increases the drying time very much or causes a change of the physical properties of the material. It is often necessary to add humidity to the air in the initial stage of drying. Lumber case-hardens, cracks, and warps if the outside is dried too fast. Ceramics crack if not heated through before drying commences. Elastic materials warp or crack if not evenly dried. Many paints case-harden if not dried under high humidity.

On the other hand, in the case of those materials whose physical or chemical properties require that they be dried at relatively low temperatures, high humidity tends to retard drying in the first stage and may even stop it altogether in the final stage. Where drying temperatures below 120 to 140 F are used, the drying rate may be highly dependent on atmospheric humidity conditions. In such instances it is often desirable to dehumidify the air entering the dryer during periods of high atmospheric humidity; where a high degree of uniformity is required, it is often possible to secure complete independence of atmospheric conditions by recirculating the air in a closed system which includes a suitable dehumidifier. For this purpose absorptive dehumidifying systems have the advantage of accomplishing the desired reduction of humidity without appreciably elevating or lowering the dry-bulb temperature of the air; for this reason after-cooling is not required, and reheating is reduced to a minimum. Dehumidifying systems are described in Chapter 38.

Air Circulation

As noted under Mechanism of Drying, air velocity is more important in the first two stages of drying than in the last, and for this reason zone drying in continuous dryers is frequently considered. It permits accurate regulation of temperature, humidity, and velocity in the different zones. High velocity results in more rapid drying, more even distribution of temperature and consequently more even drying in the first period. Too high a velocity may be detrimental because of excessive power needed for creating it, or because the material may blow away if it is light and fluffy. In the drying of paints, varnishes, and enamels, high velocity or improper distribution of the air, even with the use of filters, may cause dust already in the dryer to be blown against the material, ruining the finish.

DRYER CALCULATIONS

The fundamental calculations for the design and performance of dryers are based on the thermodynamics of air and water mixtures treated in Chapter 3, and the fundamentals of heat transfer treated in Chapter 5. For the humidity calculations a high-temperature psychrometric chart is given in Fig. 6. In addition to the fundamental heat transfer calculations of radiation, conduction and convection, the heat losses through the walls of the dryer will be computed by the methods illustrated in Chapter 6 and Chapter 41. Data on radiation calculations are given in Chapter 31.

Where products of combustion are used directly in a dryer, a knowledge of the properties of fuels and combustion products is important. Data on fuels and combustion are given in Chapter 16. For determining the heat available in products of combustion, a specific heat of 0.25 Btu per (pound) (Fahrenheit degree) may be used.

The calculations for drying during the constant-rate period are different from those applying to the falling-rate period.

Constant-Rate Period

The rate of drying by air passing over a wet surface is directly proportional to the vapor pressure difference, and also proportional to the

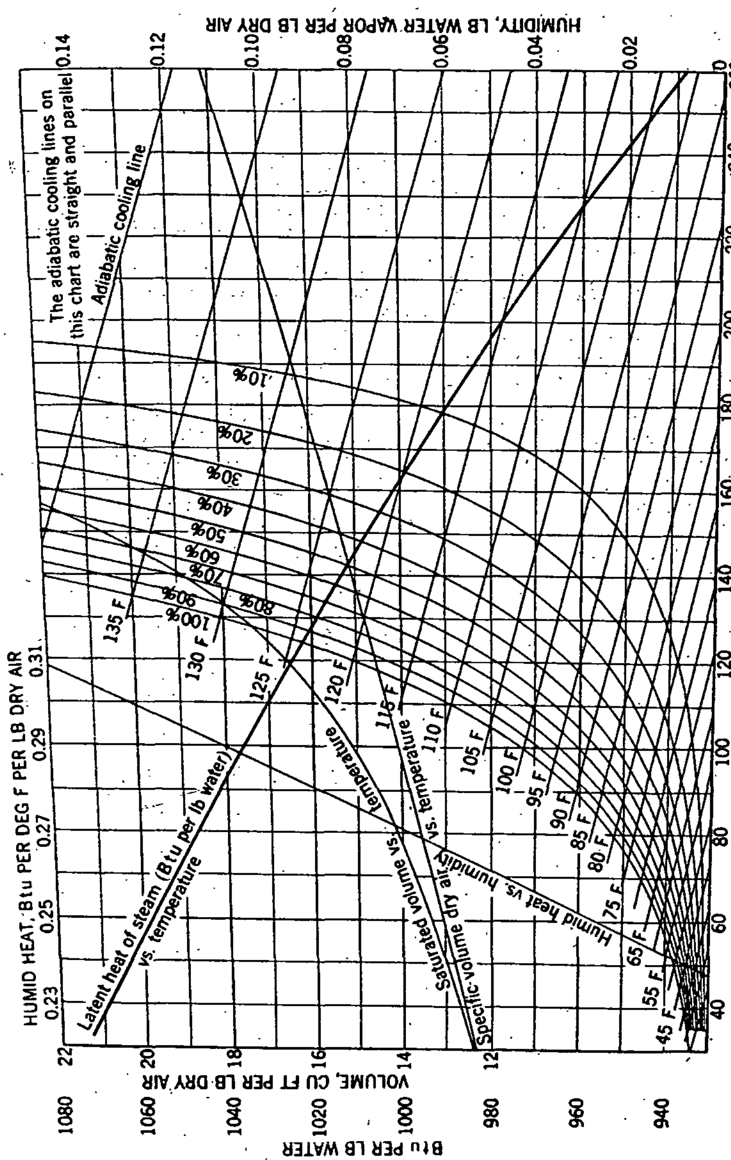

Fig. 6. Humidity Chart