

Absorbents

Any absorbent substance may be used as an air drying agent if it has a vapor pressure lower than the vapor pressure in the air-vapor mixture from which the moisture is to be removed.

Solid Absorbents. The substances used are in general the solid forms of the liquid absorbents, more commonly calcium chloride due to its low cost. 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.

Liquid Absorbents. These are characteristically water solutions of materials in which the vapor pressure is reduced to a suitable level by governing the concentration of the solution. In addition to having suitable vapor pressure characteristics a practical absorbent must also be widely available at economical cost, be non-corrosive, odorless, non-toxic, non-inflammable, chemically inert against any impurities in the air stream, stable over the range of use and especially it must not precipitate out at the lowest temperature to which the apparatus is exposed. It must have low viscosity and be capable of being economically regenerated or concentrated after having been diluted by absorbing moisture.

Water solutions, or brines, of the chlorides or bromides of various inorganic elements such as lithium chloride and calcium chloride are the absorbents most frequently used in connection with air conditioning applications and detailed attention is confined to these two in this chapter.

Nature of Absorption Process

The application consists of bringing the air-vapor stream into intimate contact with the absorbent, permissibly by passing the air stream through a finely divided spray of the brine but more generally by passing the air over a contacting pack where the liquid absorbent presents a large surface to the air stream. The difference in vapor pressure causes some of the vapor in the air-vapor mixture to migrate into the brine. Here it condenses into liquid water and decreases the concentration of the absorbent.

As the water vapor is added to the absorbent and condenses, it gives up its latent heat of condensation which tends to raise the temperature of both the absorbent and the moist air stream. For every pound of water absorbed and condensed the heat added to the air stream and the brine combined is obtainable from steam tables. For instance, at 60 F the amount of this heat is about 1057 Btu. In addition to this heat there is involved also the so-called heat of mixing which is frequently considerable.

A more complicated cycle involves heat removal from the contacting medium, either within or external to the interchanger. Thus the temperature of the medium may be higher than, equal to, or lower than that of the air, depending on the agent used and the function to be performed. In such a cycle, the dehydration process may be accompanied by cooling or heating, or neither, and such effect, if present, may be either a necessary by-product of the process, or for the specific purpose of obtaining both latent and sensible heat removal simultaneously. The heat thus produced in the bed is to a large extent transferred to the air being dried, and in the average air conditioning installation must be removed by passing the air through an aftercooler.

Temperature—Pressure—Concentration Relations

Since the absorption process can continue only as long as there is a difference in vapor pressure between the absorbent and the air-vapor mixture and since at a given temperature of the absorbent the vapor pressure depends on the concentration of the solution, evidently there must be a relation between these quantities which if known would state the limits of the process. The relationship would also depend on the absorbent being used, and would have to be determined for each substance used as an absorbent. This relationship is shown graphically in

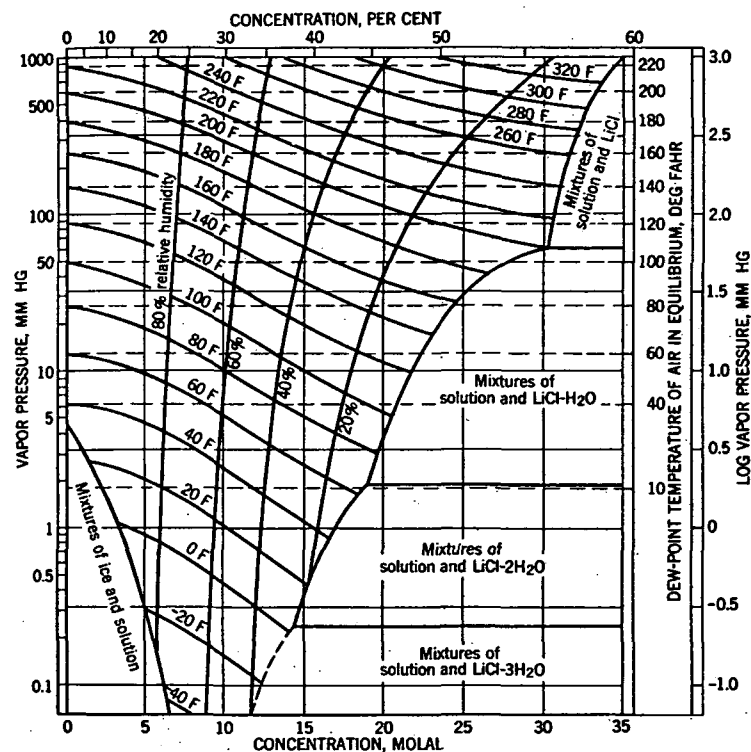


FIG. 2. TEMPERATURE—PRESSURE—CONCENTRATIONS FOR LITHIUM CHLORIDE

Fig. 2 for lithium chloride, and Fig. 3 presents similar data for calcium chloride. These charts are essentially similar to Fig. 1, and their direct usefulness is limited by much the same considerations. Other physical properties of lithium chloride are shown in Tables 1, 2 and 3.

In Fig. 2 and Table 1 the unit of concentration is the *mol*. A *M* molal solution is defined as a solution containing $M \times 42.37$ grains of anhydrous lithium chloride per 1000 grains of water. The formula connecting concentration in mols with weight in per cent is equivalent to: $(100 \times M \times 42.37) \div [1000 + (M \times 42.37)]$.