is equal to the change in temperature times the specific heat, so Equation 12 can be changed to:

$$q = \eta_c G\,(t_1 - t_s)\,0.245 \qquad (13)$$

Dehumidification of Air

When moisture is being condensed on the coil surface Equation 12 can be used. If a coil has an efficiency of 0.8 (80 per cent) for the removal of sensible heat, it will at the same time remove 80 per cent of the difference in moisture content between the entering air and saturated air at the surface temperature. This is due to the fact that 80 per cent of the air particles contact the surface and attain a dew-point temperature equal to the surface temperature. This condition is expressed graphically in Fig. 13.

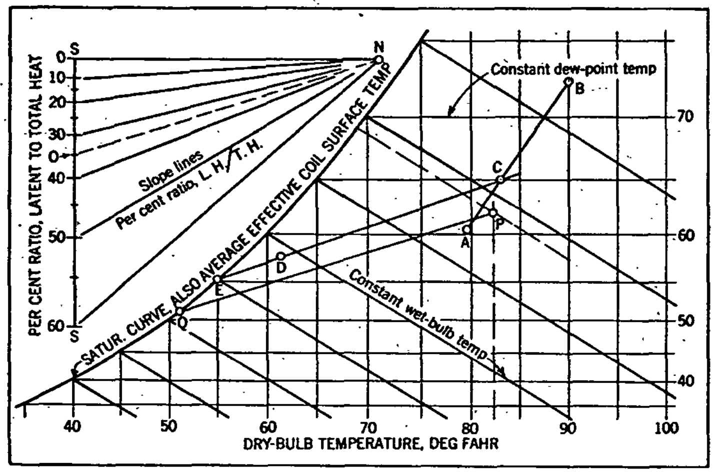

Fig. 13. Psychrometric Chart Showing Straight-Line Method for Representing Coil Performance

This psychrometric chart is constructed so that equal increments along the horizontal axis represent equal changes in sensible heat content, and equal increments along the vertical axis represent equal changes in latent heat content of air. Point *A* represents the condition of return or recirculated air, point *B* that of outside air, point *C* the mixture of two-thirds recirculated air and one-third outside air, and point *E* the average surface temperature. Point *D*, which represents the air leaving the coil, lies on a line which connects points *C* and *E*, and its distance from point *C* is equal to the length of the line *C-E* times the coil efficiency. The ratio between the vertical distance from *C* to *D* and the horizontal distance from *C* to *D*, expressed in heat units, is the ratio between latent heat and sensible heat removed. It can be shown by trigonometric relations that the slope of the line *C-D* is a measure of the ratio of latent to total heat removed, and that any line parallel to *C-D* gives the same heat ratio.

To enhance the practical usefulness of the psychrometric chart illustrated in Fig. 13, a set of marked master slope lines is included. The value of this arrangement is easily illustrated by the graphical example shown.

Example 1: To determine the required average effective external coil surface temperature. *Given:* (1) Air entering cooling coil at temperature of 83 F dry-bulb and 69 F wet-bulb. (2) Ratio of latent to total heat that must be removed from air is 35 per cent. *Required:* To find the average external coil surface temperature.

Solution. (1) Draw through point *N*, at the origin of the heat load ratio lines, a line *N-O* with a slope of 35 per cent in accordance with scale *S*. (2) Mark in the body of the chart, point *P* representing the condition of air entering the cooling coil at 83 F dry-bulb and 69 F wet-bulb. (3) Through point *P* draw a line *P-Q* parallel to line *N-O*. (4) The line *P-Q* intersects the saturation curve at 51 F, which means that the effective external coil surface temperature must be maintained at 51 F in order to obtain the desired 35 per cent latent to total ratio of heat removal from the air passing over the given cooling coil.

Inspection of Equation 12 reveals that the total capacity of a coil is dependent on the entering and leaving wet-bulb temperatures. The entering dry-bulb temperature is unimportant.

The amount of latent heat of condensation of a coil can be calculated from:

$$q_L = 1060\,\eta_c G\,(W_1 - W_s) \qquad (14)$$

where

q_L = latent heat removed, Btu per hour per square foot of coil face area.
W_1 = pounds of moisture per pound of dry air entering the coil.
W_s = pounds of moisture per pound of dry air saturated at the average surface temperature.
1060 = average value of latent heat of water vapor, Btu per pound of vapor.

The amount of sensible heat removed can be obtained by subtracting the value of q_L from the value of q in Equation 12.

Equation 12 gives accurate results when it is used for coils having a small change of temperature of the fluid in the tubes, as for example with evaporating refrigerants and with water having a small temperature rise. In cases where water in the tubes has a large temperature rise, the effective surface temperature changes throughout the depth of the coil, and in extreme cases moisture may be condensed on only a portion of the coil. In such cases it is possible to estimate the wet and dry portions of the coil separately, using cut-and-try methods.[6]

Internal Film Coefficient

The internal film coefficient, h_r, which appears in Equation 3, is evaluated in various ways, depending upon the nature of the fluid, and whether the fluid is changing state.

When evaporating refrigerants are being used in tubes, the temperature of the fluid is fairly constant, being affected principally by pressure drop through the tubes, by superheat of the evaporated refrigerant, and by the presence of oil in solution. To obtain maximum coil capacity it is necessary to keep the pressure drop through the tubes at a minimum (¼ lb per square inch), to keep the superheat as low as possible without carrying liquid back to the compressor, and to arrange for good separation and return of oil to the compressor. An additional important factor is the removal of gas so that the tube surface may be flooded with liquid as much as possible. The internal film coefficient is markedly increased by heavy heat loads, because the increased turbulence and gas velocity cause good contact of the liquid with the tubes. Values of h_r usually lie between 150 and 450. For rating of dehumidifying coils, satisfactory results are obtainable by first determining the average external surface

[6]Calculation of Coil Surface Areas for Air Cooling and Dehumidification, by John McElgin and D. C. Wiley (A.S.H.V.E. Transactions, Vol. 46, 1940, p. 139).