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United States
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Science and
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Grain Dust Abstracts

Bibliographies and
Literature of
Agriculture Number 12

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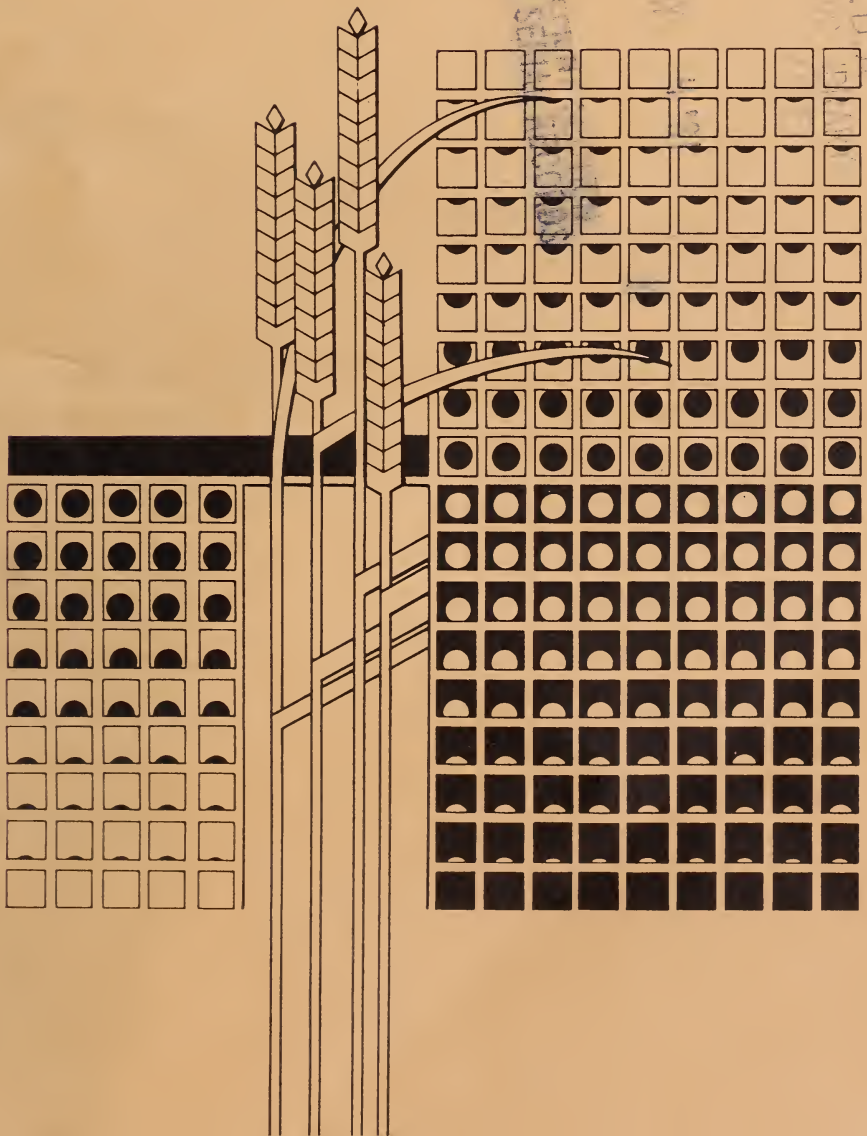

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United States Department of Agriculture

Science and Education Administration

Bibliographies and Literature of Agriculture Number 12

Grain Dust Abstracts

Compiled by Fang S. Lai

Acknowledgments

The author is grateful to Yeshajahu Pomeranz, Director of the U.S. Grain Marketing Research Laboratory, for his suggestions and advice and for providing some of the abstracts, mainly in German. The author also wishes to thank the reference branch of the Technical Information Systems for their assistance.

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Issued April 1981

Grain Dust Abstracts

Introduction

Concern over the recent disasters in personal injuries and fatalities and the accompanying property and monetary losses suffered in grain industry dust explosions prompted the grain industry, as well as the U.S. Government, to find means to prevent, or at least to minimize, the hazards of dust explosions. For that reason, a significant commitment in time and effort has been made by the U.S. Grain Marketing Research Laboratory to tackle the problems encountered in handling grain dust, to explore new methods and approaches for controlling and handling grain dust and its use, and to disseminate knowledge concerning the causes and prevention of grain dust explosions.

This bibliography gathers and makes available to the scientific and technological community and to the grain trade and industry a single, comprehensive, and authoritative source of information of all the published information on an annual basis. This first issue covers literature sources published in 1979. Sources published before that were not covered in the Review of Literature Related to Engineering Aspects of Grain Dust Explosions (Aldis and Lai 1979, U.S. Department of Agriculture Miscellaneous Publication No. 1375).

Subsequent publications will be on an annual basis. The subjects cover handling, control, and use of grain dust. Sources are the National Technical Information Service (NTIS), U.S. Department of Commerce; Commonwealth Agricultural Bureaux Abstracts (CAB ABS); Engineering Index, Inc. (COMPENDEX); Technical Information Systems (AGRICOLA), U.S. Department of Agriculture; Institute for Scientific Information (SCISEARCH); and IGV-Schnellinformationen.

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[1] Research chemical engineer, Engineering Research Unit, U.S. Grain Marketing Research Laboratory, Science and Education Administration-Agricultural Research, U.S. Department of Agriculture, 1515 College Ave., Manhattan, Kans. 66502.

General Information

1. Dust explosions in agricultural hot-air drying equipment
   BECK, G.
   1975. 7 p.
   Translated by R. G. Mansfield from air-drying equipment.
   Agrartechnik 25(3):139-141 1975.

Two dust explosions of moderate-to-great severity, which occurred in the M804 dryer, prompted a discussion of such explosions and, with these as a starting point, a consideration of the general problems of protection in dust explosions in this dryer. The M804 dryer is a manually controlled dryer used in drying green fodder and chopped or sliced root and tuber crops. [In German]

2. Dust explosions in grain handling facilities
   CHRISTENSEN, C. M.
   Dept. Plant Pathology, Univ. Minnesota, St. Paul
   Feedstuffs (Minneapolis) 50(13):57-58 1978.

After four explosions in U.S. grain elevators within a week in December 1977, the history, causes, and possible methods of preventing such explosions in grain-handling plants are reviewed, based principally on information contained in a standard work published by the U.S. National Fire Protection Association in 1922. Apart from eliminating all possible sources of ignition, and the use of flameproof motors, the most practical method of guarding against explosions is to remove all accumulations of dust and to maintain a high standard of cleanliness in the plant.

3. Recognition and control of dust explosion conditions
   COCKS, RICHARD E.
   Proctor and Gamble Co., Cincinnati, Ohio
   TAPPI Eng. Conf. Proc., San Francisco, Calif., Sept. 19-31, 1978. Publ. by TAPPI, Atlanta, Ga., Book 1, p. 23-26. 1978.

