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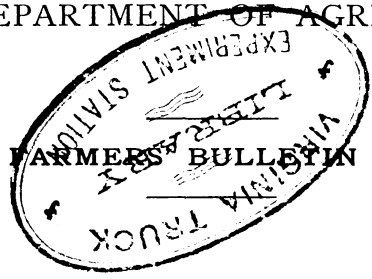

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SOME COMMON DISINFECTANTS.

BY

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U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., December 2, 1908.

SIR: I have the honor to transmit herewith the manuscript of an article entitled "Some Common Disinfectants," and to recommend the publication of the same as a Farmers' Bulletin.

Very respectfully,

A. D. MELVIN,
Chief of the Bureau of Animal Industry.

Hon. JAMES WILSON,
Secretary of Agriculture.

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SOME COMMON DISINFECTANTS.

INTRODUCTION.

There is much popular misconception as to the value and limitations of the various disinfectants which are sold in this country. For this reason the following very brief description of some of the more common of them has been prepared. Full and complete descriptions of these substances may be found in the very excellent treatises of Rosenau,[a] Rideal,[b] and others.

FORMALDEHYDE.

Formaldehyde—formic aldehyde—is available on the market as paraform (a sort of condensed formaldehyde, which is sold as a white powder or in the form of pastils) and also in aqueous solution generally known under the name of formalin. The solution is supposed to contain 40 per cent of formaldehyde, though in reality the amount of formaldehyde present rarely exceeds 37 to 38 per cent. Formaldehyde may be used for disinfection in either a liquid or gaseous form.

LIQUID FORMALDEHYDE.

Solutions of formaldehyde are best prepared by making a 5 per cent solution of formalin in water. This is applied directly to substances that require disinfection, and in the case of refuse, excreta, and similar substances should be thoroughly mixed with them. A 5 per cent solution of formalin is generally regarded as superior to carbolic acid of the same strength as a general disinfectant.

GASEOUS FORMALDEHYDE.

In disinfecting with formaldehyde gas it is essential that the compartments to be disinfected be tightly closed so that a sufficient concentration of the gas may be held in contact with the infected substances a sufficient length of time. The temperature of the air is an

[a] Disinfection and Disinfectants. Philadelphia, 1902.
[b] Disinfection and the Preservation of Food. New York, 1903.

important factor in securing efficient action, the formaldehyde being much more energetic in a warm atmosphere than in a cold. The best authorities state that gaseous formaldehyde disinfection should not be attempted if the temperature of the air is below 50° F. The gas is most conveniently secured by liberating it from the concentrated aqueous 40 per cent solution or from the solid paraform. A number of methods for accomplishing this in practice have been devised, the more important of these being as follows:

PRODUCTION OF THE GAS FROM FORMALIN.

Heating under pressure.—Portable autoclaves specially designed for the purpose are charged with a sufficient amount of formalin, the quantity depending upon the cubic air space to be disinfected. The autoclave is closed and heat is applied until the required pressure within the autoclave is attained. The gas which has been liberated from the solution by the heat is allowed to flow through an outlet tube into the closed chamber which is to be disinfected. The room is then kept closed for from two to twelve hours; the shorter time if only smooth surfaces are to be acted upon; the longer if penetration into fabrics is desired. Ten ounces of formalin should be used for each 1,000 cubic feet of air space.

Heating without pressure.—This method is similar to that just described. Formalin is placed in a specially designed retort and heated with a lamp. The gas is conducted into the compartment to be disinfected by means of a small tube which passes through the keyhole, or other small aperture. Ten ounces of formalin is required for each 1,000 cubic feet of space. The evolution of gas by this method is less rapid than when generated under pressure and a longer time is required for disinfection. The compartment should remain closed for at least six hours, and for twelve hours if penetration into the interior of fabrics, hay, etc., is required.

