	244	245	246	248	249	251	253	256	258	260	263	265	268	270	273	275	278	281	283	286	289	291
240	246	247	248	249	251	253	255	257	259	261	264	266	269	271	274	276	279	281	284	287	289	292





TABLE 19. - VISCOSITY OF HELIUM-NITROGEN SYSTEM, MICROPOISES

		MOLE FRACTION OF HELIUM*0.0000																					
T, DEG K	P, ATM	530	540	550	560	570	580	590	600	610	620	630	640	650	660	670	680	690	700	710	720	730	740
		VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
	1	268	271	274	278	281	284	287	290	294	297	300	303	306	309	312	315	318	321	323	326	329	332
	5	268	271	275	278	281	284	288	291	294	297	300	303	306	309	312	315	318	321	324	327	329	332
	10	268	272	275	278	281	285	288	291	294	297	300	303	306	309	312	315	318	321	324	327	330	332
	15	269	272	275	279	282	285	288	291	294	298	301	304	307	310	313	316	318	321	324	327	330	333
	20	269	273	276	279	282	285	289	292	295	298	301	304	307	310	313	316	319	322	325	327	330	333
	25	270	273	276	279	283	286	289	292	295	298	301	304	307	310	313	316	319	322	325	328	331	333
	30	270	273	277	280	283	286	289	292	296	299	302	305	308	311	314	317	319	322	325	328	331	334
	35	271	274	277	280	283	287	290	293	296	299	302	305	308	311	314	317	320	323	326	328	331	334
	40	271	274	278	281	284	287	290	293	296	299	302	305	308	311	314	317	320	323	326	329	332	335
	45	271	275	278	281	284	288	291	294	297	300	303	306	309	312	315	318	320	323	326	329	332	335
	50	272	275	278	282	285	288	291	294	297	300	303	306	309	312	315	318	321	324	327	329	332	335
	55	272	276	279	282	285	288	291	295	298	301	304	307	310	312	315	318	321	324	327	330	332	335
	60	273	276	279	283	286	289	292	295	298	301	304	307	310	313	316	319	322	324	327	330	333	336
	65	273	277	280	283	286	289	292	295	298	301	304	307	310	313	316	319	322	325	328	330	333	336
	70	274	277	280	284	287	290	293	296	299	302	305	308	311	314	317	319	322	325	328	331	334	336
	75	275	278	281	284	287	290	293	296	299	302	305	308	311	314	317	320	323	325	328	331	334	337
	80	275	278	281	285	288	291	294	297	300	303	306	309	312	314	317	320	323	326	329	331	334	337
	85	276	279	282	285	288	291	294	297	300	303	306	309	312	315	318	321	323	326	329	332	335	337
	90	276	279	282	286	289	292	295	298	301	304	307	310	312	315	318	321	324	327	329	332	335	338
	95	277	280	283	286	289	292	295	298	301	304	307	310	313	316	319	321	324	327	330	333	335	338
	100	277	280	283	287	290	293	296	299	302	305	307	310	313	316	319	322	325	327	330	333	336	338
	105	278	281	284	287	290	293	296	299	302	305	308	311	314	317	319	322	325	328	331	333	336	339
	110	278	282	285	288	291	294	297	300	303	306	308	311	314	317	320	323	325	328	331	334	336	339
	115	279	282	285	288	291	294	297	300	303	306	309	312	315	317	320	323	326	329	331	334	337	340
	120	280	283	286	289	292	295	298	301	304	306	309	312	315	318	321	323	326	329	332	334	337	340
	125	280	283	286	289	292	295	298	301	304	307	310	313	315	318	321	324	327	329	332	335	338	340
	130	281	284	287	290	293	296	299	302	304	307	310	313	316	319	322	324	327	330	333	335	338	341
	135	281	284	287	290	293	296	299	302	305	308	311	314	316	319	322	325	327	330	333	336	338	341
	140	282	285	288	291	294	297	300	303	305	308	311	314	317	320	322	325	328	331	333	336	339	341
	145	283	286	288	291	294	297	300	303	306	309	312	314	317	320	323	326	328	331	334	336	339	342
	150	283	286	289	292	295	298	301	304	306	309	312	315	318	320	323	326	329	331	334	337	340	342
	155	284	287	290	293	295	298	301	304	307	310	313	315	318	321	324	326	329	332	335	337	340	343
	160	284	287	290	293	296	299	302	305	307	310	313	316	319	321	324	327	330	332	335	338	340	343
	165	285	288	291	294	297	299	302	305	308	311	314	316	319	322	325	327	330	333	335	338	341	343
	170	286	289	291	294	297	300	303	306	308	311	314	317	320	322	325	328	330	333	336	338	341	344
	175	286	289	292	295	298	301	303	306	309	312	315	317	320	323	325	328	331	334	336	339	342	344
	180	287	290	293	295	298	301	304	307	310	312	315	318	321	323	326	329	331	334	337	339	342	345
	185	287	290	293	296	299	302	304	307	310	313	316	318	321	324	326	329	332	334	337	340	342	345
	190	288	291	294	297	299	302	305	308	311	313	316	319	321	324	327	330	332	335	338	340	343	345
	195	289	292	294	297	300	303	306	308	311	314	317	319	322	325	327	330	333	335	338	341	343	346
	200	289	292	295	298	301	303	306	309	312	314	317	320	322	325	328	330	333	336	338	341	344	346
	205	290	293	296	298	301	304	307	309	312	315	318	320	323	326	328	331	334	336	339	341	344	347
	210	291	293	296	299	302	305	307	310	313	315	318	321	323	326	329	331	334	337	339	342	344	347
	215	291	294	297	300	302	305	308	311	313	316	319	321	324	327	329	332	334	337	340	342	345	347
	220	292	295	298	300	303	306	308	311	314	316	319	322	324	327	330	332	335	338	340	343	345	348
	225	293	295	298	301	304	306	309	312	314	317	320	322	325	328	330	333	335	338	341	343	346	348
	230	293	296	299	301	304	307	310	312	315	317	320	323	325	328	331	333	336	338	341	344	346	349
	235	294	297	299	302	305	307	310	313	315	318	321	323	326	329	331	334	336	339	341	344	347	349
	240	295	297	300	303	305	308	311	313	316	319	321	324	326	329	332	334	337	339	342	344	347	349



