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INFORMATION CIRCULAR

DEPARTMENT OF COMMERCE -- BUREAU OF MINES

EFFECTIVE ROCK-DUSTING OF COAL MINES

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Bureau of Mines Policy on Rock-Dusting

"To prevent the propagation of mine explosions, the Bureau of Mines, Department of Commerce, recommends rock-dusting all coal mines, except anthracite mines, in every part, whether in damp or dry condition. It also recommends that rock-dust barriers be used to sectionalize the mine as additional defense; but these should not be regarded as a substitute for generalized rock-dusting." (Mine safety decision, No. 5, April 7, 1927.)

Purpose of this Circular

The purposes of this circular are to present concisely the requirements for effective rock-dusting of coal mines in order to prevent propagation of mine explosions, and to point out the principal related facts on explosibility of coal dusts and mixed coal-mine dusts, as determined by extensive testing in the Experimental Mine of the Bureau of Mines. Study of these principal facts on coal-dust explosibility in conjunction with the recommendations for rock-dusting, should help to make clear to mine operators and others concerned the necessity for systematic rock-dusting in all coal mines except anthracite mines, and the futility of inadequate or sporadic rock dusting.

The descriptions of nearly 1000 explosion tests in the Experimental Mine are available in a forth-coming bulletin[2] and in earlier publications.[3]

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1 - Chief mining engineer, Bureau of Mines, Department of Commerce.

2 - Rice, G. S., Paul, J. W., and Greenwald, H. P., Coal-dust explosion tests in the Experimental Mine, 1919 to 1924, inc. Bulletin 268, Bureau of Mines, 176 pp. (In press).

3 - Rice, G. S., and others. Coal-dust explosion tests in the Experimental Mine, first series, Bulletin 56, 1913, 115 pp; second series, 1913-1918, inc., Bulletin 167, 1922, 639 pp.

For detailed specifications as to the kind of rock-dust, amount to use, where to be applied, and method of sampling and testing, the reader is referred to Bureau of Mines Serial 2606[4], and American Engineering Standards Committee "Recommended American Practice for Rock-Dusting Coal Mines" quoted in Bureau of Mines Information Circular No. 6030[5].

Summary of Specifications for Rock-Dusting

1. Mines to be rock-dusted

All coal mines, except anthracite mines, should be rock-dusted.

2. Extent of rock-dusting

All open accessible parts of a coal mine should be rock-dusted, including slopes, entries, cross-cuts, and rooms, headings and pillar workings to within at least 50 feet of the face.

3. Amount of rock-dusting

After cleaning up the coal dust as thoroughly as practicable, sufficient rock-dust should be used to have the mixture of remaining coal-dust plus the rock-dust in any zone contain 65 per cent or more of inert or noncombustible matter. First dusting may require 3 pounds to 5 pounds per linear foot of passageway.

4. When to rock-dust

In any zone or section (made by dividing the mine for rock-dusting purposes) when the incombustible content falls to 55 per cent, that section should be re-rock-dusted so as to bring the incombustible content well above 65 per cent.

5. Kind of rock-dust

An incombustible dust, which is not unduly absorbent of moisture or which does not have a tendency to pack, should be used. Rock-dust for generalized dusting should not contain more than 25 per cent free silica. This provision is not essential for barriers, for which purpose a non-moisture absorbing non-packing dust is particularly advisable. Rock-dust should not contain more than two or three per cent of combustible material.

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4 - Rice, G. S., Paul, J. W., and Sayers, R. R., Tentative specifications for rock-dusting to prevent coal-mine explosions. May, 1924. Reports of Investigations, Serial No. 2606, Bureau of Mines, May, 1924.

5 - Rice, G. S., Sayers, R. R., and Harrington, D., Rock-dusting in coal mines, Information Circular No. 6030, Bureau of Mines, March, 1927.

Limestone and dolomite dusts are preferential rock-dusting material, as they are free from silica and are whitish in color. Their light color is in great contrast to the blackness of coal dust, and discloses to the eye when there are dangerous accumulations of coal dust. A further advantage of light color is the aid to illumination

6. Size of rock-dust

It should all pass through a 20-mesh sieve and at least 50 per cent through a 200-mesh sieve.

7. Sampling of rock-dust in defined zones of the mine should be done systematically and regularly. A minimum of 20 samples should be gathered monthly in a mine of small size and more samples in larger mines. It is recommended that at least one sample for each 1,000 tons of coal produced should be taken.