The seriousness of dust explosions is considered along with a review of the mechanism of a dust explosion, the conditions that cause explosions, and ways to control them.

4. Les poussieres explosibles. [Explosive dust particles]
   GILTAIRE, M.; DANGREAUX, J.
   Cent d'Etud et Rech des Charbon de Fr
   Ann. Mines 184(1-2):85-96 Jan.-Feb. 1978.

Different aspects of combating dust explosions are discussed. After describing the mechanism of dust explosions, the authors establish a principle for determining the explosive characteristics

of various types of dust and their order of magnitude. Broad guidelines are given for preventive measures that can be taken and protective devices that can be installed to limit the effects of explosions. These include explosion-controlling systems as well as air- and dust-particle vents. [In French]

5. Les recherches de la C.E.C.A. et la lutte contre les poussieres dans les mines et la siderurgie. [European Core on Steel Community (ECSC) research work and fight against dust in mines and the steel industry]
LEMOINE, PIERRE
Comm des Communautes Eur
Ann. Mines 184(1-2):147-156 Jan.-Feb. 1978.

The author outlines the European coal and steel community's research programs aimed at safety in mines and the steel industry, and then concentrates on that part of these programs that deals with dust problems in the two industries. In mines, research work has focused chiefly on dust control during and after coal-getting, dust measurement and analysis, epidemiology of pneumoconiosis, and combating dust explosions. Within the steel industry, research work has been aimed at controlling the red smoke dust from steel converters and dust emitted by coking plants during various production stages. [In French]

6. Grain dust explosions—an unsolved problem
General Accounting Office, Health Resources Div., Washington, D.C.
Rept. to the Congress
Mar. 21, 1979 97 p.

Since 1975, deaths and injuries from grain dust explosions have increased, and several Congressmen asked GAO to examine a number of factors regarding such explosions. Specific causes of most of the explosions are not known. The Department of Labor's Occupational Safety and Health Administration did not determine the causes of explosions it investigated, and GAO concluded that it should make a greater effort to do so. This report shows that compliance with existing safety standards may not be enough to prevent explosions. Adequacy of the Labor Department's standards and the numerous proposals for reducing grain dust explosions need a thorough evaluation. This report discusses the grain-dust explosion disasters of December 1977 and January 1978 and potential ways to prevent similar disasters.

Detection and Control

7. Ignitions in mixtures of coal dust, air, and methane from abrasive impacts of hard minerals with pneumatic pipeline steel. Bureau of Mines, Albany, Oreg. Albany Metallurgy Research Center Rept. of invest. 1976
   KELLEY, JOHN E.; FORKNER, BOB L.
   BuMines Rept. No. RI-8201 1976 25 p.

Laboratory equipment that simulated abrasive impacts between steel and minerals as might occur during pneumatic transport of coal was used by the Bureau of Mines to characterize the potential explosion hazard caused by such collisions in an atmosphere of fine coal dust-air-methane. A variety of coal mine rock materials, including sandstone, limestone, and pyrite-bearing limestone, was impacted with specimens of pipeline steel. Tests were conducted in atmospheres containing 0 to 6.4 volume-percent methane mixed with 0 to 300 mg/L coal dust. Coal dust-air alone was not ignited by abrasive impacts, but additions of as little as 1 volume-percent methane to coal dust-air resulted in ignitions. Steel impacting against sandstone caused ignitions in coal-air-methane mixtures with the probability for ignitions increasing with an increase in methane. Ignitions in coal-air-methane were found to be caused by a hot friction-induced smear on the impacted rock at the impact site rather than by sparks. High-speed photography was used to verify this observation.

8. Evaluation of violet smoke initiation under dynamic conditions in the jet airmix blender.
   General Electric Co., Bay Saint Louis, Miss., Engineering and Science Services Lab.
   Technical memo Feb.-June 1976
   McINTYRE, FRED L.
   Rept. No. EA-5161 Nov. 1976 14 p.

Empirical safety data were generated from a single initiation of 1,000 lb (454 kg) of Violet Smoke Mix IV, drawing number B143-1, during dynamic mixing conditions in a simulated Jet Airmix blender. This test was performed to determine whether mass detonation or a dust explosion would occur if violet smoke was ignited thermally during the height of maximum pneumatic dispersion. The data obtained under these "worst-case" conditions indicate that minimal risks or hazards may be attached to the charging, blending, and discharing of the airmix process during the production of up to 1,000 lb (454 kg) of Violet Smoke Mix IV per drawing number B-143-5-1, provided that appropriate fire control measures are used.

9. Development of a centralized early warning detection system identifying explosive conditions in grain handling facilities
Iowa State Univ, Ames. Energy and Mineral Resources Research Institute
Department of Energy.
BLUHM, D. D.
1977. 25 p.
Rept. No. CONF-771086-1
Int. Symp. on Grain Dust Explosions, Kansas City, Mo. Oct. 4, 1977.

Preliminary studies are reported on the feasibility of early warning detection of explosive conditions, and problem areas are defined that need additional study. An integrated minicomputer-controlled detection system can monitor continuously the states of the three conditions for combustion (combustible material, oxygen, and an ignition source) and then provide the proper response or warning. To be of practical value, however, such a system should be adaptable for installation in existing as well as in new facilities and must be highly reliable and economically attractive. Also discussed are initial work on detecting aerosol or gas emissions from grain dust at temperatures well below the ignition temperature and work on photoelectric detectors to provide early warning of dust concentrations exceeding the lower explosive limit. A brief overview is given about state-of-the-art computerized monitoring systems. Eight different types of detectors are discussed, including ionization, combustible gas, and dust concentration detectors, and the processing units that monitor the outputs of these detectors. Preliminary cost estimates indicate the centralized early warning system would cost approximately 3 to 5 percent of the total facility cost.

10. Minimize grain residues
GENGSTON, M.
Dept. of Primary Industries, Entomology Branch, Queensland, Australia
Queens. Agric. J. 103(1):9-11 1977.

Surveys show that residues of grain, grain dust, and straw in grain-handling machinery frequently contain insects and are an important source of infestation of newly harvested grain. Based on investigations by the Australian Grain Infestation Liaison Committee, about 50 recommendations are made for the design and construction of machinery and equipment for handling grain and grain products so that no grain or residue will remain lodged in any part of the machinery after use, and the time and effort required for cleaning may be kept to a minimum.

11. Thermal decomposition of grain dust: an early warning for incipient fire or explosion
GIBSON, E. D.; MORRIS, V.; CHIOTTI, P.
Iowa State Univ., Ames
Trans. Am. Soc. Agric. Eng. (Gen. Ed.) 20(2):380-385 Mar.-Apr. 1977 7 refs.