Spraying.—In this method the formalin is sprayed upon the surface of objects which require disinfection or upon sheets which are hung up in the compartment containing the infected materials. The gas is liberated by simple evaporation, this liberation being favored by the wide surface which is exposed. The gas is liberated much more slowly by this method than by either of those already described, and the diffusion is also relatively much slower. For these reasons the compartment to be disinfected should not be very large, and should remain closed for at least twenty-four hours. Not less than 10 ounces of formalin should be used for each 1,000 cubic feet of space.

Liberation of the gas by chemical means.—Several methods of liberating formaldehyde from formalin solutions without the use of arti-

ficial heat have been proposed in recent years. The most important of these is known as the " permanganate method." Formalin is poured upon crystallized or powdered potassium permanganate. A violent chemical reaction takes place immediately, heat is generated, and a rapid liberation of formaldehyde gas takes place. As will be understood, the heat is caused by the reaction between the formaldehyde in solution and the permanganate, a large portion of the formaldehyde being consumed by the reaction. The amount of gas evolved depends in great measure upon the relative weights of permanganate and formalin employed. Experiments have shown that when the formalin and permanganate are mixed in the proportion of 6 parts of formalin to 5 parts of chemically pure permanganate, by weight, 50 per cent of the formaldehyde employed is liberated in the form of gas. If 10 ounces of formalin are required for disinfection of 1,000 cubic feet of space by the first three methods described, twice that amount is necessary when the permanganate method is employed, as half of the formaldehyde is destroyed by the reaction. For disinfecting 1,000 cubic feet, therefore, use 20 ounces of formalin and 16⅔ ounces of permanganate. The needle-shaped crystals of potassium permanganate should be employed. Place the required amount of permanganate in a wide-bottomed vessel (an ordinary dish pan is excellent) and pour the formalin on quickly, then close the compartment for from six to twelve hours, depending upon the character of the materials to be disinfected.

PRODUCTION OF THE GAS FROM PARAFORM AND FROM WOOD ALCOHOL.

Heating paraform.—Lamps provided with a pan for holding the paraform are obtainable on the market. The paraform is placed in the pan and heat applied by means of an alcohol lamp. The evolution of gas in this manner is slow. Two ounces of paraform is required for the disinfection of 1,000 cubic feet of space, and the compartment should remain closed for at least twelve hours. This method is best suited to the disinfection of small spaces.

Generation of formaldehyde from wood alcohol.—Formaldehyde is readily produced by the oxidation of wood alcohol (methyl alcohol). This fact has been taken advantage of for use in practical disinfection. Lamps have been designed by means of which the vapor of wood alcohol is passed over hot, finely divided platinum. This causes the oxidation of the alcohol to formaldehyde, which is given off in the room to be disinfected. There is somewhat more danger from fire when this method is employed than in those previously described. Not less than 25 ounces of wood alcohol should be employed for disinfecting 1,000 cubic feet of space.

ADVANTAGES AND DISADVANTAGES OF FORMALDEHYDE.

The advantages may be summarized as follows:

(1) It is one of the most powerful germicides known.

(2) Its action is not interfered with by albuminous substances.

(3) It is not poisonous and may therefore be used for disinfecting hay and grain without destroying these for food purposes.

(4) It is not injurious to delicate fabrics, paint, or metals. (Formalin solutions will attack iron, but not other metals.)

The disadvantages are, briefly, as below:

(1) The gas has a strong tendency to condense in cold weather and is not reliable as a disinfectant when the air temperature is below 50° F.

(2) It is necessary to seal tightly all compartments which are to be disinfected with the gas in order that penetration may be secured and that the required concentration may be maintained for a sufficient length of time.

CARBOLIC ACID (PHENOL).

Pure carbolic acid is solid at ordinary temperatures and crystallizes in long white needles. It may be purchased in this form or as liquefied carbolic acid (Phenol liquefactum, U. S. P.). The latter form is prepared by adding 1 part of water to 9 parts of the crystals and is employed by pharmacists on account of convenience in dispensing. Carbolic acid must not be confused with "crude carbolic acid" and "liquid carbolic acid," which are described below.