The computer source program used in this work to produce tables 5-19 is presented, and with minor modifications, it can be used to compute viscosities and Reynolds numbers in more complex heat transfer and pressure drop problems. The computer program is written for an IBM 1620-II computer<sup>4/</sup> (40,000 core storage) with the Fortran II

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<sup>4/</sup> Reference to specific models of equipment is made for identification only and does not imply endorsement by the Bureau of Mines.

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programming system. The following definitions are required to locate input data and to modify the source program.

#### Dimension Statement

BN(14), CN(13), DN(7), and EN(8) allocate storage for the constants  $n_1 - n_{42}$  in equations 29-41 used to compute the composition dependency of the second, third, fourth, and fifth virial coefficients which are subsequently used in equations 25-28 to compute the temperature dependency of the virial coefficients.

Numerical values for  $n_1 - n_{42}$  are presented in table 1, and this ordered list of quantities is transmitted and stored for program execution. See READ 5001, list. X(21) provides storage for iterations in the Newton-Raphson DO loop. V(1127) is a 49 by 23 array for storage of 49 pressures, and the remaining elements of this 2-dimensional array are for the storage of computed viscosity coefficients. TEMP(22) allocates storage for 22 temperatures for one page of output. See READ 901, XHE, MINT, INC. XHE, MINT, and INC are the mole fraction of helium, the minimum temperature on a given page of output, and the