Tests were conducted to evaluate the response of ionization-type detectors and combustible gas detectors to invisible aerosols and gases evolved from heated grain dust at temperatures below the ignition temperature. The concentration of aerosol particles was determined as a function of temperature and dust layer thickness. The report discusses potential application of such detectors in an early warning system to detect hot spots approaching dust ignition temperatures in a grain elevator or feed mill environment.

12. Investigation of methods for detection and control of pyrotechnic dust fires and explosions.
General Electric Co., Bay Saint Louis, Miss. Engineering and Science Services Lab.
Contractor Rept. Nov. 1975-Nov. 1976.
NESTLE, W. R.; McKOWN, G. L.; BELMONTE, R. B.
June 1977 37 p.

The characteristics of sulfur-dust fires and a method of control based on UV detection and high-pressure suppression were investigated. Sulfur/air dispersions were found to be subject to low-order detonations, accompanied by relatively slow-moving flame fronts. A high-pressure quench system, with a burst diaphragm triggered from an ultraviolet sensor, was found to control these reactions satisfactorily. Water was found to be less efficient as a suppressant than halogenated hydrocarbons.

13. Design of explosion protection for dust control equipment
GIBSON, N.
ICI Ltd.
Dust Control Symp., Manchester, England, Mar. 21-22, 1978. Sponsored by Inst. of Chem. Eng. (London) 1978 p. 12 14 refs.

Containment plays a major role in efficient dust control. Many combustible powders form flammable dust clouds, and ignition of these clouds in a confined volume can lead to pressure development and a dust explosion. The flammability and explosibility characteristics of dust clouds that determine the violence of the explosion are described. The principles of protection against dust explosions (containment, inert atmospheres, suppression, and venting) are given, and the design features required to permit the application of these principles to dust-control equipment are defined.

14. Baghouses: separating and collecting industrial dusts
KRAUS, MILTON N.
Chem. Eng. (New York) 86(8):94-106 Apr. 9, 1979.

Dusts from industrial-gas streams often may be separated by using filters made of natural or synthetic fibers. These filter elements are bag shaped and placed in structural enclosures called baghouses. Baghouses control dust whenever dust-laden air must be discharged to the atmosphere or to recover valuable dust from a process-venting system. Sizes may range from small bin-venting filters to large multicompartment filters that receive dust from an extensive system of exhaust ducts. Filtering and collecting dust is an art. Sizing and selecting dust filters are based on (a) past experience and (b) actual tests that use specific fabrics at specific dust-to-air loadings. Because of the many types of collectors and filter fabrics, combined with numerous material properties that affect filtration, a filter should be selected by actual testing at the design load, using the least costly fabric for the requirements. Recommendations for practice are included, with emphasis on protection against explosions.

Explosibility Tests

15. Etudes des proprietes de detonation des explosifs en enveloppe. [Investigations of the detonating properties of sheathed explosives]
FOJT, L.; KIRSCHNER, J.; NEMETH, L.
Hung. Min. Res. Inst. Publ. No. 19
Budapest 1977 p. 121-125.

This article reports on measuring tests conducted for investigating the detonating properties of sheathed explosives and, especially, for evaluating the role played by the sheath. The optimal diameter and thickness of sheaths to be used in boreholds drilled underground are determined, and the contributions of the sheath in transferring shock waves are indicated. Then the ionizing effect of the shock waves on propagating the detonation of thin charges is studied. The achieved results are useful for developing flameproof and coal-dust, explosion-proof explosives of increased safety. The report describes a device developed during the research work. This device contains low-impedance evaluating elements, works on new principles, and is suitable to measure the velocity of detonation. [In French]

16. On the aftergases of coal dust explosions generated in an experimental chamber
ISHIHAMA, WATARU; ENOMOTO, HEIJI; YAMAO, SHIN-ICHIRO
J. Min. Metall. Inst. Jpn. 93(1073):483-488 July 1977 9 refs.

Characteristics of aftergases for three high-volatile, bituminous coals were investigated using a closed-type experimental apparatus. The aftergas was analyzed chemically for H_2, CO, CH_4, and other hydrocarbons; tars were not analyzed. The data show that these gases have peak concentrations near the optimum dust concentration at which the explosion pressure is highest. Among these gases, CO is the most concentrated with a maximum value of about 8 percent; the concentration of hydrocarbons, except CH_4, is less than 1 percent. A computer calculation confirmed that air-aftergas mixtures were highly explosive. [In Japanese with English abstract]

17. Dust/debris test conducted at Fort Sill, Okla., by Dugway Proving Ground Vol. 1
U.S. Army Dugway Proving Ground, Utah
Final Rept. May-Sept. 1978
Sept. 1978 271 p.

This test program was conducted to characterize battlefield dust/debris at Fort Sill, Okla., during May 1978. Twenty trials were conducted involving 155- and 105-mm artillery shells, and four trials were conducted involving vehicular movement. Data were collected using Dugway Proving Ground's electro-optical instrumentation, particle-size analyzer, dust samplers, and photographic methods along a single instrumented line of sight. The required visual-, near-, mid-, far-IR transmittance data and dust-sampler data were collected. Estimates of extinction coefficients are provided for Fort Sill dust.

18. Testing and assessment of materials liable to dust explosion or fire
BURGOYNE, JOHN H.
Chem. Ind. (London) No. 3 Feb. 4, 1978 p. 81-84, 85-87 26 refs.

In principle, any combustible solid, in a sufficiently and finely divided condition, may give rise to a dust explosion hazard. United Kingdom law requires the recognition of industrial dusts, "liable to explode on ignition," and imposes certain precautionary conditions on their handling in places of employment. To assist with such recognition, explosibility tests were agreed on some years ago between the Fire Research Station and HM Factor Inspectorate. This paper discusses the subject in the following parts: statutory

requirements connected with the handling and processing of dusts liable to explode on ignition, measuring dust-explosion parameters, and overall hazard rating (figures are given for some powdered food products).

19. Exploratory study of M-1 propellant dust explosibility
Southwest Research Inst., San Antonio, Tex. U.S. Army Armament Research and Development Command, Dover, N. J. Large Caliber Weapon Systems Lab., Shared Bibliographic Input Experiment.
GEHRING, J. WILLIAM; FRIESENHAHN, GERALD J.; RINDNER, RICHARD M.; SEALS, WILLIAM
Final Rept. Sept. 1978 79 p.

Realizing the serious potential hazards of dust particles generated when drying propellants, particularly in the new Continuous Automated Single Base Line (CASBL) facilities being erected, the Manufacturing Technology Division of the Army Armament Research and Development Command (ARRADCOM) initiated a three-pronged attack to examine the problem. The Southwest Research Institute (SWRI) was charged to concentrate on the explosibility of M-1 propellant dust and, through a brief cursory set of experiments, to determine the minimum energy of electrostatic discharge to induce an explosion; the minimum explosible dust concentration; and the effect of moisture, solvent, temperature, and particle sizes upon the explosion-threshold value of each of three M-1 propellant concentrations. The result of this exploratory study of M-1 propellant dust explosibility was most definitive because it demonstrated that severe flash fires and explosions can be initiated under certain sets of ambient conditions. Because of the exploratory nature of this study, only the parameters could be identified that contribute to making an M-1 dust fire susceptible to an explosive reaction. Concusions are drawn from the test program with regard to the minimum ignition energy and the minimum explosive concentrations of M-1 dust, and recommendations are made for expanding this exploratory study into a more detailed evaluation.

