

The Present Position of the Coal Dust Problem

(By Messrs. James and John Ashworth, Mining Engineers)

THE subject of coal-dust is still one of the most important questions which can be discussed by any meeting of mining engineers, and it therefore deserves very careful and detailed treatment, but for the purpose of the present meeting and for the useful advancement of information on this particular subject, the authors have condensed their matter so as to provide ample scope for the discussion of possibly every phase of coal-dust theories.

At the outset it may be of advantage to state what they mean by "Coal-Dust," as connected with colliery explosions—generally speaking therefore when they refer to coal-dust they will have in mind the very fine dust which is ordinarily present in coal mines and continuously produced from the coal in course of transit from the working face to the pit shaft by friction and that such dust is more dangerous than the older dust which has settled on the sides, roof and timbering of the mine.

The authors submit the opinion that this dust is the most dangerous factor in all collieries, particularly where firedamp is produced, and think that the many disasters which have occurred in Canada and the United States of America, are sufficient in themselves to take as examples, to convince every careful observer and student of coal-dust phenomena, that terrible disasters such as Monongah and Darr were mainly due to the part played by floating coal-dust, and that the incomplete combustion of this dust, coupled with the heat due to the pressure developed, acting on the older dust, created the huge volume of carbon-monoxide gas which is the actual life destroying element of every colliery explosion. To make their views on the universal production of carbon-monoxide gas more clear, they have to express the opinion that the enormous and sudden pressure created underground by explosions of mixtures of firedamp and air, or of firedamp and coal-dust, or of air and coal-dust, is sufficient by itself to produce huge volumes of carbon monoxide gas without the addition of actual flame, and in support of this contention quote the latest estimates of these pressures made by Mr. J. T. Beard, of the "Universal Correspondence Schools, Scranton, Pa., and of Prof. H. M. Payne, of West Virginia University, U. S. A. The former in his recently issued text book, entitled "Mine Gases and Explosions" estimates the possible pressure at 160 lbs. per square inch, and the latter at from 50 to 140 lbs. per square inch. (Mines and Minerals, February, 1908) and the difference in these estimates arises from the volume of air available, and particularly so in Prof. Payne's estimate which was based on what he considered did actually occur at Monongah.

The sudden and instantaneous effect of these great pressures on the miners, is to produce loss of consciousness or in some cases death by concussion of the brain, and thus men are found in the precise positions they occupied at the moment of the explosion, or when less severe pressure is produced they recover consciousness and are thus poisoned and killed in a few seconds.

Authorities are divided as to whether a small quantity of dust or a dense cloud is the more dangerous, but the authors' experience and observation leads them to the conclusion that in the majority of instances it is the dust floating in the air which is dangerous, and therefore if more than this comparatively small quantity is present there is then an insufficient volume of air to complete the combustion, and the flame is smothered out. Experience and observation also lead them to conclude that dust is more dangerous in a damp atmosphere than in a dry one and that there are numerous cases on record where a mine has been described as dry and dusty whereas the air was either saturated with moisture or so nearly saturated that not more than one grain of water vapour per cubic foot would have completed the saturation.

Writers and experts on coal-dust phenomena are generally in accord in treating coal-dust as a very small solid, but the authors of this paper think that it ought not to be treated as a solid but as a concretion of gases, because Prof. Bedson, D. Sc., of the Armstrong College Newcastle on Tyne, has proved by experiments extending over many years, that every particle of coal-dust freshly produced from the coal face, contains both firedamp and other gases of the paraffin series under pressure, and that these are continuously giving off until the supply is exhausted, and that they are then replaced by oxygen from the atmosphere and not by air, as the atoms of nitrogen are too large to pass through the pores, and are therefore filtered out. Consequently it will be readily understood that freshly produced coal-dust being surrounded by the gases escaping from the store-occluded in its own small body, floats as it were in its own balloon of gas, and is therefore immune from any dampness in the air current or in fact from any form of water. In many instances the expert evidence given to ascertain the initiatory cause of an explosion is evenly divided between coal-dust only or firedamp only, being the agency by which the original cause, generally a flame from a shot, was extended some distance into or throughout a colliery and the authors submit that no enquiry of this class can in any case be complete, without the dust has been examined by what they may term the "Bedson process," and that such an investigation would be still

more complete if the structure of the dust were examined under the microscope, as was done by Mr. W. E. Garforth after the explosion at Altofts, in England, several years ago (see the report of the Royal Commission on Explosions from Coal-Dust). Taking these two sets of experiments (both due to private initiative and not to the application of public funds) into plain matter of fact consideration the authors conceive that it has been proved by Mr. Garforth without the possibility of dissent that coal-dust is not a solid but is possessed of pores, and by Prof. Bedson that gases exist in these pores under considerable pressure, and therefore that every particle of freshly produced coal-dust ought to be practically considered as a "gas" and not as a solid. As a gas bag surrounded by air it is in its most favorable condition and position to inflame, and explode, and thus to initiate or extend the effect of any flame which is of sufficient intensity to ignite it.