C VISCOSITY OF THE HELIUM-NITROGEN SYSTEM FROM 133 TO 740 DEG. K FOR  
 C PRESSURES BETWEEN 1 AND 240 ATMOSPHERES\*\*\*\*\*  
 DIMENSION BN(14),CN(13),DN(7),EN(8),X(21),V(1127),TEMP(22),PP(49)  
 READ 5001,BN,CN,DN,EN,BP,BQ,BR,BU,BS,BT,Y,G,F,H,Q,R  
 READ 5001,PP12,CD12,WTHE,WTN2  
 READ 1001,PP  
 K=0  
 DO 1000 MN=1,1127,23  
 K=K+1  
 1000 V(MN)=PP(K)  
 700 PRINT 900  
 I1=1  
 READ 901,XHE,MINT,INC  
 PRINT 902,XHE  
 INCK=0  
 TEMP(1)=MINT  
 DO 550 I=2,22  
 INCK=INCK+INC  
 TEMP(I)=MINT+INCK  
 550 CONTINUE  
 PRINT 903,TEMP  
 PRINT 904

C DENSE-GAS PARAMETER ALPHA \*\*\*\*\*  
 ALPHA=2.5254571\*XHE\*\*2+2.0\*XHE\*(1.0-XHE)\*24.4447980+58.2659757\*(1.  
 10-XHE)\*\*2 (52)

C THERMAL PRESSURE COEFFICIENT EXPONENT BETA\*\*\*\*\*  
 BETA=1.1160332-0.36651685\*XHE+2.78372553\*XHE\*\*2-5.26596970\*XHE\*\*3+  
 13.602589636\*XHE\*\*4 (53)

C COMPOSITION TERMS OF THE EQUATION OF STATE\*\*\*\*\*  
 201 A=(BN(1))+(BN(2)\*XHE) (29)  
 202 BB=((BN(3))+(BN(4)\*XHE)+(BN(5)\*XHE\*XHE))\*BP (30)  
 203 BC=((BN(6))+(BN(7)\*XHE)+(BN(8)\*XHE\*XHE))\*BQ (31)  
 204 BD=((BN(9))+(BN(10)\*XHE)+(BN(11)\*XHE\*XHE))\*BR (32)  
 205 BE=((BN(12))+(BN(13)\*XHE)+(BN(14)\*XHE\*XHE))\*BU (33)  
 207 CF=(CN(1))+(CN(2)\*XHE) (34)  
 208 CG=((CN(3))+(CN(4)\*XHE)+(CN(5)\*XHE\*XHE)+(CN(6)\*(XHE\*\*3)))\*BP (35)  
 209 CH=((CN(7))+(CN(8)\*XHE)+(CN(9)\*XHE\*XHE)+(CN(10)\*(XHE\*\*3)))\*BQ (36)  
 CI=((CN(11))+(CN(12)\*XHE)+(CN(13)\*XHE\*XHE))\*BT (37)  
 211 DI=((DN(1))+(DN(2)\*XHE)+(DN(3)\*XHE\*XHE)+(DN(4)\*(XHE\*\*3)))\*BQ (38)  
 212 DJ=((DN(5))+(DN(6)\*XHE)+(DN(7)\*XHE\*XHE))\*BS (39)  
 214 EK=((EN(1))+(EN(2)\*XHE)+(EN(3)\*XHE\*XHE)+(EN(4)\*(XHE\*\*3)))\*BS (40)  
 215 EM=((EN(5))+(EN(6)\*XHE)+(EN(7)\*XHE\*XHE)+(EN(8)\*(XHE\*\*3)))\*BT (41)

C TEMPERATURE DEPENDENT TERMS OF THE EQUATION OF STATE\*\*\*\*\*  
 DO 551 I=1,22  
 T=TEMP(I)  
 B=A+BB/T+BC/(T\*\*2)+BD\*T+BE\*T\*\*2 (25)  
 C=CF+CG/T+CH/(T\*\*2)+CI/(T\*\*6) (26)  
 D=DI+DJ/T (27)  
 E=EK+EM/T (28)

C THERMAL PRESSURE TERMS OF THE EQUATION OF STATE \*\*\*\*\*  
 TPB=A-BC/(T\*\*2)+2.0\*BD\*T+3.0\*BE\*(T\*\*2) (43)  
 TPC=CF-CH/(T\*\*2)-5.0\*CI/(T\*\*6) (44)  
 TPD=DI (45)  
 TPE=EK (46)  
 ZCI=1.0  
 V1=4.2605563\*(T)\*\*0.67362904 (8)  
 V2=-8.9188690E-01+7.7622418E-01\*(T)-7.2970066E-04\*(T\*\*2)+4.9473812  
 1E-07\*(T\*\*3)-1.3971248E-10\*(T\*\*4) (10)