20. Dust explosion sensitivity tests on M-1, M-30, Composition B, and HMX
Hazards Research Corp., Denville N.J.; Army Armament Research and Development Command, Dover, N.J. Large Calibar Weapon Systems Lab., Shared Bibliographic Input Experiment.
PETINO, GEORGE, Jr.; SEALS, WILLIAM; RINDNER, RICHARD M.
Contractor Rept. June 1979 75 p.

An experimental program was conducted to establish the dust explosion sensitivity of M-1, M-30, Composition B, and HMX as a

function of particle size, dust-cloud concentration, and relative humidity. Values of minimum explosion concentration, minimum ignition energy, and minimum ignition temperature were determined under ambient conditions for three particle sizes. In addition, the effects of relative humidity and concentration on ignition energy have been observed. The order of decreasing sensitivity of these materials is as follows: M-1, M-30, Composition B, and HMX. The minimum ignition energy increased with increasing particle size, test-chamber relative humidity, and decreasing dust-cloud concentration. Minimum ignition temperature increased with increasing particle size.

Grain Dust Characterization

21. Characterization of particulate emissions from grain sorghum storage and handling installations
NORMAN, BILL M.; PARNELL, CALVIN B., Jr.; AVANT, ROBERT V., Jr.
Texas A&M Univ., College Station.
Amer. Soc. Agr. Eng. Winter Meeting, Chicago, Ill., Dec. 13-16, 1977.
Amer. Soc. Agr. Eng., St. Joseph, Mich., Paper No. 77-3516 24 p. 17 refs.

A small country elevator was sampled during grain sorghum harvest to determine sizes and amounts of particulate material upwind and downwind from the elevator. These data were compared to dust on the grain itself and to particulate material collected from a terminal elevator bag-filter house. Results of grain dust samples taken from two different combines and from hand-thrashed grain show that combine settings, speeds, and operating conditions can play an important role in the amount of dust that enters a country elevator. From observing trucks entering the elevator, the greater distance of haul yields a greater amount of dust compared with a haul of less distance.

22. Characterization of grain dust properties
MARTIN, C. R.
U.S. Dept. Agr., SEA-AR, Grain Marketing Res. Lab., Manhattan, Kans.
Amer. Soc. Agr. Eng. Summer Meeting, Utah State Univ., Logan, June 27-30, 1978
Amer. Soc. Agr. Eng., St. Joseph, Mich., Paper No. 78-3020, 17 p. 14 refs.

Characteristics of dusts separated by grain-elevator dust-control systems were nonuniform. Particle-size distribution was influenced by capture velocities and air cleaners in dust-control systems. Specific densities, ash contents, and heats of combustion were related closely. Dusts contained more fiber and ash than grains. Ash-free, proximate analysis values of dust were similar to their respective values in grain.

Health

23. Health and safety guide for grain mills
National Institute for Occupational Safety and Health, Cincinnati, Ohio, Division of Technical Services
Apr. 1975 98 p.
Rept. No. DHEW/PUB/NIOSH-75/144; NIOSH-74/144.

This report presents health and safety guidelines for grain mills. Contents include philosophy regarding health and safety, health and safety programs, reducing unsafe acts and practices, machine guarding, occupational health and environmental control, automatic sprinkler systems, housekeeping and fire prevention, hazards in the industry, frequently violated regulations, walking and working surfaces, ladders, exits and exit markings, manlifts, personal protection, power tools, storing and handling of materials, record-keeping requirements, checklists, and information sources. Also included are a list of NIOSH and OSHA regional offices, a fire-extinguishing chart, an emergency information chart, and a how-to-lift safety chart.

24. Study says deep cutting reduces respirable dust
BLACK, SIGMUND; SCHMIDT, ROBERT L.; JOHNSON, BRADLEY, V.
Coal Age 82(10):158-160.Oct. 1977.

This article describes tests that show airborne respirable coal dust can be reduced by deep-cutting continuous mines. By adopting the deep-cutting principle, dust explosions and risks of black lung could be reduced appreciably. A second benefit would be to maintain present production rates with lower-bit speeds, reducing possibilities of face ignition. Deep cutting also consumes less energy per ton produced, saving money and machine maintenance.

New Equipment

25. New equipment
Feedstuffs (Minneapolis) 49(53):23-37 1977.

The problem of dust explosions caused by accumulated static electricity, and the testing of an effective elevator belt for grounding the electricity, are discussed. The aim in preventing the explosions should be to ensure that all equipment is grounded effectively. Announcement of equipment for the feed and grain industry includes steel grain tanks, self-sealing bags, a pneumatic conveyor, load and batch controllers, a laboratory pellet mill, sealers, a mobile mixer for roughage, a metal detector, and a dust collector.

26. New equipment
Feedstuffs (Minneapolis) 50(17):23-36 1978.

This article discusses new equipment for dust explosions. The new equipment for the grain and feed industry includes cleaners, weighing systems, including those that are electronic, a mobile mill, vibrators, a moisture meter, and flooring material for drying bins.

Prevention

27. Dust explosions: prevention and control
COCKS, RICHARD E.
Chem. Eng. (New York) Nov. 5, 1979 p. 94-101.

In designing a new plant or modifying an old one, the explosion potential of the dust should be tested and identified, and the risks associated with the operation should be evaluated. In this report, explosion characteristics are described and the problem area is identified. Many methods of preventing explosions, including venting, are discussed.

28. Zapobieganie zagrozeniu wybuchem metanu i pylu weglowego w nastepstwie tapniecia. [Prevention of firedamp hazard and coal dust explosions caused by rock bursts]
MATUSZEWSKI, J.
Przegl Gorn 32(11):487-492 Nov. 1976 5 refs.

The following factors involving the origin of hazards are discussed: formation of firedamp (a combustible gas, chiefly methane, that enters mines from coal seams) explosive concentrations, dangerous zones before the coal dust explosion, and initiations of explosions. Formulas are derived, which determine the increase in firedamp hazard after a rock burst. An example of firedamp and coal dust explosion caused by rock burst is given and prevention measures are suggested. [In Polish with English abstract]

29. Experiments with metallic water troughs in a 300-ft (91.5 m) long surface steel gallery
ACHARI, J.; ACHARYYA, K. K.; SENGUPTA, S. K.; BAJPAYEE, T. S.; BAGCHI, S.
Cent. Min. Res. Stn., Dhanbad, India
J. Mines, Met. Fuels 25(4):119-121 Apr. 1977 4 refs.

