

air leaving the filter (D_2) is determined by passing the entire air flow through a high efficiency filtering blanket known as an absolute filter, the gain in weight of which is measured. Test data and results are presented on standardized forms made available by the *Air Filter Institute*.

The dust-spot or discoloration method of test for air cleaner efficiency was developed at the *National Bureau of Standards*⁸. In effect, this method is based on a comparison of the volumes of air before and after cleaning by the filter that must be drawn through unit areas of suitable filter paper to yield dust spots of equal opacity to transmitted light as determined by means of a photometer. For example, if equal opacities are obtained when the amount of air sampled, per unit area of dust spot, is four times as great for the downstream paper as for the upstream paper, the efficiency of the filter is considered to be 75 per cent, since the dustiness of the cleaned air, as measured by change in opacity, is one fourth that of the uncleaned air. To obtain equal opacities, samples may be drawn at equal rates for equal times through unequal spot areas, or at equal rates through equal areas for unequal times, as best suits the circumstances. Tests may be made with atmospheric air, or with an artificial dust dispersed in the air stream.

Dust-holding capacity is defined as the amount of dust which a filter can retain and have a resistance less than some arbitrary value. The term applies only to fixed type air cleaners. Under the AFI⁶ and the former ASHVE⁷ procedures dust-holding capacity is defined as the product of the weight of dust reaching the filter and the average efficiency at a specified resistance and air flow. Dust loading and arrestance determinations are made simultaneously, arrestance and resistance being determined for each increment of feed with the results plotted against weight of dust fed or against accumulated load in the filter.

Dirt loading measurements are made at the National Bureau of Standards⁸ by feeding a mixture of 4 percent cotton linters and 96 percent Cottrell precipitate (by weight) to the test filter. The two ingredients are separately dispersed into the air stream, using two aspirating-type injectors. The measurements show the relationship between the pressure drop and the weight of dirt mixture received at the filter. The curves in Fig. 4 illustrate the difference in the dirt-loading characteristics of two filters, one a viscous-impingement type and the other a dry filter with an extended surface cellulose fiber medium, with dust and with lint.

SELECTION AND MAINTENANCE

To evaluate filters and air cleaners properly for a particular application, two factors should be carefully weighed: (1) the degree of air cleanliness required and (2) disposal of the dirt after it is removed from the air. These factors affect initial costs, operating costs and the extent of maintenance that will be required. Savings that accrue through reduction in house-keeping expenses, protection of valuable property and equipment, ability to carry on dust-free manufacturing processes, improved working conditions, and even health benefits should be credited against the cost of installing and operating an adequate system. The capacity and physical size of the unit required may emphasize the need for self-cleaning features. Operating costs, predicted life, and efficiency are more important than first cost, because air cleaning is a continuing process.

While electronic air cleaners have a higher first cost, they exhibit very high efficiencies in cleaning atmospheric air, due largely to their ability

to remove fine dust which shows no gravitational effect. They are equally effective on coolant oil mists from high speed cutting and grinding machines. System resistance remains unchanged as dirt is being collected, and the resulting residue is disposed of directly to prepare the equipment for further duty. The charged-media type cleaners are less effective than the ionizing type, but are appreciably better than mechanical filters in the matter of small particle collection.

The advantage of the moving-curtain impingement type filter consists in the small amount of attention which it requires. Such devices are therefore to be recommended where labor is scarce, or where reliable and frequent attention to filters cannot be assumed. The constant pressure drop of this type of filter is an advantage. The first cost is substantially greater than that of unit filters, and the dust arrestance may not be any higher.

Unit filters constitute the majority of air cleaners now in use, and some choice is possible between the types available. Where lint in an eminently dry state predominates, a dry filter obviously may be preferable to other types because of its lint-holding capacity. If the lint is greasy, or if oil vapor exists in the air, the dry filter, if it is of the cleanable type, may be troublesome, since grease tends to make it difficult to clean. Most dry types, however, employ a throw-away type of medium which is held in permanent metal frames so that the difficulty of cleaning the medium is avoided. Some dry filters are capable of high efficiencies, compared to other unit filters on fine particles, but their dust-holding capacity for such dust may be inferior to that of the viscous impingement type.

Viscous impingement unit filters are practically standard in size, and their overall dimensions are small when compared with their ratings.

Throw-away units are often installed in series so that the one in front, which usually becomes plugged with lint, can be discarded, after which the downstream unit is moved to the front and replaced by a new unit.

Viscous impingement unit filters do not have efficiencies as high as can be expected with some other types of unit filters, but their first cost and upkeep are generally lower, whether of the cleanable or the throw-away type. They require more careful attention than the moving-curtain type if the resistance is to be maintained within reasonable limits.

FILTER INSTALLATION

Many air cleaners are available in units of convenient size for handling when installing, cleaning, or replacing. Such units are usually designated as filters or unit filters. A typical unit filter may be 20 in. square and from one to several inches thick, depending on the manufacture and proposed use. In large systems, a number of such units are installed adjacent to each other and collectively called a bank of filters.

Air cleaners are commonly installed in the outdoor air intake ducts of buildings, and generally in the recirculating and by-pass air ducts as well. Cleaners are logically placed ahead of heating or cooling coils and other air conditioning equipment in the system to protect them from dust. The character of the dust arrested by the filters in an air intake duct is likely to be mostly particulate matter of a greasy nature, while lint may predominate in dust from within the building.

The published performance data for all air filters are based on *straight through* unrestricted air flow. Filters should be installed so that the face