For disinfecting purposes carbolic acid is generally used in watery solution, though powders containing it are sold. A 5 per cent solution of crystallized carbolic acid in water is recommended for general use, for, although weaker solutions have been found efficient for destroying many nonspore-bearing bacteria, the conditions found in practice vary widely and in some cases hinder the action of the disinfectant. As carbolic acid dissolves slowly, the 5 per cent solution should be prepared with warm water, using care to see that all is dissolved before use. For disinfecting large surfaces a spray may be used and the disinfectant should be applied liberally. Garments or implements to be disinfected should remain in the 5 per cent solution for at least one hour.

ADVANTAGES AND DISADVANTAGES OF CARBOLIC ACID.

The advantages are:

(1) It is reasonably effective for destroying nonspore-bearing bacteria.

(2) Its action is only slightly interfered with by albuminous substances.

(3) It does not destroy metals or fabrics in a 5 per cent solution.

(4) It is readily available at all pharmacies.

The following disadvantages may be mentioned:

(1) It can not be depended upon to destroy the spores of such bacteria as anthrax and malignant edema.

(2) It is expensive (the pure phenol costs approximately 75 cents per pound).

CRUDE CARBOLIC ACID.

Probably no substance is so widely used in this country as a household and farm disinfectant as crude carbolic acid, and at the same time there is probably no disinfectant that is so uncertain in its effect if used without a proper understanding of its nature. The commercial crude carbolic acid is one of the products of coal-tar distillation, and consists essentially of a mixture of coal-tar oils and so-called "cresylic acid" with little or no phenol. The oils are practically inert as disinfectants, but the cresylic acid, which is a mixture of cresols and similar homologues of carbolic acid, has very marked disinfecting power.

As crude carbolic acid depends almost exclusively upon the cresylic acid which it contains for its disinfecting power, it should not be employed unless the cresylic acid content is definitely known. Even then it must be regarded as of doubtful efficiency if the percentage of hydrocarbon oils is relatively very large, for the oil will prevent to a great extent the solution of the cresylic acid in water when this is mixed with the crude carbolic acid for use as a disinfectant. As is stated in the paragraph dealing with cresol, the cresylic acid is used in 2 per cent solution in water as a disinfectant. When crude carbolic acid is employed, the amount of "acid" which it contains should be known and the disinfecting solution should be made of such strength that it will contain 2 per cent of cresylic acid. This disinfecting solution or mixture is best applied by means of a spray pump, and while spraying the mixture should be well agitated in order that the oils containing undissolved cresols may be evenly distributed over the surface to be disinfected.

There are found on the market products which are sold as "liquid carbolic acid," "straw-colored carbolic acid," etc.; these, as a rule, contain from 90 to 98 per cent of cresylic acid and very little coal-tar oil. They are considered in the next section dealing with cresols.

CRESOL.

Cresol (tricresol, straw-colored carbolic acid, liquid carbolic acid) is derived from coal tar and is found in the trade in varying degrees of purity. The cresol of the United States Pharmacopœia is a colorless

liquid, having a strong odor resembling that of carbolic acid. It consists of a mixture of three closely related bodies, all of which are superior to carbolic acid as disinfectants. The other grades of cresols usually contain a small percentage of impurities, and are sold as "liquid carbolic acid, 95 per cent," "straw-colored carbolic acid," etc. These usually contain from 90 to 98 per cent of cresol, and may be purchased under a guaranty to contain certain definite amounts of cresylic acid. Grades containing less than 90 per cent of cresylic acid are not so desirable as those of a higher degree of purity, as the coal-tar oils which are usually found in such products interfere with the solution of the cresols in water, as already stated.