8. Determinations of the noncombustible content may be made by the Bureau of Mines "volumeter" checked by occasional chemical analysis.

9. Records of analyses or determinations in specified zones should be made in a book kept for the purpose and the times of re-rock-dusting each zone. Maps for rock-dusting purposes should be maintained and posted in the mine office and in firebosses' "shanties" underground, and these maps should also show the rock-dust zones and rock-dust barriers.

10. Rock-dust barriers should be used in order to confine to the zone or section where it originates, any incipient explosion that might be started, either from failure to maintain sufficiently the rock-dusting in that zone, or from ignition of an accumulation of gas. Rock-dust barriers are not equivalent to generalized rock-dusting and are regarded by the Bureau of Mines as secondary defenses. It is easier to prevent by general rock-dusting the starting of a coal-dust explosion that it is to stop an explosion by barriers.

An explanation of what is meant by rock-dust barriers follows:

Rock-Dust Barriers

"Rock-dust barriers" are devices for limiting the propagation of an explosion of coal-dust. They are shelves, movable or fixed, or closed containers generally extending across and being close to the roof of a passageway, and loaded with sufficient rock-dust to extinguish the flame of a dust explosion and capable of quick discharge of contents. Testing has shown that to be successful they must discharge and scatter from 50 to 100 pounds of rock-dust per square feet of cross-section of the passageway into the air immediately before the arrival of the flame.

Barriers might be designed to discharge by an electric circuit established by the melting of a foil device placed at a distance inby and outby the barrier, but for simplicity barriers so far devised rely on the air pressure waves immediately preceding the flame of explosive combustion of the coal-dust for their operation. As is the case in distributed rock-dust, the particles o: barrier rock-dust absorb the heat of burning coal-dust adjacent particles and, by interposition between particles of coal-dust, screen from the effect of radiant heat. Rock-dust barriers so far devised will not extinguish gas-air explosions.

Many types of "barriers" have failed in the Experimental Mine when tested, because:

(a) The rock-dust has not been discharged quickly enough, before the arrival of flame.

(b) There is not sufficient rock-dust discharged into the air.

(c) The rock-dust has been discharged en masse, which is especially liable to occur if the rock-dust is so damp that it sticks together. Inert dust or rock-dust that absorbs moisture quickly should not be used. Where the location in the mine is moist, inclosed barriers are advisable.

Some types of barriers have been successful in tests in the Experimenta Mine under various conditions. The reports of earlier testing have been given in detail in Bureau of Mines Bulletin 167. Work of development and testing of barriers is being continued at the Experimental Mine. It is not expected that barriers will be successful under all the varied conditions found in mine explo sions and in any case explosions between barriers may and have caused loss of life, where the dependence has been solely on barriers; hence it is advisable to use them as secondary defenses in these positions:

(a) At the mouths of principal branch entries;

(b) At all openings to panels;

(c) At approximately quarter-mile intervals on main entries;

(d) At the ends and connections of passages which do not have tracks, but are needed for ventilation or travel, and therefore can not be sealed off by strong fireproof stoppings, as is recommended by the Bureau of Mines for all abandoned or unused places.

Relative Explosibility of Coal-Dusts

Intensive investigations in the Experimental Mine of the Bureau of Mine have determined these principal facts regarding the relative explosibility of coal-dust and mixed coal-mine dusts:

All coal-dusts, except anthracite dusts, if in a sufficiently dense cloud in air may be ignited by a flame or electric spark and may pro a violent explosion.

"Explosive" coal-dust is of a size that will pass through a 20-mesh sieve, so the maximum diameter of the particle is about 1/30th of an inch. The mine-dusts in semianthracite, semibituminous, bituminous, and subbituminous mines differ in explosibility according to five factors:

(1) Percentage of noncombustible in the dust as found.

(2) Percentage of external water mixed with the mine dust.

(3) Percentage of fine coal-dust in the mixture. That passing thro a 200-mesh sieve is used as a measure of fineness.

(4) Percentage of volatile matter in the combustible content of the dust, more commonly known as the volatile ratio.

(5) Percentage of inflammable gas in the mine air.

