

nature, but is, however, classed as an industrial disease. The principal varieties of animal dust are essentially of relatively large dimensions and do not pass the first natural line of defence. The continual effort to clear away these particles is the cause of catarrh (*i.e.*, inflammation of the covering membrane of the upper cavities, nose, larynx and windpipe).

Vegetable Dust.—Under this comes wood dust, which is, along with others, capable of causing asthma. It is found that asthma is peculiar to vegetable dusts, and the reason for it is very difficult to ascertain. Various theories are put forward of which the following is the most likely. In contrast to mineral dust, these particles are soft and are not natural irritants. They aggregate into pulpy masses with mucus and moisture. It is highly probable that this pulpy mass blocks the smaller air tubes. This, in turn, reduces the surface area offered by the lungs for the transfer of oxygen to the blood, and the affected person is obliged to gasp in an attempt to get more air.

Mineral Dust.—Particles of this character are the most dangerous. They do actual physical damage to the lung structure. The widely-varied effect of particles of similar shape and size, but of different materials is proof that degree of sharpness is no dependable guide to the influence on health. The death rate among emery, carborundum and glass workers is not excessive.

Mineral dusts composed mainly of calcium carbonate are not highly dangerous, but those containing a proportion of free lime tend to be chemically irritant. Lime is believed to have been the cause of pneumonia epidemics amongst basic slag workers. These dusts which are chemically irritant, are really safer in industrial processes than those which are non-irritant, as they are sufficiently unpleasant to make workers take precautions to prevent inhaling them.

Silicosis

This is the worst of respiratory diseases caused by air-borne impurities. Certain siliceous rock in the course of blasting or drilling or grinding give rise to vast quantities of extremely fine dust, and it is this extraordinarily minute particle size coupled with the composition of the material which is the source of danger.

It has been shown by Gardner that the phagocytic cells behave in an absolutely different manner in the presence of certain siliceous materials from that shown toward other types of dust. This siliceous matter is soon absorbed by the phagocytes and appears to accelerate the migration of the cells; this is probably natural reaction to the extra effort required to remove the matter thoroughly. Then it seems the cells are killed, and aggregate into lumps around which a fibrous growth forms. In time, which is usually a period of years, this condition is general throughout the lungs and is known as silicosis. The lung tissues in this damaged and inflamed state is very easily attacked by the bacteria of tuberculosis, whose size is 0.5 microns wide by 2 to 6 microns long, and this is the final stage of destruction.

Dr. William R. Jones has done very valuable research work in the elimination of this terrible disease, and has led to methods of clearing the air from dangerous dust at the zone of breathing.

In reviewing means at present available in mines for checking silicosis three methods may be mentioned. The first, the use of water when drilling; secondly, well-directed and efficient ventilation; and thirdly, regulation times for blasting.

Wet drilling has brought about an enormous decrease in miners' silicosis and practically eliminated what is medically known as third stage silicosis. Scientific investigation has shown that wet drilling does materially allay the dust,

but, where the dust has a high silica content, the concentration of dust and air is still highly hazardous. The main drawback with wet drilling is the disposal of the dust-laden water, because water droplets with entrained dust, often evaporate with the heat of the air, and leave the dust particles suspended. In spite of the fact that the rate of evaporation decreases when the relative humidity is increased, it has been proved that with a relative humidity as high as 90 per cent., droplets of 100 microns disappear before falling 6 ft.

A further disadvantage of the use of water while drilling and wetting walls of mine galleries is that, in hot deep mines a humidification of the air results which almost reaches 100 per cent. A condition such as this is extremely conducive to tubercular infection when combined with the high temperature of deep mines.

Importance of Ventilation.

Ventilation in conjunction with efficient air filters is perhaps the greatest factor in health in mines and this also applies to factories. With double and treble shift blasting, as is now the custom, an enormous amount of dust is created in mine working and, as this should be removed on account of explosive, as well as health hazards, it is a matter for engineers to decide whether it is better to extract air or to provide a forced draught; but by either method, ventilation is now regarded as the most efficient and important means in use to-day of ridding the air of fine dust and so preventing dangerous concentrations. It must be remembered that these considerations apply to all industrial processes.

Dust traps used in mining appear to be still on trial, but several specialists in this type of dust control work have obtained very encouraging results.

Absolute protection against air-borne impurities is often very difficult to provide, and an accurate scientific comprehension of the various factors which influence and cause any type of hazard for the workers in industry is vital. Industrial administration must strive to reach a point where these hazards are negligible.

Considerable advances have been made during the last decade in the fight against the dust danger in industrial plants, both above the ground and below. Dust-contaminated air still, however, occasions serious loss of working efficiency, damages our health, industrial equipment and materials in process.

(For permission to reproduce the photographs illustrating this article we are indebted to the Sturtevant Engineering Co. Ltd.)

Nomenclature

c	= Velocity in cm./sec.	
C	= Velocity in ft./min.	
d	= Dia. of particle in cm.	
D	= Dia. of particle in microns	
g	= 981 cm./sec./sec. acceleration	
η	= Viscosity of air in poises = 1.814×10^{-7} for air at 70° F.	
	= 10^{-5} cm. (mean free path of gas molecules)	
r	= Radius of particle in cm.	
S_1	= Density of particle	
S_a	= Density of air	
A	= Distance of motion in time t	
N	= Number of gas molecules in 1 mol.	
	6.06×10^{23}	Brownian movement
R	= Gas constant 8.316×10^7	
T	= Absolute temperature	
A^1	= Surface area	
K	= Constant	
k	= Constant	
W	= Weight	
t	= Time	
H	= Gas viscosity	
Q	= Constant	
U	= Maximum angular distance	
V	= Tangential gas velocity	
Y	= Angular velocity of gas and entrained particles	
Z	= Radius of gas path	Centrifugal separation

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