tion line represents the limiting concentrations of water vapor which can exist as vapor at various temperatures.

A common condition inside buildings, 70 F and 40 percent relative humidity, is represented by point A. This is a condition of partial saturation; *i.e.*, less than 100 percent relative humidity. The vapor pressure of the water present in the air, although not shown on the chart, can be calculated readily from the vapor pressure at saturation and the relative humidity, since relative humidity is very nearly equal to the ratio of the actual vapor pressure to the saturation pressure at the existing temperature.

The increasing relative humidity accompanying cooling from the condition represented by A on the chart to point B can readily be followed. At B, however, at 44.6 F, the relative humidity becomes 100 percent, and the air-vapor mixture is said to be saturated. The temperature at which this particular air-vapor mixture, upon cooling, becomes saturated is its

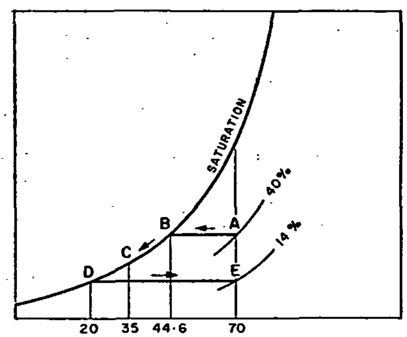

Fig. 1. Two Typical Heating and Cooling Processes in Air within Buildings Shown on A.S.H.A.E. Psychrometric Chart

dew-point temperature. Upon further cooling, to 35 F, the original amount of water vapor can no longer be retained and is reduced, in this case, to the condition represented by C, from 0.0633 lb per lb dry air to 0.0427 lb per lb dry air. The process ABC is typical of that which an air-vapor mixture experiences when it comes in contact with a cool window surface. Cooling from B to C results in visible condensation on the glass surface. If the point C were below 32 F, the condensation would be in the form of frost.

Once the temperature drops below the dew point, or frost point if below 32 F, the vapor pressure at the condensing surface is also reduced, thereby establishing a gradient of vapor pressure from the room air to the window surface. This gradient will operate, in conjunction with the convective action within the room, to move water vapor continuously to the window surface to be condensed, so long as the concentration of water vapor in the room is maintained.

A common winter process is that shown by DE, showing air at 20 F saturated, being heated to 70 F with a resulting large decrease in relative humidity. This explains, in part, the greatly reduced relative humidities

experienced in houses in extreme cold weather, when cold outside air enters the house and is heated.

WATER IN BUILDING MATERIALS

The surfaces of most common materials have an affinity for water molecules. Molecular forces of attraction will hold water molecules to the surface, but decrease very rapidly with increase in distance of molecular proportions. The film thickness and therefore the amount of water held in equilibrium with the surrounding atmosphere is roughly proportional to relative humidity. Surface films of water molecules, at low humidities, may be only one molecule thick; at moderate humidities poly-molecular films may be established, while at humidities very close to 100 percent, the films become so thick, relatively, that small pores may become filled and larger capillaries may be partially filled. At saturation conditions all voids in the material may be completely filled.

Some materials such as silica gel, alumina and most natural fibrous materials present very large effective surfaces to the water molecules, so that the amount of water held on the effective surface in these materials may be relatively large, even at moderate humidities. These are said to be hygroscopic. Other materials, such as most metals, not penetrated by the water molecules, present relatively small surfaces and so may take only minute quantities of water, except when wetted directly by liquid.

Substances having a great affinity for water, and their use as dehumidifying agents, are described in Chapter 37. Data on the moisture contents of various common materials in equilibrium with the atmosphere at various relative humidities are given in Table 2 of Chapter 46, and equilibrium moisture content is further discussed in Chapter 47 on Industrial Drying Systems.

Significant dimensional changes take place in many materials used in buildings, with change in moisture content. Those which take place in wood, of the order of 0.1, 2, and 4 percent in the longitudinal, radial and tangential directions, respectively, on a change from air dry at 12 to 15 percent moisture content to oven dry are perhaps the best known. Most wood-fiber products, including papers, will exhibit moisture expansion consistent with the basic wood properties to a degree dependent on the fiber orientation and arrangement. Data on wood are available in publications on wood technology. Almost all plant and animal fibers experience appreciable moisture changes with changing relative humidity and undergo substantial dimensional changes of the same order as those in wood. Less generally recognized are the dimensional changes which can occur in masonry materials as a result of changes in moisture content.

Water is either an essential or a contributory factor in almost all cases of breakdown of building materials resulting from chemical changes such as the rusting of steel, physical changes such as the spalling of masonry by frost action, or biological processes such as the rotting of wood. The control of water in building constructions may be necessary to ensure adequate service from the materials involved.

Condensation of water vapor, although not the only means by which wetting may be brought about, is nevertheless a most insidious one particularly in respect of freeze-thaw breakdown, since from its nature it is most likely to occur at points of low temperature at which there may later be risk of freezing while the material remains in a saturated condition.