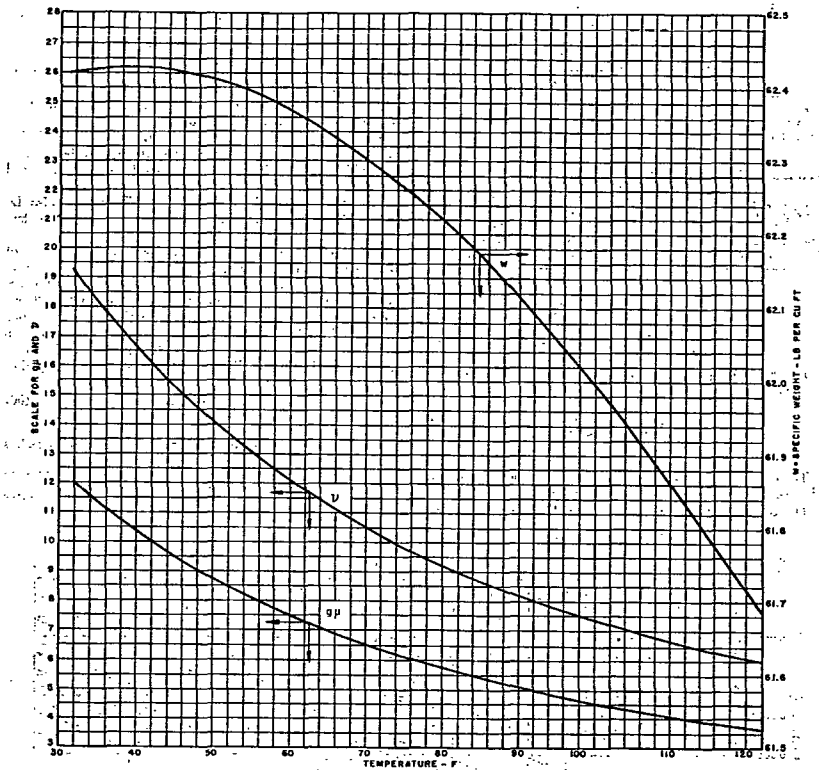


For values of gμ multiply scale reading by 10^{-4}, μ in (pounds force) (seconds) per square foot.
For values of ν multiply scale reading by 10^{-4}, ν in square feet per second.

Fig. 13 .... Specific Weight and Viscosity of Water Under a Pressure of 1 Atmosphere[15]

The pressure loss of the new elbow with splitters is calculated by using a loss coefficient based on the radius to duct depth ratio of the subdivided elbows. It should be mentioned that turning vanes may be lighter and have a lower pressure loss if a large number of duct divisions are used.

In the design of heat exchangers or other equipment which include in their geometry a sudden expansion and possibly blockage elements which may interrupt the expansion process, it is desirable to know the percentage of the sudden expansion pressure rise as a function of axial distance downstream of the expansion interface. Fig. 11 shows the wall static pressure rise expressed in terms of the velocity pressure in the smaller tube as a function of the axial distance downstream expressed non-dimensionally in terms of the difference in diameters for several sudden expansion diameter ratios. A blockage element does not materially alter the wall static pressure upstream of the element, and therefore, the curves in Fig. 11 can be used to describe conditions ahead of a blockage element.

PHYSICAL PROPERTIES OF FLUIDS

Physical properties of many of the common fluids used in heating ventilating are included in other chapters of this volume as shown in Table 6.

In determining friction pressure losses it is necessary to calculate Reynolds numbers; to make this calculation, fluid viscosity must be known more precisely than is shown elsewhere in this volume. In Fig. 12 the viscosity of some commercial gases are plotted as a function of temperature. In Fig. 13 the dynamic viscosity (μ), kinematic viscosity, (ν), and density of water are shown as functions of temperature. Kinematic viscosity is the ratio of dynamic viscosity to density (μ/ρ).

LETTER SYMBOLS USED IN CHAPTER 6

A = duct cross sectional area, square feet.
a = sonic velocity, feet per second.
b = shortest dimension of a rectangular duct, feet.
C_L = loss coefficient, dimensionless.
c = chord length, feet.
c_p = specific heat at constant pressure, Btu per (pound) (Fahrenheit degree).
c_v = specific heat at constant volume, Btu per (pound) (Fahrenheit degree).
D = equivalent diameter of duct, feet.
e = absolute roughness, feet.
f_D = D'Arcy-Weisbach friction factor, dimensionless.
g = acceleration due to gravity, 32.174 feet per (second) (second).
k = isentropic exponent = c_p/c_v.
L = length, feet.
M = Mach number, dimensionless.
m = molecular weight, pounds per mol.
N_{Re} = Reynolds number, dimensionless.
n = number of vanes.
P = total pressure, pounds per square foot.
P_w = wetted perimeter of duct, feet.
p = static pressure, pounds per square foot.
p_v = velocity pressure, pounds per square foot.
ΔP = total pressure drop, pounds per square foot.
Δp = static pressure drop, pounds per square foot.
Δp_a = acceleration component of two-phase pressure drop, pounds per square foot.
Δp_f = frictional component of two-phase pressure drop, pounds per square foot.
Δp_{TP} = two-phase pressure drop, pounds per square foot.
Q = volumetric flow rate, cubic feet per second.
R = gas constant, foot pounds per (slug) (Rankine degree).
$R_u = mR$ = univeral gas constant, foot pounds per (mol) (Rankine degree).
r_i = inside bend radius, feet.
r_v = vane radius, feet.
s = vane gap, feet.
T = absolute temperature, Rankine degrees.
$\overline{U}$ = vector velocity, feet per second.
V = fluid velocity, feet per second.
w = two-phase mass flow rate, slugs per second.
$\overline{X}$ = correlating parameter in two-phase flow, dimensionless.
x = quality (mass fraction of vapor), dimensionless.
x_L = position along duct, feet.
z = elevation relative to some datum, feet.
α = angle of attack, degrees.
γ = specific weight, pounds per cubic foot.
η = number of smaller elbows.
θ = bend angle, degrees.
μ = dynamic viscosity, slugs per foot second.
ν = kinematic viscosity, square foot per second.
ρ = mass density, slugs per cubic foot.
$\sigma\rho$ = density corresponding to total pressure.
Φ_f = Lockhart-Martinelli frictional multiplier, dimensionless.
Φ_a = Martinelli-Nelson frictional multiplier, dimensionless.

Subscripts
avg = average.
e = tube exit.
f = liquid phase of two-phase flow.
g = vapor phase of two-phase flow.
i = tube inlet.
o = all liquid flow at two-phase mass flow rate.

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