pressure drop of flowing fluids, by assuming that molecules of a fluid lose their momentum upon contact with a solid.

The fact that a coil starts to condense moisture when the surface temperature drops below the dew-point temperature of the entering air makes it possible to measure the surface temperature of a coil, an otherwise practically impossible task. After the surface temperature has been determined, it is possible to analyze completely the surface film coefficient of both the air side and refrigerant side of a coil.

The air side coefficient, h_a, of a dry coil of particular dimensions is an exponential function of the mass velocity of the air:

$$h_a = Z\,G^n \qquad (5)$$

where

h_a = film coefficient of heat transfer, Btu per (hour) (square foot external surface) (degree Fahrenheit mean temperature difference between air and average surface temperature).
G = air mass velocity, pounds per (hour) (square foot of coil face area).
Z and n = constants which depend upon both air turbulence and surface arrangement.

The difficulty of obtaining sufficient tests to evaluate the constants Z and n for all conditions of coil design and operation makes it desirable to use Equation 6 for determining the air side coefficient:

$$h_a = 0.245 \times \frac{G}{A} \times 2.3 \times \log_{10}\left(\frac{1}{1-\eta_c}\right) \qquad (6)$$

where

0.245 = specific heat of humid air, Btu per (pound) (degree Fahrenheit).
2.3 = the constant which converts logarithms from base e to base 10.
A = external surface area, square feet per square foot of coil face area.
η_c = coil efficiency, a decimal less than 1.0.

This formula gives values of h_a after tests have been made to evaluate the coil efficiency. Equation 6 can be derived[4] by combining the basic equations of heat transfer, mean temperature difference and coil efficiency:

$$q_s = h_a \times A \times MTD_a \qquad (7)$$

$$MTD_a = \frac{t_1 - t_2}{2.3\log_{10}\left(\frac{t_1 - t_s}{t_2 - t_s}\right)} \qquad (8)$$

$$\eta_c = \frac{t_1 - t_2}{t_1 - t_s}\ \text{(by definition)} \qquad (9)$$

$$q_s = 0.245 \times w \times (t_1 - t_2) \qquad (10)$$

where

q_s = sensible heat transferred, Btu per hour per square foot of coil face area.
t_1 = temperature of air entering coil, degrees Fahrenheit.
t_2 = temperature of air leaving coil, degrees Fahrenheit.
t_s = average temperature of coil external surface, degrees Fahrenheit.
MTD_a = logarithmic mean temperature difference between air and coil surface.

Coil Efficiency

One method of expressing air-coil contact efficiency is the ratio between the weight of air that actually contacts the coil surface and the total weight of air passing through the coil. Due to the fact that the specific heat of air is fairly constant over a wide range of temperature, coil efficiency[5] can be expressed as equal to the number of degrees that the entire amount of air is cooled, divided by the degrees difference between the entering air temperature and the coil surface temperature.

[4]Loc. Cit. Note 2.

For a particular heat transfer surface, coil efficiency is only a function of the mass velocity of the air, which may be observed by equating Formulae 5 and 6 and combining all constants into K and u:

$$\log_{10}\left(\frac{1}{1-\eta_c}\right) = \frac{K}{G^u} \qquad (11)$$

This equation can be used in graphical form by plotting coil efficiency against mass velocity as shown in Fig. 12. The significance of coil efficiency can be visualized in Fig. 13, where the length of the line C-D, divided by the length of line C-E, measures the coil efficiency. The relation between coil capacity and coil efficiency is given by:

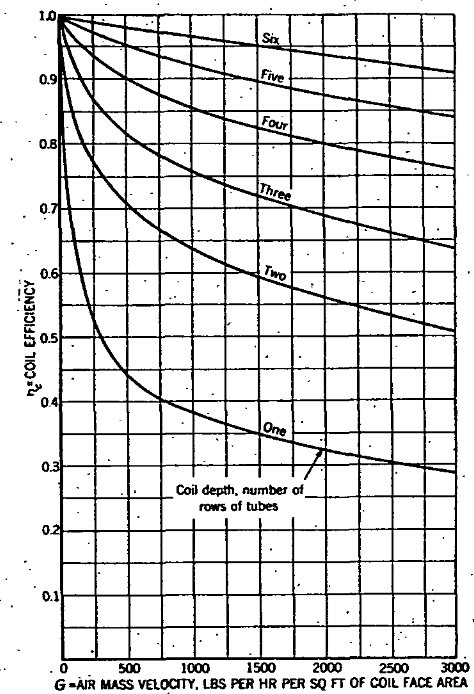

Fig. 12. Relation of Coil Efficiency to Mass Velocity

$$q = \eta_c G\,(h_1 - h_s) \qquad (12)$$

where

h_1 = specific enthalpy of air entering coil, Btu per pound.
h_s = specific enthalpy of saturated air at surface temperature, Btu per pound.

When no latent heat is being removed from air, the change in enthalpy

[5]When coil efficiency is used herein it is intended to express air-coil contact efficiency and does not express total performance efficiency.