Experiments on coal dust explosions, conducted with metal water troughs in a surface steel gallery, reveal that water troughs are

quite effective in arresting the spread of flame beyond the barrier zone. Another finding is that the movable water troughs are more effective than those fixed to the body of the gallery. An optimum concentration of water must be present in the barrier to prevent the propagation of air explosion.

30. Determination of combustible volatile matter in coal mine roadway dusts by backscatter of x-rays from a radioisotope source
AILWOOD, CHRISTOPHER R.; BUNCH, KENNETH; FOOKES, REGINALD A.; GRAVITIS, VILIS L.; WATT, JOHN S.
New South Wales Dept. of Mines, Australia
Proc. Australia Inst. Min. Metall. No. 261 Mar. 1977 p. 47-51 6 refs.

This X-ray technique can be used only when the combustible volatile content of the coal matter (cvm) varies within a limited range, and a separate calibration is required for each coal seam. Portable equipment based on a radio-isotope x-ray source and digital ratemeter makes possible simple and rapid analysis and, with adaptation to use in coal mines, should lead to much more comprehensive testing of roadways and, hence, improved overall prevention of coal dust explosions.

31. Atmosfere impoverite di ossigeno quale mezzo di prevenzione delle esplosioni da polvere. [Oxygen-lean atmospheres as a means of preventing dust explosions]
FUIMARA, A.; CARDILLO, P.
Stn. Sper. per i Combust, San Donato (Milanese), Italy
Riv. Combust. 31(4):115-121 Apr. 1977 6 refs.

To prevent dust explosions, the most efficient precaution is to operate in the presence of oxygen at a concentration insufficient to propagate the flame. This safety concentration is obtained by diluting the air with inert gases. It can be determined experimentally for any material. In this work, the results of measuring the safety oxygen concentration for certain finely dispersed materials are presented, together with the results of determining the explosion pressure and maximum rate of pressure rise in partially inert atmospheres. [In Italian]

32. Incombustile dust used at Wankie
LIEDBERT, S. A. Z.
Wankie Colliery
S. Afr. Min. Eng. J. 88(4129):89,91,95,97 June 1977.

Until the Wankie disaster in June 1972, Wankie coal was believed to be a nonexplosive. New safety measures have been developed

since at the colliery, and this article looks at the use of incombustible dust as a means of preventing the ignition of coal-dust explosions.

33. Preventing dust explosions in factories
MARTIN, R.
Filtr. Sep. 14(2):157-158, 160, 162 Mar.-Apr. 1977

The hazard of explosions is ever-present in factories and is a problem for designers, installers, and operators of dust collection systems. Basic facts about dusts, such as explosion limits and ignition sources, are given, followed by such preventive methods and measures as explosion-preventing equipment and fire extinguishers.

34. Coal mine fire and explosion prevention. Proc. Bureau of Mines Technology
Transfer Seminars, Pittsburgh, Pa., Mar 2, 1978, and Denver, Colo., Mar 14, 1979
Bureau of Mines, Washington, D.C., and Bureau of Mines, Pittsburgh, Pa.
BuMines Rept. No. IC-8768.

These proceedings consist of papers presented at two Bureau of Mines Technology Transfer Seminars for disseminating recent advances in mining technology related to coal mine fire and explosion prevention. Primary emphasis, although not exclusive, is placed on underground coal mining. The papers address research accomplishments ranging from methods for detecting mine fires to remote sealing systems for extinguishing coal-mine fires. Each paper represents the current state of the art in the respective research categories. Presentations include research occurring from both Bureau in-house and contract offers.

Protection and Control

35. Dust control during grain processing operations
U.S. Department of Agriculture, Washington, D.C.
Patent application
GETCHELL, NELSON F.; COCKE, JOSEPH B.
Filed Sept. 21 1977 10 p.
Rept. No. PAT-APPL-835 104
(Government-owned invention available for U.S. licensing and, possibly, for foreign licensing. Copy of application available NTIS.)

This invention is used for treating cereal grains with a small amount of animal, vegetable, or mineral oil to reduce greatly the generation of dust during subsequent processing and handling operations. The oil, applied as a spray or as an oily vapor, also provides a lubricating effect that helps reduce grain breakage.

Review and Bibliography

36. Literature survey of dust explosions in grain handling facilities: causes and prevention
Iowa State Univ., Ames
VERKADE, MILTON,; CHIOTTI, P.
Mar. 25 1976 126 p.

Concern over recent fatalities and monetary losses suffered in grain industry dust explosions prompted a study of the causes and means of preventing them. A historical review of dust explosions in flour mills and other industries is presented. Grain elevator explosions are discussed with regard to cause, prevention, control, and enforcement of preventive measures. The following general characteristics are discussed: structural materials; physical layout; handling and conditioning the grain; types of grains handled; and personnel, economics, and management. Other topics discussed are requisite conditions for dust explosions, characterizing explosion hazards of dusts, dust-control systems, venting, flame arrestors, separating devices, and general recommendations. (ERA citation 01:026559)

37. Fundamentals of fire and explosion
STULL, DANIEL R.
Dow. Chem. Co., Midland, Mich.
AIChE Monogr. Ser. 73(10) 1977 128 p.

This report reviews the following fundamental elements of fire and explosion: thermochemistry; kinetochemistry; ignition; flames; dust explosions; thermal explosions; gas phase detonations; condensed phase detonations; reactivity hazard potential; blast effects, fragments, craters; and protection against explosions.

38. Overview of grain dust explosion problems
Iowa State Univ., Ames. Energy and Mineral Resources Research Inst., Department of Energy.
VERKADE, MILTON; CHIOTTI, P.
1977 47 p.
Rept. No. CONF-771085-1
Internatl. symp. on grain dust explosion problems, Minneapolis, Minn., Oct. 4, 1977.

The increase in grain elevator dust explosions in Iowa during the past decade prompted the 1975 State legislature to sponsor a study of this problem at Iowa State University. A literature survey and bibliography were completed, and an investigation of the low-temperature decomposition products of grain dust was initiated. Results of the literature survey are summarized. The response of ionization and combustible gas detectors to low-temperature (150° to 225°C) aerosol and gases evolved from grain dust was tested. Results obtained indicate that such detectors may form the basis for an early warning system capable of detecting incipient fire or explosion. Further evaluation is needed under a simulated dust environment. The gases evolved from various grain dusts in the temperature range 120° to 190°C were found to be primarily H_2O, CO_2, CO, and, with some dusts, also H_2. The data show that hydrogen concentrations can reach hazardous levels. Low levels of methane and other low molecular-weight organic compounds also evolve. The concentrations are sufficiently high to trigger combustible gas detectors.

39. Dust explosions
GRIFFITH, WAYLAND C.
North Carolina State Univ., Eng. Res. Cent., Raleigh
Annu. Rev. Fluid Mech. vol. 10 1978. Publ. by Annu. Rev. Inc., Palo Alto, Calif. p. 93-105 21 refs.

