Two serious hazards from coal dust confront the bituminous-coal miner—a physical or safety hazard and a physiological or health hazard. The first threatens the miner with loss of life from coal-dust explosions, and the second with loss of health and earning rapacity from inhalation of large quantities of the dust. Studies by the Bureau of Mines have shown that coal dust, except for some grades of anthracite dust, is capable of initiating an explosion when no explosive gas is present and that its property of extending or propagating an explosion has been responsible for nearly all the widespread explosions that have occurred in bituminous mines in the United States in the present century. For years many mining people believed that low-volatile coal dust was not explosive, but not only is it explosive but if the source of ignition is intense, it is as explosive as the dust of many high-volatile coals. Because the war is creating increased pressure for greater coal production and because of the trend toward greater mechanization in mines, explosion and health hazards from coal dust are likely to increase considerably.

As an Explosion Hazard

By R. R. Sayers
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The fine dust which has lodged on ribs, roof, timbers, and floor in virtually every bituminous coal mine is particularly hazardous. Such settled dust is constantly a potential medium for ignition and propagation of explosions, for not only is it generally extremely fine (frequently more than 75 per cent of it will pass through 200-mesh) but also anything that dislodges this dust tends immediately to mix it intimately with the air to form the dust-air cloud that is necessary before dust can be exploded.

Means of igniting coal dust are present in all our bituminous and lignitic mines, either in the form of open lights or electric arcs, or through the use of black blasting powder or dynamite, or misuse of permissible or other explosives in firing with fuse, or in the employment of so-called bulldozing, adobe, or sand-blasting shots.

Mechanical mining of coal naturally produces larger amounts of fine coal dust than do hand-loading methods; therefore, the need for allaying the dust at its source is greater, and if more particles barely passing a 20-mesh sieve and even larger will participate in extending the explosion.

A dust cloud of finely divided bituminous coal in the amount of 0.05 oz. of coal dust per cubic foot of air will propagate or extend an explosion; this amount is less than 4 oz. of coal dust to the linear foot of ordinary coal-mine entry. In practically all coal mines several times this amount of dust may be thrown into the air.

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adequate measures are not taken in the future to remove the hazards from dust in the coal mines of the United States, the industry ultimately will have a heavy bill to pay, not only in connection with explosions but also as health compensation.

Minimizing the Dust Hazard

AIR dustiness in bituminous coal mines can be remedied by preventing the formation of dust at the source, so far as possible; at the same time adequate ventilation should be provided to dilute and remove any gas that may be present. The two principal methods used to minimize the explosion hazard of dust in the coal mines of the United States are control of the dust at point of origin, or watering, with or without wetting agents, and reduction of combustibility of the dust by rock-dusting. Some experimental work also has been done on the use of exhaust or suction methods to remove dust from coal-mine surfaces and mining equipment.

Although really efficient rock-dusting probably has been done in fewer than 100 of the approximately 6000 larger coal mines, and has not been done at all in more than two thirds of the coal mines of the United States, nevertheless it has had a decidedly important effect in diminishing the severity of explosions of gas and dust. Presence of explosive gas in the mine air increases the amount of inert matter required to make coal dust nonexplosive. Tests have indicated that the minimum incombustible content of mine dust should be increased 1 per cent for each 0.1 per cent of methane gas in the air current. Unfortunately many mine operators do not believe that nongassy mines need to be rock-dusted, and at the same time decline to consider a mine gassy unless explosive gas can be detected with a flame safety lamp. The fallacy of this conception has been proved by the fact that many gas explosions have occurred in so-called nongassy mines, and this is to be expected since the ignition of as small a quantity as 150 cu. ft. of an explosive mixture of methane and air may under some circumstances precipitate an explosion which will sweep through a mine. An explosion initiated by methane generally has a much more violent start or “kick” than one originating from dust alone, and this violence tends to cause the formation of dust-air clouds whose ignition promotes explosions. Fairly accurate data taken from studies of individual coal-mine disasters indicate that rock-dusting in the coal mines of the United States for the past ten years or more has reduced the losses of lives by at least 200 a year. This saving in mortality has been accomplished notwithstanding the fact that only eleven of our 26 coal-producing states have any requirements as to rock-dusting, fewer than 2 per cent of the larger coal mines of the United States can be considered as being adequately rock-dusted, and few if any of the thousands of small mines use rock dust.

Although the value of rock-dusting as a means of minimizing the explosion hazard of coal dust is being more widely acknowledged each year, the use of water at and around working faces, and on the floor of main haulageways and on the floor of main haulageways as a means of allaying coal dust is gaining adherents relatively slowly. Steps to install such systems have not been taken by some mine officials because they think the amount of water required would be excessive and the added water would be detrimental to the sale of this coal and also under some conditions would be detrimental to the roof or floor in the mine. An attempt has been made to meet these objections by the proposal to use wetting agents other than water. (By the term “wetting agents” in the following paragraphs, those other than water will be meant.—Ed.) Such wetting agents have been used for many years, principally in the textile industry and in metallurgical and milling processes. Two types of mixtures are employed—one in which the ingredient forms an emulsion and the other in which the agent mixes intimately with water.