This course of argument and practical demonstration naturally leads up to another of their conclusions on the use of explosives, viz., that it is not possible to use any known explosive with absolute safety in a gaseous mine.

There is, however, another danger which is probably never taken into account, viz., that due to detonation. Every high or so-called flameless explosive requires the application of a detonator, and if the detonator is not sufficiently strong, ignition and not detonation is the result, but assuming that the detonation is complete and that it is an over weighted shot, we have then to contend with results

which are in some senses more dangerous than a blown out powder shot, because we have created a huge detonating vibration which is unaffected by any amount of watering, and which may be communicated to the most distant corners of a mine without demonstrating any effects en route. Supposing therefore that either large or small accumulations of firedamp mixed with air exist in any part of a mine, these may be simultaneously exploded by this detonating effect. The Wattstown explosion in South Wales was probably an instance of this effect.

The question which naturally seems to follow this line of thought is "What percentage of firedamp is permissible in a mine or place where explosives are used?" and this is not so easily answered, because experiments have already demonstrated that less than one per cent. may be dangerous. If then one per cent. of firedamp will make a mine dangerous, it would appear rather absurd to blast excepting in such cases where it is absolutely necessary, and then only under the most stringent precautions, but the absurdity of the position is increased when we find that the usual tests for firedamp are made with safety lamps which are incapable of discovering less than two per cent, and on this showing the mine is certified as clear from gas and safe for shots to be fired. The only possible safeguard which the authors have to suggest to add to the safety of gaseous mines when explosives are used, is to limit the weight of the explosive in each shot, that is to say, a large number of small shots might be safe where the same weight of explosive in one shot

might cause a disaster—for this valuable discovery, "the charge limit," the writers believe we are mainly indebted to French engineers. The conclusion of the writers is that not more than one per cent. of firedamp is permissible, and that the weight of explosive per shot hole should be limited.

As to whether it is possible to render a coal mine safe against the initiation or extension of an explosion by any application of water, the writers are of opinion that it is positively impossible to restrain the extension of an explosion by any known means of applying water, and further that any form of water to dampen the air assists in the extension of an explosion, because as proved by Prof. H. B. Dixon the maximum explosive effect of mixtures of gas and air are only obtained when the atmosphere contains five per cent. of water vapour, and as this percentage can only be attained by the use of steam it is therefore an impossible application and the writers say positively that there is no known means of applying water so as to control the extension of an explosion.

The difficulty of applying water does not, however, end here, because the weight of water which will saturate an air current may vary from say 4 to 13 grains per cubic foot, and therefore either 4 or 13 grains ought to be equally effective in controlling the extension of an explosion, but this proposition is absurd when we have already proved that five per cent. of the weight of the air and gas mixture is required to give the maximum explosive effect, that is to say not less than 25 grains per cubic foot of the mixture.

Possibly resulting from the escape of the occluded gases from coal-dust, it has been found to be extremely difficult to dampen fresh coal-dust, and a practical demonstration of this fact was given to the juryman at the Monongah inquest by putting about a pound of fine dust into a basin of water, and after stirring it up, and pouring off the water, blowing into the dust when it immediately flew about the court room like soot.

The possibility of rendering a deep, dry and dusty mine proof against the extension of an explosion by water saturation has, however, another barrier against its adoption, and investigation has demonstrated in the most positive manner possible, that if miners are to work in such mines with any degree of comfort or efficiency the air must be kept as dry as possible, so that the perspiration from their bodies can pass into the air and afford a sense of coolness, but if it does not, then the body temperature rises until what is now described as "heat apoplexy" results, with loss of muscular power, and the men die. In many deep mines the heat ranges from 75 to 90 degrees Fahr., and therefore if the air were saturated with water (9.4 to 14.8 grains) the miners could not possibly work. About 8 grains of water vapour per cubic foot of air should be the maximum dampness permissible in the air of a deep mine.

Another phase of the coal dust problem still remains to be considered, viz., the explosion of dust in mines where firedamp has never been discovered, such as Camerton and Tinsbury, in the Somersetshire Coalfield, in England, and so far no experiments have been made to ascertain if any or what gases are occluded in such coal-dust and as these explosions have originated in old roads, it is possible that the dust had become altered by exposure to the air current and having absorbed oxygen had become more susceptible to the influence of flame. Only by submitting such dusts to courses of experimental research similar to those already referred to can its ignition or explosion when exposed to a flame of great intensity be satisfactorily explained.

