where h_c = heat-transfer coefficient by convection, J/(m²·s·K) [Btu/(h·ft²·°F)]; t = air temperature, K; t_w = wet-bulb temperature of air, K; k'_g = mass-transfer coefficient, kg/(s·m²) (kg/kg) [lb/(h·ft²)(lb/lb)]; λ = latent heat of evaporation at t_w, J/kg (Btu/lb); H_w = saturated humidity at t_w = kg/kg of dry air; and H_a = humidity of the surrounding air, kg/kg of dry air.

For air–water-vapor mixtures, it so happens that $h_c/k'_g = C_s$ approximately, although there is no theoretical reason for this. Hence, since the ratio $(H_w - H_a)/(t_w - t)$ equals $h_c/k'_g/\lambda$, which represents the slope of the wet-bulb-temperature lines, it is also equal to C_s/λ, the slope of the adiabatic-saturation lines as shown previously.

A given humidity chart is precise only at the pressure for which it is evaluated. Most air–water-vapor charts are based on a pressure of 1 atm. Humidities read from these charts for given values of wet- and dry-bulb temperature apply only at an atmospheric pressure of 760 mmHg. If the total pressure is different from 760 mmHg, the humidity at a given wet-bulb and dry-bulb temperature must be corrected according to the following relationship.

$$H_a = H_o + 0.622 p_w \left(\frac{1}{P - p_w} - \frac{1}{760 - p_w} \right) \qquad (12\text{-}23)$$

where H_a = humidity of air at pressure P, kg/kg of dry air; H_o = humidity of air as read from a humidity chart based on 760-mm pressure at the observed wet- and dry-bulb temperatures, kg/kg dry air, p_w = vapor pressure of water at the observed wet-bulb temperature, mmHg; and P = the pressure at which the wet- and dry-bulb readings were taken. Similar corrections can be derived to correct specific volume, the saturation-humidity curve, and the relative-humidity curves.

HUMIDITY CHARTS FOR SOLVENT VAPORS

Humidity charts for other solvent vapors may be prepared in an analogous manner. There is one important difference involved, however, in that the wet-bulb temperature differs considerably from the adiabatic-saturation temperatures for vapors other than water.

Figures 12-37 to 12-39 show humidity charts for carbon tetrachloride, benzene, and toluene. The lines on these charts have been calculated in the manner outlined for air–water vapor except for the wet-bulb-temperature lines. The determination of these lines depends on data for the psychrometric ratio h_c/k'_g, as indicated by Eq. (12-22). For the charts shown, the wet-bulb-temperature lines are based on the following equation:

$$H_w - H = (\alpha h_c / \lambda_w k'_g)(t - t_w) \qquad (12\text{-}24)$$

where α = radiation correction factor, a value of 1.06 having been used for these charts. Values of h_c/k'_g, obtained from values of $h_c/k'_g C_s$ as presented by Walker, Lewis, McAdams, and Gilliland (*Principles of Chemical Engineering*, 3d ed., McGraw-Hill, New York, 1937), where C_s = humid heat of air with respect to the vapor involved, are as follows:

Material	Carbon tetrachloride	Benzene	Toluene
$h_c/k'_g C_s$	0.51	0.54	0.47

A discussion of the theory of the relationship between h_c and k'_g may be found in the psychrometry part of this section. Because both theoretical and experimental values of h_c/k'_g apply only to dilute gas mixtures, the wet-bulb lines at high concentrations have been omitted. For a discussion of the precautions to be taken in making psychrometric determinations of solvent vapors at low solvent wet-bulb temperatures in the presence of water vapor, see the paper by Sherwood and Comings [*Trans. Am. Inst. Chem. Eng.*, **28,** 88 (1932)].

GENERAL CONDITIONS FOR DRYING

Solids drying encompasses two fundamental and simultaneous processes: (1) heat is transferred to evaporate liquid, and (2) mass is

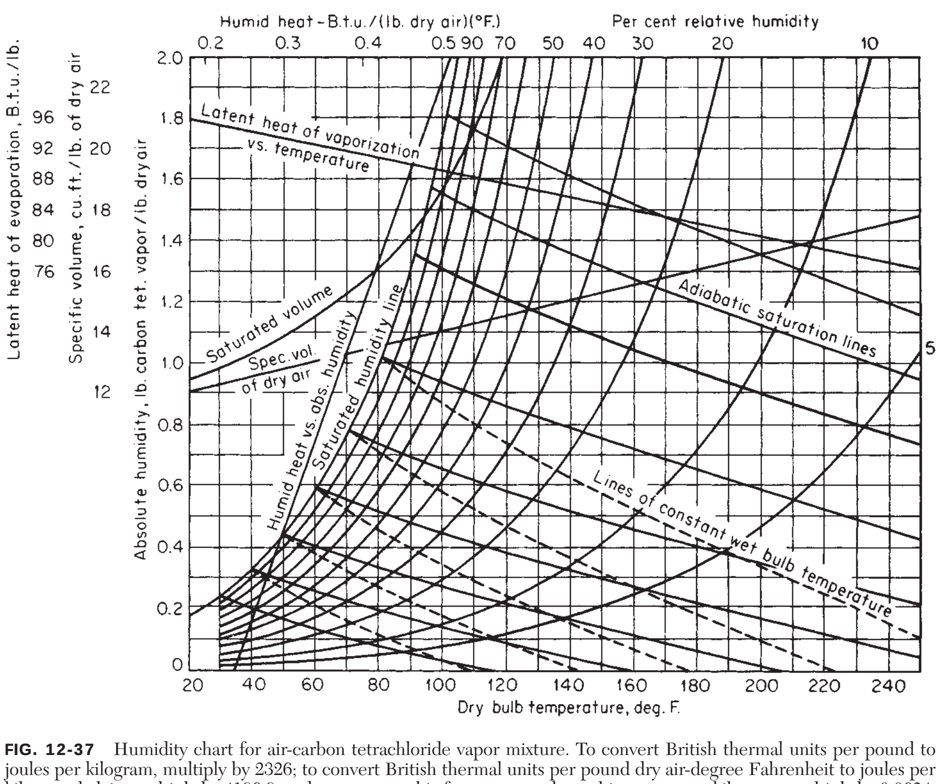

FIG. 12-37 Humidity chart for air-carbon tetrachloride vapor mixture. To convert British thermal units per pound to joules per kilogram, multiply by 2326; to convert British thermal units per pound dry air-degree Fahrenheit to joules per kilogram-kelvin, multiply by 4186.8; and to convert cubic feet per pound to cubic meters per kilogram, multiply by 0.0624.