One of the claims made is that wetting agents will greatly reduce the quantity of water required to allay dust, a claim that has been substantiated by tests. Certain agents probably will reduce only a half or a third as much liquid as water alone. During one test in which a wetting agent was used with the water, dust at a discharge point in a tippie was reduced about 70 per cent, and the amount of water used was reduced about the same percentage, thus indicating that the amount of water necessary can be reduced materially through efficient use of a suitable wetting agent.

The amount of water used during top-cutting also may be reduced through application of wetting agents. More than 50 per cent greater reduction in dust density is possible with wetting agents in water than with water alone, or less than half as much liquid need be used for the same dust density.

The safety problem in coal mines arising from excessive coal dust, namely the hazard of widespread explosions and fires, ultimately will be solved by the measures indicated. These are:

1. Use of water at and around the working faces.
2. Use of water on the floor of main haulageways, with rock-dusting of all other accessible dry surfaces.
3. Maintenance of active circulation of pure, fresh air currents throughout mines.
4. Restriction or absolute prohibition of open flames (including smoking materials) or electric arcs.

Coal Dust Injures Health

A FEW years ago many investigators believed that coal dust not only was not harmful but that it exercised a favorable effect when inhaled with more dangerous dusts. More thorough investigation of the physical condition of workers in dusty industries is leading
to a realization that although some dusts are more dangerous to health than others, all are more or less harmful under certain conditions of exposure. Although silica dust has been the principal focus of attention of those interested in dust diseases, other dusts may cause respiratory affections that may result in much suffering and economic loss. Such diseases as bronchitis, influenza, pneumonia, and tuberculosis are more prevalent among coal miners exposed to high concentrations of dust than among the general population engaged in occupations not having such dust exposure. Coal mining per se does not necessarily increase the incidence of respiratory disease, provided adequate precautions are taken.

A wider difference in the proportion of deaths from this cause compared with "all other males" than in 1918. The percentages in 1920 were 29 for the soft-coal miners and 16 for "all other males." In this epidemic the bituminous miners at ages 40 to 60 suffered heavy excess mortality from influenza-pneumonia, but the differential mortality was not quite so great as at ages 16 to 30. Among hewers and getters of soft coal in England and Wales, the death rate from influenza and pneumonia, 1921-23, was about 12 per cent greater than among males of comparable social status. Thus, an abnormal mortality from influenza and pneumonia is consistently indicated among miners of coal, both anthracite and bituminous, in England as well as in the United States.

In a study of 774 bituminous-coal miners of the Southern Appalachian region, B. G. Clarke and C. E. Moffet found a tendency of bituminous-coal miners to develop presilicotic and silicotic lung changes after prolonged employment. The mine where the study was made, 2 per cent of the worker showed presilicotic changes, and roentgenograms of the chests showed silicotic nodulation in 1 per cent, principally among undercutting machine operators and coal loaders. The shortest exposure period necessary to produce nodulation was observed in a rock driller who had worked at this occupation for eleven years.

In a study by the U. S. Public Health Service, in co-operation with the Utah State Board of Health, of bituminous-coal miners in Utah, sixteen cases of anthracosilicosis were found among 507 miners whose only occupational dust exposure had been in bituminous-coal mines. These cases were not advanced or seriously disabled. Only one case of moderately-advanced (second-stage) anthracosilicosis was found and no well-advanced (third-stage) case was observed. The typical picture of well-advanced anthracosilicosis found by the Public Health Service in a study of 2711 anthracite miners was not experienced among the Utah bituminous-coal miners, but the changes disclosed in their films were similar to those in anthracite miners with early anthracosilicosis. The results of the investigations cited indicate the possibility of the occurrence of severe dust disease among bituminous-coal miners with long exposure to high concentrations of dust.

Methods of Control

CONTROL of dust diseases in bituminous-coal mines requires the application of known, effective engineering, medical, and legal methods.

Engineering control—Use of water at and around the working faces; use of water on the floor of haulages, particularly where sand, an important source of silica in mines, is used to prevent slipping of locomotives; maintenance of active circulation of pure, fresh air throughout; and other engineering methods devised for control of dust to minimize the explosion hazard also are effective in reducing the health hazard. The engineer, however, must bear in mind the objective in instituting his controls. For, although his methods for reducing dustiness may be similar the degree of control he will wish to exercise in particular sections of a mine or in the mine as a whole will depend upon whether he is primarily concerned with the danger to health or safety. Along main haulages, for example, both hazards are of concern. Yet, should he approach the problem only from the safety standpoint and attempt to minimize the explosion hazard merely by extensive application of rock dust, he may be doing nothing to remove or minimize the health hazard, and in fact may actually increase the health hazard.