IF (XHE-XHE\*\*2) 500,1500,302

302 RT=T/PP12

C LENNARD-JONES (6-12) COLLISION INTEGRAL 1,1 FUNCTION\*\*\*\*\*  
 CI11=+7.6070438E-01-1.0254183E-02\*RT+2.7105188E-04\*(RT\*\*2)-4.67750  
 142E-06\*(RT\*\*3)+4.6185077E-08\*(RT\*\*4)-2.3278934E-10\*(RT\*\*5)+4.51968  
 219E-13\*(RT\*\*6)+5.9761505E-01\*(1.0/RT)+1.9897294E-01\*((1.0/RT)\*\*2)-  
 31.3561679E-01\*((1.0/RT)\*\*3)+2.9639310E-02\*((1.0/RT)\*\*4)-1.9903389E  
 4-03\*((1.0/RT)\*\*5)-8.4408981E-05\*((1.0/RT)\*\*6) (15)



```

C   LENNARD-JONES (6-12) COLLISION INTEGRAL 2,2 FUNCTION*****
    CI22=+8.6881587E-01-1.2672727E-02*RT+3.6256347E-04*(RT**2)-6.57680
    194E-06*(RT**3)+6.7033760E-08*(RT**4)-3.4490075E-10*(RT**5)+6.78461
    222E-13*(RT**6)+4.7185172E-01*(1.0/RT)+5.4259734E-01*((1.0/RT)**2)-
    33.7823299E-01*((1.0/RT)**3)+1.0882350E-01*((1.0/RT)**4)-1.5367909E
    4-02*((1.0/RT)**5)+8.8652554E-04*((1.0/RT)**6)
    ASTAR=CI22/CI11
    V12=26.693*((2.0*WTHE*WTN2*T)/(WTHE+WTN2))**0.5/(CD12**2*CI22)
C   CHAPMAN-ENSKOG EQUATION *****
    XN2=1.0-XHE
    XV=XHE**2/V1+2.0*XHE*XN2/V12+XN2**2/V2
    YV=(3.0/5.0)*ASTAR*((XHE**2*WTHE)/(V1*WTN2)+(2.0*XHE*XN2*V12*(WTHE
    1+WTN2)**2)/(4.0*WTHE*WTN2*V1*V2)+(XN2**2*WTN2)/(V2*WTHE))
    ZV=(3.0/5.0)*ASTAR*((XHE**2*WTHE)/WTN2+2.0*XHE*XN2*(WTHE+WTN2)**2
    1/(4.0*WTHE*WTN2)*(V12/V1+V12/V2)-1.0)+(XN2**2*WTN2)/WTHE)
    VM=(1.0+ZV)/(XV+YV)
1500 I2=0
    I1=I1+1
    DO 551 K=I1,1127,23
    I2=I2+1
    P=PP(I2)
C   NEWTON-RAPHSON LOOP--ITERATION USED TO COMPUTE DENSITIES *****
220 X(1)=ZCI*(R*T)/P
221 DO 227 M=1,20
222 XT=(P*X(M)**5)/(R*T)-X(M)**4-B*X(M)**3-C*X(M)**2-D*X(M)-E
    XTB=(Y*P*X(M)**4)/(R*T)-G*X(M)**3-F*B*X(M)**2-H*C*X(M)-D
    X(M+1)=X(M)-XT/XTB
    ZCC=(X(M+1)*P)/(R*T)
    DELTA=ABSF(ZCC-ZCI)
    ZCI=ZCC
C   CRITERION FOR CONVERGENCE OF THE ITERATIVE PROCESS *****
    IF (DELTA-BU) 87,87,227
227 CONTINUE
    PRINT 4005
    87 DZCC=P/(ZCC*R*T)
C   TP=THERMAL PRESSURE COEFFICIENT*****
    TP=(R*DZCC)*(1.0+DZCC*TPB+(DZCC**2)*TPC+(DZCC**3)*TPD+(DZCC**4)*TP
    1E)
    IF (XHE-XHE**2) 500,401,402
401 IF(XHE) 500,501,502
C   VISCOSITY OF HELIUM *****
502 V(K)=V1+ALPHA*TP**BETA
    GO TO 551
C   VISCOSITY OF NITROGEN *****
501 V(K)=V2+ALPHA*TP**BETA
    GO TO 551
C   VISCOSITY OF MIXTURES *****
402 V(K)=VM+ALPHA*TP**BETA
551 CONTINUE
    IF(I1-23)600,1600,1600
1600 PRINT 905,V
    600 GO TO 700
    500 PRINT 5099
    900 FORMAT (1H1,29X,60HTABLE . - VISCOSITY OF HELIUM-NITROGEN SYSTEM
    1, MICRPOISES)
    901 FORMAT (F7.0,2I3)
    902 FORMAT (1H0,44X,23HMOLE FRACTION OF HELIUM,F7.4)
    903 FORMAT (1H0,9H T, DEG K,22I5)
    904 FORMAT (1H0,119H P, ATM VIS VIS VIS VIS VIS VIS VIS VIS VIS
    1 VIS VIS VIS VIS VIS VIS VIS VIS VIS VIS VIS VIS VIS VIS
    2VIS)
    905 FORMAT (/17,3X,22I5/,5(/(10(I7,3X,22I5/))))
    906 FORMAT (F18.11)
1001 FORMAT (16F5.0)
4005 FORMAT (1H0,15HN-R LOOP FAILED)
5001 FORMAT (F20.0)
5099 FORMAT (1X,15HDATA SET ERROR )
END

