

of the total mass. This method of continuous regeneration and re-concentration tends to hold the relative humidity of the leaving air always at a very definite point.

There are two methods of regeneration. One is the boiling of the excess moisture by raising the temperature of the adsorbing liquid to above the boiling point of the particular concentration. As the salt in the solution does not vaporize, it is not carried off in the boiling process. The only care required is that in the small amounts of liquid diverted to the regenerator for concentration, too much moisture is not driven off, occasioning freezing or solidification of the salts, or solids.

The second method of regeneration which lends itself particularly well to ordinary low pressure heating systems, where steam pressure of about 12 lb per sq in., corresponding to a temperature of 242 F, is to raise the temperature of solution with ordinary steam coil interchangers to about 225 F, and then to pass the solution at this temperature over various types of scrubbers, over which ordinary air is passed. The increase in temperature of the liquid adsorber tends to increase its vapor pressure to such an extent that there is an exchange of vapor between the liquid adsorber and the air, as well as an equalization of temperature between the air and the liquid adsorber, so that the air is capable of taking up part of the moisture from the liquid adsorber to increase its density and to carry this excess moisture out into the atmosphere with the leaving air.

After this vaporation has taken place, the highly concentrated, hot liquid adsorber is taken through an interchanger through which the water used in cooling the main solution can be re-used to reduce the temperature of the concentrated solution to a point where it may be thrown back into the main solution tank at a slightly higher temperature than the main body of the solution. As approximately only 10 per cent of the solution is regenerated continuously, a difference of 5 to 10 F in the concentrating solution only creates a rise of 1 F or less in the main body of the adsorber, so that its effect on increasing the temperature of the air to be dried is negligible.

As can be seen, there are two conditions of continuous operation which have a tendency to raise the temperature of the liquid. One is the adsorption of vapor from the air, which, through a change of state, changes the latent heat of the vapor adsorbed to sensible heat, to raise the temperature of the liquid and consequently, the temperature of the air; secondly, the necessary heat added to the regenerator liquid in order to reevaporate and carry off the excess moisture which has been condensed in the first stage.

In the regeneration process, the air currents in this method have a tendency to carry away the excess heat of evaporation. In the first stage, that is, the main stage of adsorption, the temperature of the main body of liquid is continuously cooled, and the excess heat carried away by some type of interchanger, through one part of which either cooling tower or city water is utilized. Of course, this water may be refrigerated, but under most conditions that is unessential. With the ordinary liquid interchanger, using cooling tower water, the maintained condition of the liquid and the air can be kept at a point very close to the prevailing wet-bulb, possibly within 5 F, and certainly within 10 F.

Design of System

When designing air conditioning systems, the capacity of equipment is decided by selecting apparatus of sufficient size to maintain predetermined temperatures and humidities in treated spaces when arbitrarily established maximum atmospheric temperatures occur coincident with given conditions of population, lighting, and power consumption. These factors determine the maximum duty of the cooling system. The duty does not necessarily determine the size or capacity of the refrigeration apparatus. The refrigerating capacity is expressed in *tons*, each ton being equal to the absorption of the heat given up by one ton of ice at 32 F melting to water at 32 F in 24 hours. This is equivalent to heat absorption at a rate of approximately 200 Btu per minute, or 12,000 Btu per hour.

After the maximum duty is determined, the other factors concerning the installation must be investigated. The total heat to be removed by the cooling system has many sources, some substantially constant and others extremely variable. These sources can be roughly classified as follows, the first column indicating the order in amount and the second the order in variability:

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| 1. Fresh air supplied. | 1. Fresh air supplied. |
| 2. Population. | 2. Transmission through the structure. |
| 3. Transmission through the structure. | 3. Light and power consumed. |
| 4. Light and power consumed. | 4. Population. |

By combining these two columns, a third grouping is obtained as follows:

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| 1. Fresh air supplied. | 3. Population. |
| 2. Transmission through the structure. | 4. Light and power consumed. |

In this last arrangement, the first two items are governed by atmospheric conditions and they are therefore subject to tremendous fluctuations in value. As they generally form 40 to 60 per cent of the entire maximum load, the duty of the cooling system will be much less than maximum most of the time.

The transmission through the structure is especially influenced by the sun. (See Chapter 8.) In many cases, because of the heat flow resistance of the structure, the heat from the sun is retarded until it is compensated for by a reduced general temperature out-of-doors.

A survey of Weather Bureau records indicates that maximum temperatures occur less than 5 per cent of the cooling period and also that the duration of peak conditions is never more than three or four hours.

Two factors control the size of the refrigeration system, the evaporator or suction temperature, and the condenser or head temperature. With the knowledge that the system will operate most of the time with a load of not over 60 per cent of maximum, and that maximum demands will occur infrequently and only for short periods, some provision must be made to insure economical operation under average conditions. This can be done by overloading the machine under extreme demands and basing the design on normal or average loads. Flexibility in arrangement can be provided in several ways.

Variations in load change the efficiency of any machine and a refrigerating system can be costly and inefficient if improperly designed or operated.