Considering these five factors separately:

(1) Percentage of noncombustible

A mine dust, to prevent its propagating an explosion, (no fire damp being present) must contain from about 20 per cent, in the case of a low-volatile or semi-anthracite dust, to 75 per cent noncombustible in the case of a high-volatile very fine size of coal-dust. In samples of mine dust it is impossible to distinguish between the ash of the coal-dust and the inert dust mixed with it by natural agencies. External ashy material or rock-dust has greater effect in absorbing heat than the inherer ash of the coal but it is not practical to separate in sampling

(2) Percentage of external water

Small percentages of external or free moisture, that is, not inherent in the coal as water of composition or held in pores, has the practical effect on explosibility of dust projected int the air of so much incombustible, but in larger proportion ther is a physical effect of causing the dust to adhere together or stick to the floor, ribs, and timbering so that the dust will r be capable of being raised by air waves into the air as a dust cloud and propagation of an explosion will not occur in that pl

If, however, fine inflammable dust is carried along by the advance air waves in sufficient amount, the explosion may be propagated through a wet zone. The percentage of free moisture in the mixed dust that will prevent it rising as a dust cloud at the inception of an explosion, varies from 15 per cent for coarse dust to 30 per cent for the finest sized dust.

The method of wetting coal-dust to prevent propagation of an explosion has failed because of the rapid drying of the coal-dust. Humidifying the intake has also failed because high relative humidity or even saturation of the mine air does not prevent an explosion from propagating in coal dust.

Watering at the face however, and the use of sprays on cutter bars of mining machines, also sprinkling the tops of loaded cars, lessens the distribution of dry coal-dust and hence less frequent rock-dusting is required.

(3) Percentage of fine coal dust

The finer the size of coal-dust in air, the more explosive it is. The criterion of fineness used by the Bureau of Mines is the percentage of dust passing through a 200-mesh sieve. A coarse mine dust, say 10 per cent passing through 200-mesh, may require, for an explosive dust like the Pittsburgh bed coal-dust, 50 per cent incombustible to render it harmless; whereas, a fine size of such dust may require 75 per cent incombustible.

Most untreated mine dusts from top, sides, and floor, it is found from sampling hundreds of mines, average in size 20 per cent through 200-mesh. Rib and timber dust samples, however, are usually much finer and if there are considerable amounts containin over 5 or 6 ounces of pure coal-dust per linear foot of passageway then an increase of incombustible may be needed to prevent propaga tion of an explosion up to the percentage required for the fine (pulverized) coal-dust of the specific kind.

It has been demonstrated by tests that a coal-dust explosion may be propagated by timber and rib dust containing a large proportion of pure coal-dust, even if the bottom or floor dust is not an explosive mixture and the reverse is also true that a floor dust ric in coal-dust may propagate an explosion, although the ribs and timber have been rock-dusted, unless the cross timbers are so lade with rock-dust as to act like rock-dust barriers. Hence the necessity of sampling separately dust from the timbers and ribs from dust on the floor of mine workings, to determine when there i need of cleaning and of re-rock-dusting.

(4) Percentage of volatile combustible matter

The percentage that the volatile combustible matter is of the tota combustible (commonly spoken of as the volatile ratio) is a most important factor in comparing the explosibility of mine dusts of different composition. The Bureau of Mines uses as a measure of this factor, the per cent of incombustible in a dust (ash plus moisture) which will just prevent propagation of an explosion by a specific coal dust. The limiting percentage varies from 20 per cent incombustible, to render a semianthracite non-explosive to 75 per cent for high-volatile coal dust of the finest size. With coarser dust, such as most often found in mines, 20 per cent throu 200-mesh, the requirement, when no appreciable amount of fire damp is present, is about 65 per cent (ash plus moisture) for an average high-volatile coal dust.

(5) Percentage of inflammable gas

The effect of methane in air below the lower explosive limit of th methane-air mixture, about 5.2 per cent, is that, to prevent propa gation, an increase of incombustible in the dust is required in direct proportion to the percentage of methane. The increase varies from 3 per cent incombustible in case of the finest size of high-volatile coal-dust, to 10 per cent for dusts of low-volatile coals, which without any methane present have a low order of explosibility.

Conclusion

From a study of the foregoing factors in the relative explosibility of different coal dusts, it is evident that while each of the different factors has a wide range of values and some combine to increase while others tend to decrease explosibility of a given mine dust, the only safe procedure in the preventing of disastrous explosions is to rock dust thoroughly in every accessible part of a mine. Re-rock-dust immediately when the content of either floor dust or rib and timber dust falls to 55 per cent in any zone in the mine and maintain at all times the average noncombustible content of the mine dust above 65 per cent.- Information Circular, Bureau of Mines, Department of Commerce