dry filters and electric precipitators are proving economical. By use of combinations of filters, advantage may be taken of specific characteristics of the various types of filters. There are many applications in which the air is passed through a series of two or more different types of filters so that the special advantages of each type are utilized to obtain optimum air cleaning and least maintanance cost.

A description of various types of air filters available commercially will be found under *air filters* in the catalog section of THE GUIDE.

AIRBORNE PARTICULATE MATTER

Airborne solid matter, from the viewpoint of air filtering, is considered as lint and dust, the latter including smoke and fumes. Some lint originates outdoors, as animal hair, vegetable fibers, etc., but much is generated within buildings by the wear and brushing of fabrics in the form of clothes, draperies, carpets, etc. Lint is comparatively easy to capture in an air filter because of its comparatively great length. So far as air filter performance and testing are concerned, lint is chiefly important because of its tendency to impede or stop the flow of air through the filter. In general, lint, if not captured, will accumulate in corners and under furniture in a building in areas of slight air motion, and in some cases may seriously obstruct heating and cooling coils. Dust settles, or is precipitated by heat or air motion, upon furniture, fixtures and walls, and the only satisfactory treatment is washing or re-painting. Dust is more difficult to capture than lint, and, obviously, small particles are more difficult to capture than large ones. The air cleaning problem is complicated by the vast difference in size of dust particles, the range of which is shown in Fig. 1, Chapter 8. Further complications arise, due to variations in kind and quantity of airborne contaminants with the geographic location of the installation as well as the position of outside-air and return-air intakes. Due consideration should be given to the type and amount of ambient dust at the point of intake. The type of filter required is frequently dictated by the kind and amount of contaminant to be encountered in the installation under consideration.

Even if the discussion is limited to the range from 0.2 micron to 50 microns, that is, between the smallest particle observable in the conventional microscope and the smallest particle visible to the naked eye, this range is so far outside the usual experience that it is difficult to visualize. If particles could be examined through a super microscope having a magnification of 250,000 diameters, a tobacco smoke particle of 0.1 micron would appear to be 1 in. in diameter, or approximately the size of a golf ball; a soft coal smoke particle 0.3 micron in diameter would appear like a baseball; a ragweed pollen grain of 20 microns in diameter would appear 16.5 ft in diameter, while the 50 micron particle (just visible to the naked eye and able to pass through a 270 mesh screen) would appear to be 50 ft in diameter. Consideration of this range in particle size from a golf ball to a sphere 50 ft in diameter will emphasize the difficulty of devising any single test to measure adequately the performance of air cleaning devices under all conditions of service.

As a general rule, the removal of the coarser dust particles and lint from the ventilating air produces tangible results in so far as cleanliness in a house or building is concerned, because much of the finer dust remains suspended in the air and is removed from the building by the circulating air. However, since some of the fine dusts, especially smoke and fume particles, are undoubtedly deposited by means other than settling, such

as electrical or thermal precipitation[2, 3] and by contact, the ability to remove small particles is desirable in an air cleaner if it can be obtained at not too great a cost.

VISCOUS IMPINGEMENT TYPE FILTERS

The viscous impingement type of filters consist of relatively coarse media constructed of a suitable fiber, screen, wire, mesh, metal stamping or plates, or a combination of medias. The filter may be either of the unit type manually-cleaned, the replaceable type, or the automatic self-cleaning design type.

The medium in a viscous impingement type filter is usually a fiber pack for non-automatic types, or a series of metal plates for automatic self-cleaning types. In either case, the medium is treated with a viscous substance, often an oil or grease, called the *adhesive* or the *saturant*, intended to retain dust particles which come in contact with it. Also, in either case, the arrangement is such that the air stream is broken up into many small air streams, and these are caused to change direction abruptly a number of times in order to throw the dust particles, by momentum, against the adhesive. Several desirable characteristics of an adhesive for air cleaners of this type are: (1) its surface tension should be such as to produce a homogeneous film or coating on the filter medium; (2) the viscosity should vary only slightly with normal changes of temperature; (3) it should prevent the development of mold spores and bacteria on the filter medium; (4) the liquid should have high capillarity, or ability to wet and retain the dust at all operating temperatures; (5) evaporation should be slight; (6) it should be fire resistant; (7) it should be odorless.

Various fibrous materials have been used as filtering media in unit filters of the viscous impingement type. These include glass fiber, steel wool, similar *wool* of non-ferrous metals, wire screen, animal hair, hemp fibers, and other materials. In such filters, the medium is often packed more densely on the discharge than on the approach side, in order to increase the dust holding capacity. This results in a selective arrestance of dust with the larger particles nearer the approach face. The arrangement also permits some penetration of lint into (but not through) the filter, so that the amount of lint which can be tolerated on the filter is also increased. Due to plane surface area the viscous impingement type filter, however, may be inferior to some dry types if the air carries a high percentage of lint.

The resistance of air filters obviously increases with the rate of air flow through them. Face velocities of about 300 fpm, and resistances in the range from 0.1 to 0.2 in. water, when the device is new and clean, are usual for ventilation system filters. Special filters with low resistances are available for use with gravity warm air furnaces, and for other applications where only low pressure is available.

Filters designated as high velocity units are also available. In most instances these filters employ a uniform media pack and give best performance at velocities about 500 fpm. Impingement type air filters should hold a substantial amount of adhesive so that the dirt collected by the filter will be retained. The design and construction should also provide a goodly proportion of free space through the media so that high velocities can be used without excessive resistances. The design should assure that the media throughout the thickness of the filter will be effectively utilized and therefore, the filter should be designed to minimize the formation of a