```

(15)

(14)

(14)

(14)

(14)

(14)

(42)

(20)

(20)

(20)





temperature increment on a given page of output, respectively. PP(49) allocates storage for 49 pressures, 1., 5., and so forth at intervals of 5. to 240. transmitted to the program in 16F5.0 format.

#### Input Data

The numeric quantities to be transmitted for BN, CN, DN, and EN are those given in table 1,  $n_1 - n_{42}$ . BP, BQ, BR, BU, BS, and BT have the numerical values  $10^2$ ,  $10^4$ ,  $10^{-2}$ ,  $10^{-6}$ ,  $10^6$ , and  $10^8$ , respectively, and these constants are coefficients in equations 29-41. Y, G, F, and H have the numerical values 5.0, 4.0, 3.0, and 2.0 respectively. See the Newton-Raphson DO loop for the use of these numbers. R, PP12, CD12, WTHE, and WTN2 are the gas constant, energy well parameter  $\epsilon_{12}/k$ , collision diameter  $\sigma_{12}$ , molecular weight of helium, and the molecular weight of nitrogen. Numerical values used in the program are  $82.0597 \text{ cm}^3 \text{ atm/g mole } ^\circ\text{K}$ ,  $36.18^\circ \text{ K}$ ,  $3.1198 \text{ \AA}$ , 4.0026, and 28.0134, respectively, for the variables named in the READ list.

All other quantities are computed in the program. Equation numbers in the report associative with Fortran arithmetic statements have been typed on the right-hand side of the source program listing to aid the reader relevant to the coding. Program names and symbols used in the report for physical properties have the following equivalency:  $ZCC = Z$ ,  $DZCC = \rho$ , and  $TP = (\partial P / \partial T)_V$ .

Some prudence must be applied in computing compressibility factors in the Newton-Raphson DO loop if extensive changes are made in the present program. It is obligatory that the iterative solution for



compressibility factors on a given isotherm be started at a pressure where the compressibility factor for the real gas is not too far removed from 1.0, such as 1.0 atmosphere, and then moved through successive increments of pressure; otherwise, the Newton-Raphson method will converge slowly or not at all. If the Newton-Raphson method fails to converge, an error message is printed in the present program.

