curvature like a point or edge, so making possible the high electrical field at its surface which is necessary for the ionisation of the gas. The other, which is called the collecting electrode, has a lesser or no curvature and serves for the precipitation of most of the separated dispersoids.

Mechanism of Precipitation

Due to the high electrical field, the ions formed through ionisation by collision near the discharge electrode, and of the same electrical sign as this, are carried over through the gaseous medium to the collecting electrode with a velocity which is probably more than 100 ft. per second. When the gas between the electrodes carries dispersoids, the ions attach themselves to the particles which thus themselves become ions and are, therefore, also forced towards the collecting electrode. The velocity of these ionised dispersoids is naturally much smaller than that of the gas ions. It is, however, considerably higher than is ordinarily surmised.

Since the gas ions are molecular, they are smaller than the smallest fume or mist particles. The number of these gas ions ordinarily present in the gas of the precipitator is also probably many thousand times larger than the greatest possible number of dispersoid particles in that gas.

By studying these remarks, it can be seen that the effectiveness of this process is not limited by the size, weight, or number of the particles. With the progress which has been made in materials of construction, it is possible to build electrodes to withstand both high temperatures and chemically active gas and so make the process practically universally applicable to the separation and collection of air-borne matter.

In addition to serving to move the ionised particles to the collecting electrode, the electrical field and current also exert a pressure on the collected material which serves to prevent its being re-dispersed in the gas.

The efficiency of a precipitator is a function of the time that the gas remains in the active field and can be made to approach 100 per cent. very closely. Since, however, the size of equipment increases with the efficiency, an economic limit is necessarily set which usually lies between 90 and 99·9 per cent.

The precipitation rate depends to a large extent on the size of the particles and their characteristics, *e.g.*, their surface conductivity, since sufficient surface conductivity is necessary to permit the discharge of the dispersoid ion when reaching the collecting electrode.

This surface conductivity is perhaps the most important factor; where this is inadequate the addition of water or other conducting material which can be absorbed on the dispersoid surface increases the surface conductivity and greatly increases the rate of precipitation.

The particles having arrived at the collecting electrodes adhere to them and are dislodged in most designs by rapping. Certain classes of dust are removed from their gaseous medium of suspension in such a hot dry atmosphere that either their own weight is sufficient to remove them or comparatively very light rapping; in most precipitators, mechanically-operated rapping gear is required for both discharge and collecting electrodes. Liquid particles which are precipitated require no removal apparatus, but trickle down the walls of the tubular collecting electrode. On being removed by the rapping operation the particles must not be re-dispersed. In ultra-high-efficiency equipment, the precipitator is divided into sections which are shut down during the periods of rapping and are scavenged by an air blast thoroughly to remove dispersoids which may still adhere before putting the section back into service.

With careful design, however, this is not necessary in the majority of instances. When the gas flow along the tubes is streamline, the gas velocity is highest in the centre and falls off at the walls. With this low velocity at the wall, it is possible for particles to gravitate without being entrained in the gas stream. Another reason is that, during the period between rapping, particles adhering to the collecting electrodes agglomerate into larger particles which gravitate more rapidly on account of increased weight.

Numerous factors effect the design of equipment of this sort, the principal ones being the volume, temperature and analysis of gas, and the composition, size and concentration of the dispersoids.

Almost every process presents a different problem, great variations being obtained by relatively small differences in conditions.

Sound Wave Precipitation

In addition to the methods of collecting air-borne matter described, the United States Bureau of Mines is developing another method of precipitating fly ash, smelter fumes, etc.

In 1866, Kundt discovered that sound waves passed through a tube containing fine powder will cause that powder to concentrate at points free from vibratory motion. It has also been shown that high frequency sound waves affected the diffusion of solid or liquid particles in a gas. With these facts as foundation to build on, the Bureau developed its process, initially for the purpose of treating smelter fumes. It consists of simply passing the smoke or fumes through a tube in which stationary sound waves are maintained. The tube must be carefully proportioned, however, and must be of such a length that the waves reflected from the upper end are in phase with the original sound waves produced at the lower end. Furthermore, to get the best results, the wave-length must be approximately equal to the diameter of the tube. For a tube of practical diameter the frequency ranges from 3,000 to 20,000 cycles per second.

To set up sound waves of the proper frequency a shrill air whistle is used. The sound waves produced by this are reflected at the top of a closed glass tube, so as to be in phase with the original wave, setting up standing waves separated by planes of no motion, called nodes, spaced approximately half a wave-length apart. In its complicated movement between nodes, the suspended matter collides and thus coagulates, the heavier flocculated masses finally collecting, at the points of no motion.

Dust Explosions

This hazard is found most frequently in coal mines where fine coal dust is mixed with inflammable gases. It is not, however, limited to coal dust or to mines. There are dusts that are to a lesser or greater degree explosive, and in fact all carbonaceous materials and other substances which will burn must be included among the dangerous dusts. To this category belong sugar, rice, cork starch, cocoa, wood-dust, malt grain, wheat-flour, tea, spice and numerous other common industrial powdered materials.

The fineness of the dust or degree of dispersion is of considerable importance in studying the explosive hazards of air-borne matter. The finer the particles of a dust concentration are, the larger is the area of the dust particles and the more readily a chemical reaction with the oxygen of the air takes place.

The most characteristic property of any explosion, however it may be caused, is the ultra-rapid, almost instantaneous generation of a sudden increase in pressure. This may be due to the production of an increased volume of gas which may shatter the confining walls of the containing structure, or it may be due to the impact of a wave of compression that travels through the gas with a velocity equal to or greater than the velocity of sound.

There is little increase in pressure if the combustion occurs so slowly that the heat of reaction is dissipated as rapidly as it is produced. It is obvious, therefore, that