B. TWO-STAGE CLEANING SYSTEMS

A natural outgrowth of the classification shown on page 240 is a basic two-stage system comprising a preparation stage and a separation stage. There are a number of well-known examples of this arrangement now in use: (*1*) two-stage electric precipitator, with particle charging preceding precipitation (Figure 19), (*2*) venturi scrubber, with simultaneous agitation and liquid injection preceding cyclone separation (Figure 23), (*3*) sonic agglomeration systems, with simultaneous agglomeration and gravitational precipitation followed by inertial or centrifugal separation. In the third example, preparation itself may occur in two stages, when fog is injected at the entrance to the sonic chamber to improve the cohesive property of particle aggregates.

C. CONCENTRATORS: SUBDIVISION OF AIR STREAMS

As the air passes through a cleaning system, it may be handled as a single stream from inlet to outlet. There are numerous installations, however, in which the air stream is subdivided one or more times in order to specialize the task of cleaning and make each stage more effective. A common example is conveyance of the small-volume high-concentration effluent from the apex or periphery of a cyclone to a secondary separator generating greater centrifugal force. In such cases the primary cyclone may be designated as a *concentrator*. The louvered cone separator described earlier (Figure 3) is also a concentrator from which a small fraction of the air flow is directed to a centrifugal separator for more complete removal of air-borne particles.

XIV. Entrainment Prevention

In dust-collecting problems, the attention of air-cleaning engineers has been focused almost entirely upon the forces of separation, with little attempt to bring the dust-raising or entraining forces into view. As a result, there is practically no reliable published information, at this time, on the action of separating devices as dust-suspending mechanisms, which most of them are to some extent. Interest in this problem may begin with a consideration of studies dealing with the dust-raising ability of winds in open air, and with the action of controlled air jets impinging against dusty surfaces.

In the absence of dust-entrainment data for a specific separator, the engineer tries to get the dust-accumulating surface rapidly away from the turbulent air stream. One of the easiest ways is the application of a liquid film that can be carried off by gravity or centrifugal force.

A. AIR TURBULENCE

Although air turbulence can be quite helpful in diffusional and contact processes, it is generally damaging in inertial and impact processes where control of the particle trajectory is desired. In diffusional processes, increased turbulence

facilitates the approach to equilibrium at the interface or boundary between the air and the solid or liquid separating material. In inertial processes, the probability of resuspension or entrainment of particles increases as air velocity increases, with its resulting increase in air turbulence. Therefore, the use of increased air velocity to improve separation by higher centrifugal forces makes it necessary to arrange deflecting surfaces so that air may turn at high speed over smooth surfaces encountering a minimum of irregularities that cause air turbulence and particle entrainment.

B. VISCOUS LIQUIDS OR ADHESIVES

Separating surfaces may be treated continuously with liquids to improve retention and facilitate disposal of accumulated solids. They may also be treated periodically with liquids of relatively high viscosity that remain on the surfaces until removed by cleaning or regenerating procedures. Accordingly, the desired properties of the adhesive are influenced in large measure by the design and operating features of the separator or filter. Nevertheless, it is possible to state the desirable characteristics in general terms so that application engineers may be on guard in their selection of viscous liquids or adhesives for special duty.

Desirable Characteristics of Separator Adhesives

1. Viscosity should vary only slightly within the specified range of operating temperatures.
2. Viscosity should be low enough to permit a continuous flow of liquid in recirculating systems.
3. Surface tension should be sufficient to maintain an even film over the contact surfaces, prevent draining of liquid from upper portions of the medium in conveyorized systems, and prevent carry-over of mist.
4. Surface tension should not be high enough to inhibit the penetration of solid particles.
5. Capillarity should be sufficient to keep the exposed surfaces of the deposit wet.
6. Volatility should be low.
7. Adhesive should be odorless at the maximum operating temperature, when treating air for human consumption.
8. Adhesive should be fire-resistant, and preferably nonflammable, to prevent smoke panic and damage.
9. Adhesive should inhibit or prevent the growth of spores or bacteria.
10. Solubility in water is desirable to facilitate the cleaning of collecting surfaces.

XV. Continuous Service Arrangements

There is a growing demand for air-cleaning systems having steady and continuous performance characteristics, and the ability to operate for long periods of time without interruption for regeneration or removal of collected materials.