This article examines the nature of dust explosions in terms of their recognizable, fundamental parts. Unanswered questions range from how a single dust particle burns to what is involved in the fluid mechanics of collective phenomena and shock-wave propagation. Practical questions on the explosive behavior of dust are raised in connection with a number of both professional and amateur ventures designed to cope with energy shortages.

40. Annual review of fluid mechanics
VAN DYKE, MILTON; WEHAUSEN, J. V.; LUMLEY, JOHN L., eds.
Stanford Univ., Palo Alto, Calif.
Annu. Rev. Fluid Mech. vol. 10 1978. Publ. by Annu. Rev. Inc., Palo Alto, Calif. 75 p. 63 refs.

This volume contains 20 articles, 19 of which are indexed separately. Some of the aspects of fluid mechanics that are discussed include gas-flow simulation, drag reduction by polymers, dust explosions, weather prediction, river meandering, Ross by waves, vortex breakdown, boundary layer theory, river ice formation, and hydrodynamic problems of ships in shallow water proportional to the number of simulated molecules.

41. Supplement to a bibliography of topics related to the study of grain dust fire and explosion with keyword indexes, Nov. 1976-May 1978
Iowa State Univ., Ames. Energy and Mineral Resources Research Inst., Department of Energy
VERKADE, MILTON; BLUHM, D. D.
July 1978

This bibliography compiles recent work published in the many areas that may be of interest to those involved in studying, designing, and implementing programs to reduce the hazards of grain dust explosions. The literature search focused primarily from January 1976 to May 1978. A key word index is included. Previous publications surveyed the literature from 1900 through 1975, with special emphasis on the years 1955 through 1975.

42. Literature survey of dust explosions in grain handling facilities: causes and prevention
Iowa State Univ., Ames. Energy and Mineral Resources Research Inst., Department of Energy
VERKADE, MILTON; CHIOTTI, P.
Apr. 1, 1978 127 p.

Concern over the recent toll in personal injuries and fatalities and the accompanying property and monetary losses suffered in dust explosions of the grain industry prompted the survey and study of the causes of these disasters and means of preventing or minimizing them. The circumstances and factors that contribute to a disastrous grain-dust explosion are complex and far reaching. As a result, the study of dust explosions encompasses many factors, including (1) occurrences, causes, and prevention; (2) dust-collection methods; (3) safety training and education; (4) insurance standards, national codes, and government regulations; (5) grain-handling operations; (6) management principles; (7) economic aspects; (8) chemical and physical properties of dusts; (9) flame-propagation mechanisms; (10) fire and explosion detection; and (11) explosion suppression and contol, or both. The literature search focused primarily from 1955 to 1975. To provide perspective, older sources also were consulted, some of which dated back to the early 20th century.

43. Bibliography of topics related to the study of grain-dust fire and explosion with keyword indexes
Iowa State Univ., Ames. Energy and Mineral Resources Research Inst., Department of Energy
VERKADE, MILTON, CHIOTTI, P.
May 1978 176 p.

This bibliography, which contains 871 citations, is for use by those studying the problem of dust explosions in grain elevators, feed mills, and related industries. The survey focuses primarily from 1955 through 1975, although older sources, when considered relevant, and a number of 1976 references are included. Within these limits, a complete listing of pertinent sources has been included, along with a keyword index.

44. Mine safety, Part 1. Fires and explosions (a bibliography with abstracts)
National Technical Information Service, Springfield, Va.
Rept. 1964-Aug. 1979
HABERCOM, GUY E., Jr.
Oct. 1979 209 p.

These citations cover research on underground mine fires and explosions, as well as safety and prevention measures. The primary concern is methane- and coal-dust explosions. Safety barriers, dust control, combustion products, fire sensors, fire suppression, metal spark inhibition, and dust explosions are all included. (This updated bibliography contains 200 abstracts, 29 of which are new entries to the previous edition.)

45. Coal dust flames: A review and development of a model for flame propagation
KRAZINSKI, JOHN L.; BUCKIUS, RICHARD O.; KRIER, HERMAN
Univ. Ill., Urbana
Prog. Energy Combust. Sci. 5(1):31-71 1979 3 refs.

Coal-mine explosions have been a problem for hundreds of years. The projected need for coal as an energy source will demand increased subsurface mining, which, in turn, requires improved techniques to prevent dust explosions. A review of coal-dust combustion as reported in the literature is presented, and a mathematical model of flame propagation through coal dust-air mixtures is developed in detail. The model is used basically to predict burning velocities and to study the structure of coal dust-air flames.

46. Review of literature related to engineering aspects of grain dust explosions
ALDIS, D. F.; LAI, F. S.
U.S. Dept. Agric. Miscel. Publ. No. 1375 1979 42 p.

Grain dust, a hazardous material if not controlled properly, can be a fire and explosion hazard as well as a health hazard. This report reviews dust-cloud composition and generation, including grain-

dust generation during grain handling, grain-dust evolution from a grain mass into the air, dust entrainment from a dust layer to an airstream, and dust settling from a moving or stagnant cloud. It also reviews dust combustion without explosion; dust explosibility; theoretical analysis of a dust explosion; flammability of mixtures of vapors, gases, and dust clouds; dust cloud detonability; methods of preventing rapid exothermic chemical reactions; and methods of preventing damaging overpressures.

Risk Analysis

47. Vorbeugende und konstruktive Schutzmassnahmen gegen Gas- und Staubeexplosionen. [Preventive and constructional measures against gas and dust explosions]
SCHOLL, E. W.; FISCHER, P.; DONAT, C.
Bergbau-Versuchsstrecke, Dortmund, Germany
Chem. Ing. Tech. 51(1):8-14 Jan. 1979 6 refs.

This study provides the basis for estimating explosive risks in a plant and for decisions concerning the extent to which safety measures against the occurrence of explosions or the effects of explosions can be implemented. An explosion-proof plant can be accomplished by preventive measures hindering an explosion or by constructional measures suppressing the effects of an explosion. This work is intended to be of assistance in the choice of explosion-proofing equipment. [In German with English abstract]

Suppression

48. Engineering study of jet airmix fire suppression
General Electric Co., Bay Saint Louis, Miss. Engineering and Science Services Lab.
Contract rept. Dec. 1974-May 1975
McINTYRE, FRED L.
Rept. No. EA-6103 Aug. 1975 17 p.

Present state-of-the-art technology can prevent catastrophic events during dust explosions. A rupture disk satisfies the criteria for venting, and an ultraviolet-type sensor satisfies the criteria for detection. A manufacturers' survey indicates that off-the-shelf items with minimum delivery time are readily available with more than a single supplier for end-type devices.

49. Water barriers for suppressing coal dust explosions
LIEBMAN, ISRAEL; CORRY, JOHN; RICHMOND, J. KENNETH
Pittsburgh Min. & Saf. Res. Cent., Bureau of Mines, Pa.
BuMines Rept. Invest. No. 8170 1976 29 p. 8 refs.

