Let $y = \frac{28.8AV_m\rho_v}{UPl}$ for rectangular ducts, and $\frac{7.2DV_m\rho_v}{Ul}$ for round ducts and solve for t_1 and t_2:

$$t_1 = \frac{t_2(y+1) - 2t_s}{(y-1)} \quad (25) \qquad t_2 = \frac{t_1(y-1) + 2t_s}{(y+1)} \quad (26)$$

For low velocities and long ducts of small cross-section, a somewhat more accurate formula may be used as follows:

$$t_2 = \frac{t_1 - t_s}{e^z} + t_s \quad (27)$$

where

$z = \frac{UPL}{14.4A\rho_v V_m}$.

e = Naperian base of logarithms = 2.718.

In using Equations 25, 26, and 27, one of the duct air temperatures will be unknown and will be obtained by substitution of the other known or assumed values.

Heat loss coefficients for insulated ducts with various conductivities are given in Fig. 16. The conductivities of various materials, which are based on mean temperatures, ranging from about 70 to 90 F, will be found in Table 2 of Chapter 9. For cases where the mean temperature is other than that at which the test was conducted, a correction should be made. However, in most cases the effect of this factor will be small and may be neglected.

Example 7: Determine the entering air temperature and heat loss for a duct 24 × 36 in. cross-section and 70 ft in length, insulated with ½ in. of a material having a conductivity of 0.35 Btu at 86 F mean temperature, carrying air at a velocity of 1200 fpm, measured at 70 F, to deliver air at 120 F with air surrounding the duct at 40 F.

Solution: Referring to Fig. 16, the overall heat transmission coefficient is found to be 0.49 Btu. From Table 1, Chapter 3 the density of air at 70 F and 29.921 in Hg. is found to be 1/13.348 = 0.0749 lb per cu ft. Substituting these and the other given values in Equation 25, y and t_1 will be as follows:

$$y = \frac{28.8 \times 6 \times 1200 \times 0.0749}{0.49 \times 10 \times 70} = 45.3$$

$$t_1 = \frac{120(45.3+1) - 80}{45.3 - 1} = 123.7F$$

Substituting in Equation 23:

$$Q_w = 0.49 \times 10 \times 70\left[\left(\frac{123.7 + 120}{2}\right) - 40\right] = 28{,}100 \text{ Btu per hr.}$$

For special considerations which apply to insulation of ducts in marine installations see Chapter 48.

MAINTENANCE

Ducts should be designed in such a manner as to enable easy maintenance.[23] They should have enough access doors, not only to enable inspection, but also to facilitate cleaning of the ducts.[24] The periodic cleaning of the ducts should be part of the regular maintenance schedule. It should be done efficiently and competently to avoid difficulties or hazards in the operation of the system.[25,26]

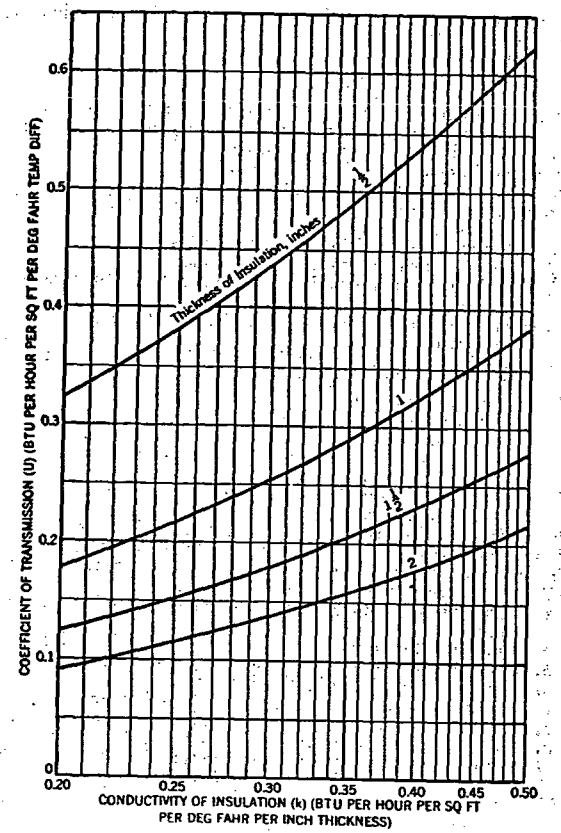


FIG. 16. HEAT LOSS COEFFICIENTS FOR INSULATED DUCTS[a]

[a] For round ducts less than 30 in. diameter, increase heat transmission values by the percentages shown below.

THICKNESS OF INSULATION (Inches)	½	1	1½	2
12 to 21 in. Duct Diameter	3%	5%	7%	9%
21 to 30 in. Duct Diameter	1%	2%	3%	4%

LETTER SYMBOLS USED IN CHAPTER 32

α = coefficient of contraction.
ϵ = absolute roughness, feet.
ρ_o = density of air under actual (operating) conditions, any consistent units.
ρ_s = density of air under standard conditions, any consistent units.