ABSORBENTS

Any absorbent substance may be used as a dehumidifying agent if it has a vapor pressure with respect to water lower than the partial pressure of the water vapor in the mixture from which the moisture is to be removed.

Solid Absorbents. The substances used are generally the solid forms of the liquid absorbents. At present they are used principally in small desiccating chambers and in small dryers of the cartridge type, through which air is forced under pressure. Calcium chloride is frequently used because of low cost.

Liquid Absorbents. These are primarily water solutions of materials in which the vapor pressure is reduced to a suitable level by controlling the concentration and temperature of the dehumidifying solution. Water solutions of the chlorides or bromides of various inorganic elements and certain organic compounds, are the liquid absorbents used in air conditioning.

In addition to having suitable water vapor pressure characteristics, an absorbent, to be satisfactory, should also meet the following requirements:

1. Be widely available at low cost.
2. Be non-corrosive, odorless, non-toxic, and non-inflammable.
3. Be chemically inert against any impurities in the air stream.
4. Be stable over the range of use.
5. Must not precipitate at the lowest temperature to which the apparatus is exposed.
6. Have low viscosity, and be capable of being economically regenerated or concentrated after having been diluted by the moisture absorbed.

DEHUMIDIFICATION BY LIQUID ABSORBENTS

In liquid absorption systems the air-vapor stream is brought into intimate contact with the absorbent solution by passing the air stream through a tower into which the brine is introduced as a finely divided spray, or by passing the air through a tower or contactor which is continuously sprayed with the brine, thereby presenting a large surface of absorbent to the air to be dehumidified. The difference in the partial pressure of the water in the concentrated brine and the partial pressure of the water vapor in the air, causes the water vapor to be given up by the air to the brine until equilibrium is approached. The water vapor is condensed during this operation, and its addition to the absorbent solution results in a decrease in the concentration of the solution. As the water vapor condenses, the latent heat of condensation is released in the absorbent solution. An additional, frequently appreciable, quantity of heat known as the heat of solution or heat of mixing, is also released. The heat released as the result of condensation and mixing, is directly transferred to the brine, to the equipment, and to the air being dehumidified, thereby causing a rise in temperature.

A modified system includes means for removing heat from the absorbent solution, either within the contactor or externally. Thus the temperature of the solution may be higher than, equal to, or lower than that of the air, depending on the chemical employed and the ultimate use of the dehumidified air.

Fig. 3 shows the relationship between temperature, vapor pressure and moisture content of a typical absorbent of the *inorganic* type. These curves indicate the general performance of such absorbents, although the exact values vary for the different compounds.

When the given absorbent is in equilibrium with air having a dry-bulb temperature of 70 F and a relative humidity of 70 percent, *i.e.*, having a dew-point of 60 F, or a water vapor pressure of 13.2 mm Hg, the water content of the solution is 4.8 lb water per pound of anhydrous absorbent. With air having the same dry-bulb temperature and a dew-point of 37 F, or a vapor pressure of 5.6 mm Hg, the water content is 2.1 lb per pound of absorbent. Therefore, when a solution of 2.1 lb water per pound of absorbent is exposed to an atmosphere of 70 F and 70 percent relative humidity, it will absorb an additional 2.7 lb of water in reaching equilibrium.

The effect of temperature on the absorptive capacity may be observed by following a constant vapor pressure line in Fig. 3. At a temperature of 70 F and a vapor pressure of 13.2 mm Hg, the moisture content is 4.8 lb water per pound of absorbent. At 100 F, the moisture content is 1.8 lb water per pound of absorbent.

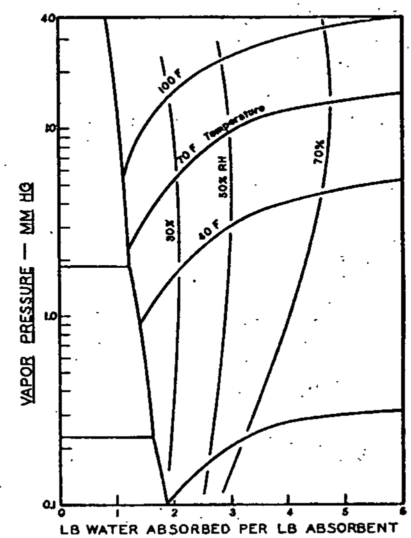

FIG. 3. TEMPERATURE—VAPOR PRESSURE—CONCENTRATION CHARACTERISTICS FOR A TYPICAL INORGANIC ABSORBENT (HALOGEN SALT GROUP)

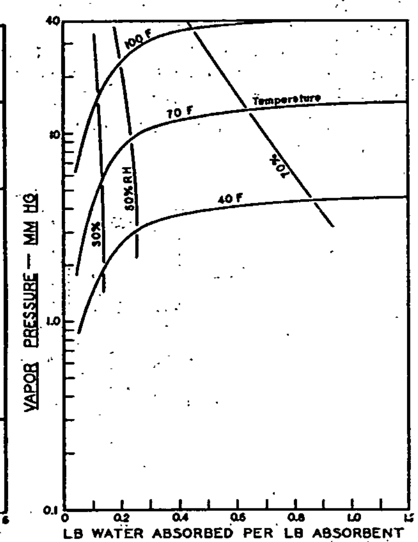

FIG. 4. TEMPERATURE—VAPOR PRESSURE—CONCENTRATION CHARACTERISTICS FOR A TYPICAL ORGANIC LIQUID ABSORBENT

Fig. 4 shows the relationship between temperature, vapor pressure, and moisture content of a typical liquid absorbent of the *organic* type.

DEHUMIDIFICATION EQUIPMENT USING LIQUID ABSORBENTS

One type of system utilizing liquid absorbents includes an external interchanger having essential parts consisting of a liquid contactor, a solution concentrator, a solution heater and a cooling coil, all as shown in Fig. 5. The contactor and cooling coil are located in the wet air stream. The air to be conditioned is brought into contact with an aqueous brine solution having a vapor pressure below that of the entering air, resulting in a transfer of moisture from the air to the brine solution. This results in a conversion of latent heat to sensible heat, which raises the solution temperature and consequently, the air temperature. The temperature change of the