Control of the health hazard by en-
Mineral engineering methods requires actual reduction of dust particles in the air in which men are exposed over long periods of time. From an explosion standpoint, a dust count of particles in the air running into the hundreds of millions of particles per cubic foot of air is not dangerous, but from the health standpoint the maximal permissible dust concentration should probably be in the neighborhood of five to fifty million, depending upon the amount of free silica present in the dusty air and the length of time which men are exposed in it. Moreover, another important distinction must be borne in mind: as mentioned before, it is the potential air-dustiness, namely the dust on roof, ribs, and floors which can be dislodged instantly and thrown into the air in response to sudden force, that constitutes a primary explosion hazard; whereas it is the dust actually in the air that constitutes the health hazard.

The aim of the engineer, in dealing with the health hazard, should be to work towards eliminating dust entirely from the air, and from a practical standpoint the engineer should carry out control measures which at least will effectively reduce the dust in the air to a concentration that will not cause disability during a working lifetime.

Medical control — The principal means of medical control is the physical examination of workers to determine their fitness for work requiring exposure to dust and the efficiency of control measures in effect. This presupposes not only pre-employment but also periodic postemployment examinations. Some states require the physical examination of employees, and one state, North Carolina, requires pre-employment and periodic postemployment examinations of all employees exposed to the hazards of asbestos and silica dust. Another medical control measure is the education of all concerned regarding the danger of breathing large quantities of dust and the necessity that every individual (including workers) must do his personal share in trying to aid in reducing air-dustiness.

Legal control—Compensation for industrial diseases is one of the principal methods of legal control. At present 25 states and the District of Columbia have laws for the compensation of occupational diseases and in some silicosis is specifically mentioned in the law. In Pennsylvania the law applies to anthracosilicosis contracted in the anthracite mines. Formulation of codes of good practice, which attempt to establish allowable concentrations of dangerous dusts, is a comparatively recent trend in several states. In Wisconsin and New York the codes are legal and binding.

Although many medical and engineering problems remain unsolved, enough experimental and other data are available that, if properly applied, will enable those concerned to reduce to a negligible quantity the dust in bituminous-coal mines and thereby lessen the hazard to the life and health of the soft-coal miner.

Mining a Dangerous Industry

ACCIDENT Facts, 1942 Edition, lists the accident frequency and also the accident severity rates of 31 key industries for 1941. Mining is given an accident frequency rate of 38.90, the lumbering industry with a rate of 52.45 being the major industry with a higher or worse accident frequency rate than mining. The average frequency rate for the 31 reporting industries was 15.39.

In severity, mining, with a rate of 9.42, had the highest or worst rate of the entire 31 reporting industries, the average of the 31 being 1.53, hence the severity rate of mining was more than six times that of the average of the 31 industries.

Although only one lost-time injury in 98 in industrial work in the United States results in death, the proportion of fatalities in lost-time injuries in mining is 1 in 34, this high proportion being exceeded only by quarrying with a rate of 1 in 31.

The rate of permanent partial disabilities in lost-time injuries in mining is reported as 1 in 14, with an average time charge per case of 734 days. This rate is exceeded by four industries: the cement industry, 1 in 7, with 938 days per case; the meat-packing industry, 1 in 7, with 274 days per case; the non-ferrous metals industry, 1 in 7, with 405 days per case; and the steel industry, 1 in 8, with 622 days per case. The best accident record last year was held by a tobacco company of Philadelphia with 14,314,436 injury-free man-hours. Mining ranked as No. 27 out of the 29 industries and its best injury-free man-hour record was that of the Wakefield Iron Co., Gogebic, Mich., with 1,243,854 man-hours without an injury.

At Work on Brazil's Itabira Iron Ore Deposit

ACTIVE development of the Itabira iron ore deposit in Brazil is now under way, according to information supplied by the Office of the Coordinator of Inter-American Affairs. The Itabira iron mines are 250 miles north of Rio de Janeiro, in the valley of the Rio Doce, in Minas Gerais. They are estimated to contain some five billion tons of high-grade iron ore. Formerly they were the property of the British-owned Itabira Ore Co., but last March were acquired by Brazil with United States aid and transferred to a new company organized by the Brazilian Government. As part of the development, the Victoria-Minas railway is being improved to transport the ore to the seaboard. The ore should be particularly suited to the manufacture of steel in Great Britain, to take the place of the ore formerly imported from Sweden, and the deposits will also help to supply United States needs.

The town of Itabira has been renamed President Vargas, and a typical boom town is Governador Valadares. Malaria is the greatest threat to health, but a good job at mosquito control has been done. Much other sanitary work is also in progress.