### DISCUSSION

The small deviations between experimental and computed viscosities clearly show that the correlation equations presented have led to an acceptable interpolation method. The suitability of the model to predict viscosities in areas not covered by experimental data is not so self-evident. The chief difference between interpolation and extrapolation lies in the reliability of the result. The low-density viscosity values computed for helium-nitrogen mixtures below 183.15° K are outside the range of experimental data. Unfortunately, the calculation of any gas transport property must be based on an assumed analytical form for the intermolecular potential because the correct functional form of the potential energy of interaction has eluded science.

Potential functions have been derived and classified in terms of families. Hanley and Childs (24) postulate that members of different potential families can be interchanged without materially altering the fit of experimental data, one can only make a significant selection of a function and its parameters from experimental viscosity



data outside the reduced temperature range of about  $2 < T^* < 5$ , and any function will fit data in this reduced temperature range. Thus, from Hanley and Childs' postulates it is evident that low-temperature viscosity data in the above region of reduced temperatures cannot contribute to the selection of a potential model or the evaluation of its force constants.

The Lennard-Jones (6:12) potential function chosen in this report to represent the low-density viscosity behavior of helium-nitrogen mixtures indicates that  $\epsilon_{12}/k$  is about  $36.18^\circ \text{K}$ . This value for  $\epsilon_{12}/k$  was obtained from experimental mixture data in the temperature region  $183.15^\circ$  to  $952.55^\circ \text{K}$ . Therefore, assuming the L-J (6:12) potential is satisfactory for representing the viscosity behavior of low-density helium-nitrogen mixtures, experimental viscosity data in the temperature region  $72^\circ$  to  $181^\circ \text{K}$  could not contribute to either the selection of this potential or the evaluation of its force constants.

Hanley and Childs (24) also provide, from their studies on the transport properties of argon, the corollary that only one member of a potential family can fit viscosity data outside the insensitive reduced temperature range,  $2 < T^* < 5$ , and the given function will automatically fit data within this range.

The most optimistic surmise would be that the L-J (6:12) potential is the correct potential for the helium-nitrogen system and that low-density viscosity values can be safely predicted from a sensitive reduced temperature range over the entire insensitive range. We do not take this viewpoint. A perfect fit of any potential model to experimental data is obviously unrealistic, and Hanley and



Childs' corollary suffers from a lack of clarity due to effects of experimental uncertainties. The L-J (6:12) potential was chosen as only one of many possible potentials, and it is quite evident that a perfect fit of the experimental data was not obtained. Therefore, the model chosen may not necessarily be the unique potential model of Hanley and Childs' corollary, only one potential model to fit the data, and the uncertainty in extrapolated values can be expected to be higher than in regions covered by experimental data. However, the temperature range subject to extrapolation is not great and using a potential model rather than some other empirical method undoubtedly increases the probability as to the correctness of the results.

Very few investigators evaluate or estimate the error in their viscosity measurement; they usually report only the precision (reproducibility) of their measurements. Discrepancies in the reported viscosity data of various investigators indicate that uncertainties in viscosity values are from 2 to 5 times, and more, than that of the estimated precision of measurements. Also, the accuracy of the computed viscosities is not necessarily a function of source data with which comparisons were made. Uncertainty in experimental data may not be due solely to random error but may result from unknown systematic errors.

Considering the experimental data used as a basis for the correlation equations and the hazards of extrapolations, we estimate that uncertainties in the computed viscosities are:  $\pm 5$  percent for the region  $325^{\circ}$  to  $740^{\circ}$  K,  $\pm 2$  percent for the region  $183^{\circ}$  to  $325^{\circ}$  K, and  $\pm 5$  percent at temperatures below  $183^{\circ}$  K. The latter uncertainty





may rise to  $\pm 10$  percent as critical conditions are approached.

An interesting phenomenon of the helium-nitrogen system is that the low-density viscosity at constant temperature of a particular mixture may be higher than that of either of the pure components. This is shown in figure 3. The viscosity of the compressed gas at a given temperature of a particular mixture may be higher than that of either pure component, as can be seen in figure 13. An explanation of this phenomenon for the helium-nitrogen system has not been found.

The transport properties of helium-nitrogen mixtures are of great importance in the design of heat exchangers for helium purification processes. Data at low temperatures and high pressures are lacking. We hope that workers in this area of research will soon provide more experimental data.

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