

water. This will control exactly the temperature and relative humidity of the leaving air. Two or more tempering sections are required for this method.

4. The fourth method is desirable where recirculation is used and consists in maintaining the temperature leaving the washer at about 40 deg. by means of a thermostat located at this point controlling the admixture of fresh and return air through automatically operated dampers. This prevents over-humidification, eliminates danger of freezing, and effects the highest economy in cost, as no steam is required for either tempering or humidifying, except after the air has passed the washer.

5. The fifth method of automatic control is to reheat the air leaving the air washer to a definite thermostatically controlled temperature, and to control the relative humidity of the air by means of a hygrostat which operates either on the tempering sections to heat the air or which controls a water heater for the spray water.

Steam Requirements

Where the spray water is not heated it is necessary that the wet-bulb temperature of the incoming air be above the freezing point; otherwise the eliminator plates will coat with ice and stop up, even if the dry-bulb temperature of the leaving air is above the freezing point. It is necessary to heat zero air to 43 deg. in order that the wet-bulb temperature may be 35 deg. The temperature of the leaving air may then be expected to be approximately 39 deg. dry bulb and 35 deg. wet bulb, with a dew-point of 31 deg. If the humidifying capacity of the washer is 75 per cent the additional heat required to furnish humidification is that indicated by the temperature drop of 9 deg., or 162 B.t.u. per 100 cu. ft. of air, or 1 b.hp. for every 3,400 cu. ft. of air per minute.

These are the minimum requirements for humidification, above those required for heating the air. Table 1 gives the heat required, from various outside entering wet-bulb temperatures, to various dew-point temperatures corresponding with various relative humidities at 70 deg.

These values are the total heat required for both heating and humidifying the air. The amount of heat required for humidifying only, may be found by subtracting from the values given, the heat required to raise the temperature of 1,000 cu. ft. of air per minute between the limits specified. The heat required for heating the air is given by the formula

$$H = 1,000 \frac{t_2 - t_1}{55.5}$$

where

H = B.t.u. required to raise 1,000 cu. ft. of air from a temperature of t_1 to a temperature of t_2 deg. fahr.

VISCOUS CELL FILTERS

Viscous-coated air filters are distinguished from air washers in that they clean the air without the use of water. Thus the temperature and moisture content of the air are not changed by passing through a viscous filter.

The principle of air cleaning used in these filters is that of *adhesive impingement*. Dust and dirt in the air, especially soot and carbons, are trapped and retained by successive impingements on oil coated surfaces. While the arrangement of filtering media and the kind of materials used are almost unlimited, there are certain rather definite requirements for a practical commercial filter.

TABLE 1. HEAT REQUIRED TO RAISE 1,000 CU. FT. OF AIR FROM VARIOUS OUTSIDE ENTERING WET-BULB TEMPERATURES TO VARIOUS DEW-POINT TEMPERATURES AND CORRESPONDING RELATIVE HUMIDITIES AT 70 DEG. FAHR.

See Marks' Engineers Handbook.

WET-BULB TEMPERATURE OF ENTERING AIR, DEG. FAHR.	RELATIVE HUMIDITY, PER CENT AT 70 DEG. FAHR. (AND DEW POINT, DEG. FAHR.)					
	30% (37.25)	40% (44.5)	50% (50.5)	60% (55.3)	70% (59.6)	80% (63.5)
-10	1194	1452	1653	1860	2044	2245
0	984	1246	1447	1663	1840	2039
10	750	1025	1228	1445	1621	1822
20	510	779	983	1200	1377	1581
30	300	496	700	920	1097	1300
40	-----	-----	-----	-----	-----	-----
50	-----	-----	-----	-----	-----	-----
60	-----	-----	-----	-----	-----	-----

In order to secure maximum efficiency it is necessary to divide the air into innumerable fine streams; the more intimately and freely the air is brought into contact with the viscous-coated media the better the cleaning will be. As the dirt and dust particles are leached out of the air and collected on the adhesive-coated surfaces, additional supplies of viscous liquid are required in order to bind further layers of dirt. For this reason the filter medium in *unit filters* is usually designed to hold, somewhere within the cell, additional supplies of viscous liquid, capable of distribution by capillary attraction.

Investigations in this country and abroad demonstrate that the first impingement of dust laden air on a viscous coated surface removes about 60 per cent of the dust, the next impingement takes 60 per cent of what then remains—that is, 24 per cent—the next impingement removes 9.6 per cent, etc. This tendency to eliminate progressively smaller amounts of dust at each impingement, even though finer dust particles are caught at each successive impingement, has led to progressively packed filter media in practically all unit filters. Such an arrangement provides relatively large spaces for the collection of dirt in the front part of the filter, where the bulk of solids is taken out, without undue increase in resistance, while at the back of the filter the openings are smaller and finer dust particles are removed.

The binding liquid used with viscous filters should have the following properties:

1. Its surface tension should be such as to produce a homogeneous film-like coating on the filter medium.
2. The viscosity should vary only slightly with normal changes of temperature.
3. It should be germicidal in its action to prevent the development of mold spores, bacteria, etc., on the filter media.
4. The liquid should flow freely at low temperatures.
5. Evaporation should not exceed 1 per cent.
6. It should be fireproof.
7. It should be odorless.