The Bureau of Mines developed three types of passive water barriers for suppressing slow-moving, coal-dust explosions. One type, modified conventional tub barrier, depends on the dynamic pressure generated ahead of an explosion to tilt the tub to release its water and suppress the explosion. The other two barriers operate in response to increased static pressure developed ahead of the explosion. Tests indicate the first barrier begins to release its water at air speeds as low as 50 ft/s, and the second and third barriers will operate at a rise in static pressure as little as 0.5 psi. All three barriers were found to be effective in suppressing coal-dust explosions propagating at speeds as low as 100 ft/s. A plan is described for installing a water barrier in a working mine on a trial basis.

50. Exploratory studies of flame and explosion quenching
Midwest Research Inst., Kansas City, Mo. Bureau of Mines, Washington, D.C.
Final Rept. June 30, 1972-Dec. 31, 1975
MILNE, THOMAS A.; BEACHEY, JACOB E.
June 25, 1976 254 p.

Using flame stabilization and direct sampling techniques developed under this contract, the combustion and inhibition processes in coal dust-air flames were studied. Premixed, laminar, flat flames of 10 to 20μ Pittsburgh seam coal, stabilized on a 6.3 cm burner, were probed for both gaseous and particulate species. Emphasis was on high spatial resolution sampling of the ignition and primary reaction zone. Results are presented involving five kinds of profiles through rich coal dust-air flames as follows: (1) direct, molecular beam mass spectroscopy of O_2, N_2, CO_2, H_2O, nitrogen, and sulfur-containing species; (2) gas chromatography of collected samples for O_2, N_2, CO, CO_2, H_2, CH_4, and C_2 hydrocarbons; (3) proximate analysis of coal and char samples collected in bulk; (4) scanning electron microscopic analysis of directory impacted coal and char particles; and (5) fine-wire thermocouple temperature measurements. Observations also are included on the quenching behavior or Pittsburgh seam coal-air flames and on the gaseous potassium- and phosphorus-containing species evaporating from dry-powder inhibitors in the reaction zone of CH_4 air flames. Suggestions are made for future research.

51. Longwall ignition suppression
Foster-Miller Associates, Inc., Waltham, Mass. Bureau of Mines, Washington, D.C.
Final rept.
ROTHCHILD, RONALD D.; BUZDAR, ADI R.
BuMines Rept. No. BM-7511 Sept. 1976 146 p.

This report describes the results of a study of longwall ignition hazards and specific suppression systems to minimize each of the major hazards. The major ignition hazards were identified by conducting a literature search and conversing with knowledgeable individuals in the U.S. mining industry. Three classes of potential ignition suppression systems are discussed: triggered suppression systems for face ignition, passive suppression systems, and control of ignition hazard in the gob. The triggered suppression systems include protection for the shearer, headgates and tailgates, welding equipment, and the shearer power cable. Passive systems include improved ventilation and water sprays and charges in the shearer head. Gob protection can be improved by isolating the gob from working areas and by introducing inerting agents into the gob.

52. Suppression of dust explosions in coal mines: use of a stirred reactor to test mechanisms of reaction of coal dust flames
Pennsylvania State Univ., University Park. Bureau of Mines, Combustion Lab., Washington, D.C.
ESSENHIGH, ROBERT H.; GOLDBERG, PHILIP M.; SHULL, H. EUGENE
Final Rept. Mar. 1978 117 p.

A stirred reactor combustion system was developed to gather information on the mechanisms of ignition and flame propagation of coal dust under conditions similar to those found in flames of coal-dust explosions. Experiments were carried out using pulverized bituminous coal. These experiments provided information on the mode of coal ignition and yielded information on the kinetics of coal pyrolysis by using the stirred reactor theory.

53. Coal dust explosion barriers
LIEBMAN, ISRAEL; RICHMOND, J. KENNETH
Pittsburgh Min. & Saf. Res. Cent., Bureau of Mines, Pa.
Bureau of Mines Inf. Circ. No. 8768; Bureau of Mines Technol. Transfer Sem. Proc., Pittsburgh, Pa., Mar 2, 1978 and Denver, Colo. Mar 14, 1978
Publ. by U.S. Dept. of the Interior, Bureau of Mines, Washington, D.C. 1978 p. 15-26 7 refs.

Two triggered barrier systems were tested against dust explosions. One uses a Cardox cylinder to discharge the suppressant, and the other uses low-pressure gas to power the disperser. Both systems were capable of suppressing coal-dust explosions.

54. Experiments on prevention and suppression of coal-dust explosions by bromochlorodifluoromethane and on prevention by carbon tetrachloride
RAE, D.; THOMPSON, W.
Saf in Mines Res Establ, Buxton, Derbyshire, England
Combust. Flame 35(2):131-138 June 1979 6 refs.

Vaporizing liquids of the halocarbon type are efficient fire-fighting materials, especially against liquid-fuel fires. They are also effective in extinguishing gas explosions during vapor phase. This investigation was undertaken mainly to assess the efficacy of one such compound, bromochlorodifluoromethane (BCF), against explosions of coal dust such as those that occur in pulverized fuel lines. Tests were made at ambient temperature of some pulverized fuel lines. A few tests also were made with carbon tetrachloride.

Symposia and Conferences

55. International Symposium on Grain Elevator Explosions, Washington, D.C.
July 11-12, 1978, vol. 1:preprints
U.S. Department of Agriculture, National Materials Advisory Board, Committee on Evaluation of Industrial Hazards, Washington, D.C.
Final Rept. 1978 264 p.

The International Symposium on Grain Elevator Explosions was organized by the National Materials Advisory Board Committee on Evaluation of Industrial Hazards at the request of the U.S. Department of Agriculture. The purpose of the symposium was to provide among the interested segments of Government (Federal and State), the grain industry, and the American people, a common understanding of the state of the art and available courses of action regarding the grain dust hazard. It was intended that information on which to base a short-range corrective action would be provided to USDA and that a data base would be developed for a follow-on study to investigate long-range solutions. Papers were presented from the United States, the United Kingdom, Canada, Switzerland, France, The Netherlands, the Union of Soviet Socialist Republics, Union of South Africa, and Australia, thereby mobilizing world experience in the problem. The problem was discussed from the viewpoints of the U.S. Government (Departments of Agriculture, Labor, and Health and Human Services; technology (universities,

government, and industry); elevator operators (domestic and foreign); insurance industry; and manufacturers of preventive and protective equipment. U.S. Senator Dick Clark of Iowa and Federal Grain Inspection Service's Administrator Leland Bartelt were the keynote speakers. Some long-held beliefs were shaken, and new data leading to improved practice were supplied. This preprint volume includes 23 papers presented at the symposium. Additional papers and proceedings of the discussions are given in Report NMAB-352-2, Proceedings of the International Symposium on Grain Elevator Explosions, July 11-12, 1978. The symposium report consists of this preprint volume and the proceedings volume.