The possible speed of a coal-dust explosion has frequently been debated, but without reliable data on which to base an opinion, until the Monongah disaster, when the difference of time between the explosion reaching the surface outside of No. 8 and No. 6 mines respectively was observed to be five seconds, and one of the writers has calculated that this would give a speed of 3,000 feet per second. This fact is particularly interesting because it quite upsets those theories which require a considerable time to produce a series of explosions which are not instantaneous, and do not take into account the effect of cooling or condensation.

The writers trust that these few notes on a subject which has such a wide range of interest may be sufficient to provoke very considerable discussion and result in the gathering together of much very valuable information and also produce suggestions for some better and more effective means of exorcising the demon of coal-dust than the present day ineffective systems of watering.

Note.—Messrs. J. B. and W. N. Atkinson, E. Bainbridge, W. E. Garforth and W. Caloway made an estimate of the velocity of the explosion at Altofts based on the movement of materials and this was placed at 90 to 100 miles. Coal-Dust Report Q 3821.

If per minute this would be 7920-8799 feet per second or more than the speed at Monongah, but if per hour this would only be 132-147 feet per second.

GASES ENCLOSED IN COAL AND CERTAIN COAL DUSTS

(By F. G. Troubridge, Society of Chemical Industry.)

To show that coal after removal from the mine not only gives off its "enclosed gases" but takes up gases from the air and oxygen preferentially to nitrogen, analysis was made with the following results.

	Freshly Heaven Coal.	Coal after exposure to the air.
Carbon-mon-oxide	1.65	1.18
Oxygen	3.75	23.80
Marsh gas or firedamp	44.60	3.68
Nitrogen	44.68	71.44
	100.00	100.00

In sample of dust from the Fernie mine (remarkable for its fineness) the gases differ from those of the dusty seam in character of the combustible constituents, which are undoubtedly mixtures of higher homologues of the marsh gas series. In fact, the composition of these gases is not dissimilar to that of the gases obtained by Bedson from the Ryhope coal-dust and coal.

Fernie coal dust at ordinary temperature gave 12.8 c.c. of gas from 100 grammes of coal. The coal at atmospheric temperature gave (d) 22.2 c.c. and at 100 Cent. (e) 23.1 c.c., and Carbon dioxide 35.4, Oxygen 1.0, CH₄ 2n, 0.4, Carbon monoxide 7.9 (CH₄ plus 2 equals 52.7 paraffines) and Na₂O.

When ordinary analysis of coal is being made the sample is usually dried at a temperature of 100 deg. Cent. and therefore the gases given off as above are dissipated before the ordinary analysis commences.

Mr. W. E. Garforth's microscopic examinations of coal dust showed the presence of spores of cryptogams also the megaspores and microspores of some cryptogamous plants (Selaginella).

Every time an engagement is announced men wonder what she can see in him and women wonder what he can see in her.

If Germany Declared War on England

(Continued from Page 9.)

sula, with its right flank on the estuary of the Stour, and its left on the sea, and is therefore secure in its isolation, unless attacked by enormously superior numbers. There remains the Aldeburgh-on-Sea army; but even assuming that 50,000 can attack and defeat 40,000 men, a rather hazardous assumption, the issue could scarcely be decided before the Yarmouth army would be threatening the left of the British. It will be remembered that the railway bridge at Manningtree had been destroyed (probably by German waiters from London), and a glance at the map will suffice to show the consequent limitations of access by rail to eastern Suffolk. It is in any case impossible for troops to be detrained close to a battlefield, unless the rail-head has first been amply secured, and a certain amount of marching is therefore inevitable. Wherever the British army might concentrate, the Germans from Yarmouth could certainly be as near to Aldeburgh-on-Sea as the former could be, by the morning of Monday, August 24. The chances of Lord Roberts being able to defeat the enemy's forces in detail appear to be very small, quite apart from the fact that his infantry would actually be inferior in efficiency to that of the Germans; many boys would be in the ranks and the reservists would not have had time to "shake down" in their places. To attack successfully a well-trained enemy, reasonably well posted, a superiority of at least two to one may be taken as the essential minimum. Such superiority would be denied us, and upon the contrary an attempt against any one of the hostile armies, except that at Harwich, would probably involve being caught in the act by another of them.

