Air-Borne Matter, Part III

Characteristics and Industrial Implications

By Harry L. Muntgomery Larcombe

It has been proved that different air-borne materials vary widely in their readiness to burn for several reasons. It may be that the substance under consideration oxidises with comparatively great ease, in which case very rapid combustion is attained. Some dusts may burn readily on account of their open structure; this is because there is little interference to the air in its access to the unburnt portions of the particle.

Perhaps the greatest factor is the amount of volatile matter created on the application of heat. It is often the case that volatiles are given off at temperatures which are well below the ignition temperature of the material itself. These volatiles often become particles in themselves much finer than the parent particle. This state of affairs is admirably shown in the example of powdered coal which is known to have volatiles of a highly explosive nature.

The presence of inert air-borne material in the air, however, may be in such a proportion that it may be sufficient to absorb so much of the heat of combustion that the temperatures of the combustible material will not be raised to the ignition temperature. Under these conditions the propagation of the flame through the dust cloud will be impossible.

Therefore, the extent to which inert material can prevent ignition is dependent upon the proportion of such matter that is present and also upon the specific heats of it and the combustible matter. Again, this is exemplified in coal mining where the practice of stone dusting is one of major importance.

The inflammability of a given dust is highly dependent upon the size of the particles, their structure, the presence of adsorbed gas upon them and the extent to which they are electrically charged. The enormously increased electrical capacity of matter in a finely-divided state is a frequent contributory cause of explosions of combustible dust.

Degree of Dispersion

For a given concentration of any dust cloud, both the inflammability and the rate of combustion are increased by increasing the degree of dispersion. In addition to the increase in surface area which makes it more available, it can be easily understood that the smaller the particle the more readily it can be raised to ignition temperature. Also being in greater numbers, the particles are closer together and better able to communicate heat one to another. In circumstances where some of the material is exceedingly small some of the particles will be in Brownian movement these will greatly facilitate the propagation of ignition in the cloud. As has already been indicated the more finely-divided the dust is, the more clearly does its behaviour approach that of a gas. In no case, however, has dust been observed to burn with a velocity comparable to that of a gas mixture. This is due to the fact that even the most minute particle of dust will take a relatively long time to become ignited and burn out when compared with the molecules of a gas. We must not forget the complete combustion of certain organic substance results in the formation of relatively large volumes of gas so that dust explosions may develop a maximum pressure that may be greater than that generated by a gas mixture.

Little is known at present of the relationship that exists between the inflammability of a given material when in a finely-divided state and the structure of the particle, in particular the surface characteristics. On account of the fact that powdered material readily absorbs the gas in which it is suspended, it may be reasonably concluded that an open cellular surface will absorb gas more easily than a relatively close-grained structure.

When particles possess an open structure they will, in similar conditions, burn more readily and more completely than particles of a compact make-up.

Composition of the Atmosphere

The inflammability of dust concentrations diminishes rapidly when the oxygen percentage of the air is reduced and increases with the increase of oxygen content.

At a certain minimum percentage of oxygen which varies with all air-borne matter, dust is no longer inflammable. This principle has been used with grinding machinery for reduction of material to powdered form by leading flue gases into the zone of working.

The theory which Harger put forward, to eliminate entirely the dust explosions in coal mines, was to reduce the oxygen content to 17 per cent., at which figure explosion was impossible. It is well known that the introduction of combustible gases into the medium of suspension of dispersoids increases their inflammability.

From the point of view of possibility of explosion the ignition of the dust is perhaps the most important factor. Methods of ignition can roughly be grouped in three classes:—

(1) *Spontaneous Combustion.*—In the case of dust, this is usually due to static electricity that has accumulated.

(2) *Thermal Ignition.*—This may cause explosions because of the ease of oxidation of many materials, however, the fact that the heat of oxidation is often dissipated very quickly after it is generated makes this method unusual in all materials with the exception of coal.

Particles of asbestos × 79