The commercial cresols guaranteed to contain more than 90 per cent of cresylic acid are relatively cheap and well suited to the disinfection of cars, barns, and yards. For general disinfection a 1½ to 2 per cent solution of cresol in water should be used, allowance being made for the impurities when the cheaper grades are employed. Cresol is not easily soluble in water; therefore, in preparing solutions warm water should be used and care taken to see that all is dissolved before applying the solution. A 2 per cent solution of cresol is regarded as being a more efficient disinfectant than a 5 per cent solution of carbolic acid and should be applied in the same way.

ADVANTAGES AND DISADVANTAGES OF CRESOL.

Briefly, the advantages are:

(1) A 2 per cent solution of cresol is as efficient as a 5 per cent solution of carbolic acid.

(2) It is not interfered with by albuminous substances.

(3) It is cheaper than carbolic acid.

(4) It does not destroy metals or fabrics in a 2 per cent solution.

(5) It is more effective than carbolic acid for destroying spores of bacteria, such as anthrax.

The main drawback to the use of cresol is that it is not readily soluble in water, hence may be used in too weak solution unless great care is taken in the preparation of the solution.

COMPOUND SOLUTION OF CRESOL.

This preparation, known as liquor cresolis compositus, United States Pharmacopœia, is recognized as official by the last edition of the United States Pharmacopœia, and is a mixture of equal parts of cresol (U. S. P.) with a linseed-oil-potash soap. The mixture is a thick, dark, amber-colored fluid which mixes readily with water in all proportions to form a clear soapy solution. A very efficient disinfectant may be made from the commercial cresols or liquid car-

bolic acids of known strength by mixing these with the soap described in the United States Pharmacopœia under the heading "Liquor cresolis compositus." When other than United States Pharmacopœia cresol is used a sufficient excess must be added to insure 50 per cent of actual cresylic acid in the mixture. Compound solution of cresol is recommended for use as a general disinfectant in a 3 to 4 per cent solution in water. In this strength it will accomplish the same results as a 1½ to 2 per cent solution of cresol and may be applied in the same manner as a 5 per cent solution of carbolic acid.

It may be said in favor of the compound solution of cresol that it possesses all the advantages of cresol, and in addition is far more readily soluble. It is, however, somewhat more expensive than cresol, owing to a stronger solution being required; this is in great measure compensated for by its ready solubility.

CHLORINATED LIME (CHLORID OF LIME).

This substance is prepared by exposing slaked lime to the action of chlorin gas. It is a white powder which gives off a disagreeable odor of chlorin, and decomposes rapidly upon exposure to air. It can not be depended upon unless kept in hermetically sealed containers. It is prepared for use in the general disinfection of cars, pens, or refuse by mixing 6 ounces with a gallon of water. This is applied liberally, and infectious excreta must be mixed thoroughly with the solution to insure disinfection. Chlorinated lime is a powerful deodorant and is valuable for use in foul-smelling cesspools and similar places.

As a disinfectant, chlorinated lime possesses no advantages over formaldehyde, carbolic acid, cresol, etc. It has, moreover, certain disadvantages, chief among which are uncertainty of strength and destructiveness to metals and fabrics.

BICHLORID OF MERCURY.

This is a white crystalline substance which is also known as mercuric chlorid and corrosive sublimate. It is usually prepared for use in the form of tablets with ammonium chlorid, which facilitates the solution of the bichlorid in water. The bichlorid is used in solution in water in a strength of 1 to 1,000, though solutions 1 to 500 may be employed with correspondingly quicker action on nonspore-bearing bacteria and much more effective action on the spores of bacteria. Bichlorid of mercury is a violent poison, and has the property of combining with albuminoids to form inert compounds. These facts necessarily limit its usefulness as a general disinfectant. It should

never be used to disinfect excreta, or substances containing blood or serous fluids. Bichlorid solutions should not be kept in lead or tin vessels, or poured through lead pipes, as the mercury combines with these metals and injures them, besides affecting the germicidal efficiency of the solution itself.

The chief advantage in the use of bichlorid of mercury lies in its great germicidal power when employed under proper conditions. The disadvantages are its poisonous nature, its tendency to attack certain metals, and the interference by albuminoids and other organic substances.

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