Assuming that the British Commander-in-Chief found himself unable forthwith to attack and defeat the enemy in detail, it is interesting to consider a possible development. The Germans are at least as well acquainted with the topography of our Eastern counties as we are ourselves. German officers have motored or ridden bicycles along every road and noted everything; and it is alleged that they have even gone so far as to carry out very extensive and carefully arranged "Staff Rides," with especial reference to all sorts of conditions that might arise in case of an invasion taking place. Marches would therefore be rapid unless vigorously opposed. From Cromer to Thetford is less

than forty-five miles, or say three days' march, and from Yarmouth to Stowmarket is about the same distance. Aldeburgh-on-Sea to Ipswich is about twenty-five miles. We will assume that practically the whole of the rolling stock of the Eastern Counties Railway was safely withdrawn inland before the enemy could lay hands upon it. Therefore, the invader is compelled to march on the roads; and to deploy his army, from the vicinity of Thetford to the sea about Harwich would thus occupy about three days. We will assume that

horses even for the whole of the cavalrymen actually serving with the colors, and of guns we have enough. The infantry battalions cannot conveniently be swelled beyond about 1100 apiece. Therefore there is a surplus of infantry reservists which would doubtless be utilized to strengthen and stiffen the Militia, or Volunteers, or both. There are about 125,000 reservists available, of whom nearly 90,000 are infantry. Let us—although quite unjustifiably—suppose that, in all, we have been able by Wednesday, August 26, to concentrate: of Regulars, say, 120,000; of Yeomanry and Volunteers, 200,000; and of Militia, 50,000; total, 370,000 men. The Regulars having been hastily mobilized, and officers and non-commissioned officers and men being therefore to a great extent strangers to one another, the fighting value of the 120,000 may be put at 100,000 at the outside, and that of the 250,000 Militia, Yeomanry, and Volunteers at perhaps 85,000. We have thus a net value of 185,000 to put against 150,000. Could we with this motley array feel assured of victory over a homogeneous army encouraged by the success which has hitherto attended the enterprise upon which it has engaged, whereas those portions of the British forces that have as yet unavailingly opposed it must have been correspondingly discouraged? Men fighting for their national existence will do and dare much; yet the hazard involved is a terrific one to contemplate. Who shall say what the result might be? Let us hope that we may never be confronted by such a crisis, and meanwhile that we may be awakened, as a nation, to the need of preparing better times so as to prevent it from arising. The sooner the proposed new Naval base at Rosyth is established the better, and a strong North Sea Fleet kept permanently in commission in connection with it.

If it be indeed true, as Mr. Haldane has recently suggested, that it may be found impossible for us to maintain in perpetuity the "two-Power Standard" for the Navy, then we must provide a cheaper defence on shore by raising the new Territorial Force to a strength of at least 500,000 men, recruited by compulsion if needful, and see to it that this national army shall be capable of mobilization in a condition of thorough efficiency for service, within the space of twelve hours.



A FINE IMPARTIALITY
Dame Europa: "Of course, as they're fighting outside the school premises, I look the other way. But—if I may use the expression—I back the winner!"

Lord Roberts would meanwhile have been able to concentrate every available man—Regulars, Militia, and Volunteers—who could, even at grave risk, be withdrawn from other parts of the kingdom. Let us further assume that the Channel has been re-opened, that the united British Fleet is in the North Sea, and that it is victorious, or at all events unbeaten. Reinforcements cannot reach the invaders, and all we have to do is to defeat his now united army of 150,000 combatants. Can we do it?

The Reserves of Cavalry, Artillery, Engineers, and Army Service Corps, etc., are of little use to us; we are unable to provide trained

THE GARDEN

Prepare Box weeks by deep Perennials, Rose early.
Plant: Hardy Climber especially—Roses, Delphiniums, Shrubs, Strawberries, Pinks, Irises, Snowdrops, Scilla, Amaryllids, Pot Tulips, Pot Cinthos, Cabbages.
Sow: A little Mustard and Salad, Lettuce.



fain would s very large inches across nothing still beautiful as a color is a de pink, with a to primrose in themselves readily imag trusses will flowers, and whole more panicle, diff Rambler tri

Whatever as an outdo beautiful oblar, the fine, to summit u whole plant pearance, an If will becom Crimson Ra who grow th

Not only may be gro own-root pl within an in up two and will produce some will fa is more a qu ripeness th Tausendsch plant, and l iage and sm and Noissett ently, it esc when thus p presented b be planted i was introdus same year t flowering P This latter a much addic a near reser which make from the sa to be the re Rambler an Polyantha b difficult to schon spring goes on, I f able breaks from cross- lieve the str ious crossed ed, from w Wherever t a pillar it sh an undergro beautiful be say, a dozen with A. M Tausendsch I should say when thus i almost as in Illustrated.

LARGE

These es fast that fering spec Personally, double or s magnificent reason I be recent Rose once—name Bernhardt— I believe Hybrid Tea the present bridged se single, and on the inside the outside. William largest of flowers of shell-shaped