56. Proceedings of the International Symposium on Grain Dust—Its Characteristics, Explosibility, Hazard Control, and Utilization
Oct. 2-4, 1979
U.S. Grain Marketing Research Laboratory, Manhattan, Kans.
B. S. Miller and Y. Pomeranz, eds.

The symposium on grain dust, held on the campus of Kansas State University, Manhattan, October 2-4, 1979, attracted international attention. Representatives came from 19 foreign countries and 32 came from the United States.

The symposium provided a forum for exchanging the latest research and ideas in four major areas of grain dust, including physical and chemical characteristics, explosibility, utilization and risk analysis, and prevention of explosions. Included were two keynote addresses:

(1) Teamwork Means Progress in Research—Anson R. Bertrand, Director, U.S. Department of Agriculture, Science and Education Administration-Agricultural Research, Washington, D.C.

(2) FGIS Concerns on Grain Elevator Safety—Leland Bartelt, administrator, U.S. Department of Agriculture, Federal Grain Inspection Service, Washington, D.C.

Thirty-eight papers covered a variety of subjects. Several reports from four committees represented the National Grain and Feed Association, the American Society for Testing and Materials, the American Society of Agricultural Engineers, and the National Institute for Occupational Safety and Health. Included also are a transcript of a round-table discussion on grain dust and a transcript of a presentation on fighting fires in grain-storage facilities.

57. Proceedings of the First National School on Explosibility of Industrial Dusts, Nov. 14-16, 1978, Karpaig, Poland
Edited by P. WOLANSKI; English translation by Y. POMERANZ
Pub. Dept. Chem. Eng., Kansas State Univ., Manhattan 1979 160 p.

Studies on explosibility of industrial dusts have been conducted in Poland for many years. Recently, the need to conduct such investigations increased as powders and dusts are often the main product of food processing, and dust residues often constitute an explosion hazard.

At present, the two Polish programs on dust explosions are in the areas of foods and fibers. Additional studies are conducted as part of a program on problems of burning and explosions, funded by the Ministry of Higher Education and Technology. Six schools of technology participated in this program, which also involved a cooperative study between the Warsaw Polytechnic and the University of Michigan on explosibility of coal dusts. The study is sponsored by the National Science Foundation of the United States.

More than 10 laboratories from technological institutes of higher learning and industry in Poland are participating in studies on explosibility of industrial dusts. The broadest programs among the university laboratories are conducted at the Warsaw and Wroclaw Polytechnics. In addition, studies on dust explosibility are conducted in the laboratories of the experimental coal mine "Barbara" in Mikolow.

In September 1976, an international colloquium, Eutomech-82, devoted to "Uncontrolled Explosions in Industry and in Mines," took place in Jablonna near Warsaw. Reports of the meeting were published, mainly in English, in *Archiwum Termodynamiki i Spalania* by the Polish Academy of Sciences.

The First National School on Explosibility of Industrial Dusts was organized by teams of people who study food and fiber dusts. Participants represented all centers that study dust explosibility. Various aspects included theories and initiation, propagation, and dissipation of dust explosions. The participants also reviewed the basis for classifying dusts, reaction kinetics, risk analysis, and methods of avoiding and controlling explosions.

58. Proceedings of Elevator Design Conference, A Practical Guide to Elevator Design, Sept. 27-28, 1979
National Grain and Feed Association, Washington, D.C.
R. C. GORDON and J. E. MANESS, eds.

The conference, A Practical Guide to Elevator Design, was held in Kansas City, Mo., September 27-28, 1979. It represented an integral part of the vigorous and multifaceted Fire and Explosion Research Program conducted by the National Grain and Feed Association.

The chapters of the proceedings consist of the indepth, technical, and fully illustrated papers that were prepared and summarized by the speakers who addressed the conference. Each chapter also includes a transcript of the questions asked by the speakers during the conference, as well as a bibliography of additional readings on each subject prepared by the speakers. The content of the chapters covers (1) structural design and general layout of elevator facilities; (2) electrical control and automation; (3) mechanical handling, conveying, and processing; and (4) maintenance, general safety, and safety devices.

Venting

59. Explosion protection methods by reliefs
ROGOWSKI, Z. W.
Build. Res. Establ., England
Inst. Chem. Eng. Symp. Ser. No. 49, Paper of the Symp. on Chem. Process. Hazards with spec. ref. to plant des., Univ. Manchester Inst. Sci. and Technol., England, Apr. 5-7, 1977 p. 63-71 14 refs.

Of all methods for protecting the process plant against the damaging effects of internal gas vapor or dust explosion, explosion relief is the simplest and most robust method. This paper presents experimentally tested empirical relationships for the design of vent openings and appropriate covers for gaseous and dust explosions.

60. Selected aspects of explosion venting
HATTWIG, M.
Bundesanst fuer Materialpruef, Berlin, Germany
Proc. Int. Symp. on Loss Prev. and Safety Promotion in the Process Industry, 2d, Heidelberg, Germany, Sept. 6-9, 1977, Publ. by Dtsch. Ges. Fuer. Chem.
Apparatewesen (EFCE-Eur. Fed. Chem. Eng. Publ. Ser. No. 1), Frankfurt AM, Germany, 1978 p. iv 249-IV, 256

Because venting is a widely used protective measure against the dangerous effects of explosions in chemical plants, the German Engineering Association (VDI) developed and published a guideline for venting dust explosions. According to this guideline, the vents have to be installed on the top of the vessel that is to be protected. The venting direction should be vertically upwards, preferably immediately into the open air. No obstacles should be in the

direction of venting, and provisions should be made to ensure that no additional dust is raised by the discharge jet. Practice has shown these requirements and others of the guideline cannot be realized in all cases. Experiments were conducted, therefore, to determine the course of pressure in the surrounding area of a vented vessel, especially in the direction of venting. Results show the possibility of determining quantitatively the consequences if pressure relief equipment has to be installed in plants under nonideal conditions.

61. Calculation of dust explosion vents
GIBSON, N.; HARRIS, G. F. P.
Imp. Chem. Ind. Ltd., Manchester, England
Chem. Eng. Prog. 72(11):62-67 Nov. 1976 13 refs.

The need to provide explosion vents for powder-processing equipment is increasing. Such protection must be compatible with the normal design and use of the equipment. In many situations this requires that the pressure rise developed in a dust explosion should not exceed 69 kN/m^2. Two independently developed methods, one based on vapor data and one based on dust data, using a k factor and cube root of value scaling factors, prescribe explosion vents that are in good agreement. The areas prescribed by these empirical relationships, rather than the larger areas calculated by the traditional vent ratio methods, should be used to protect powder-processing equipment that can withstand an internal pressure rise of 69 kN/m^2.

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