AAE 539
Chapter 3: 1-D Incompressible Flow
Friction Factor and K_t Tables

All figures and tables below are from:

"SAE Aerospace Applied Thermodynamics Manual," Developed by SAE Committee AC-9, Aircraft Environmental Systems, Society of Automotive Engineers, Inc., New York, 1969.

Moody Diagram

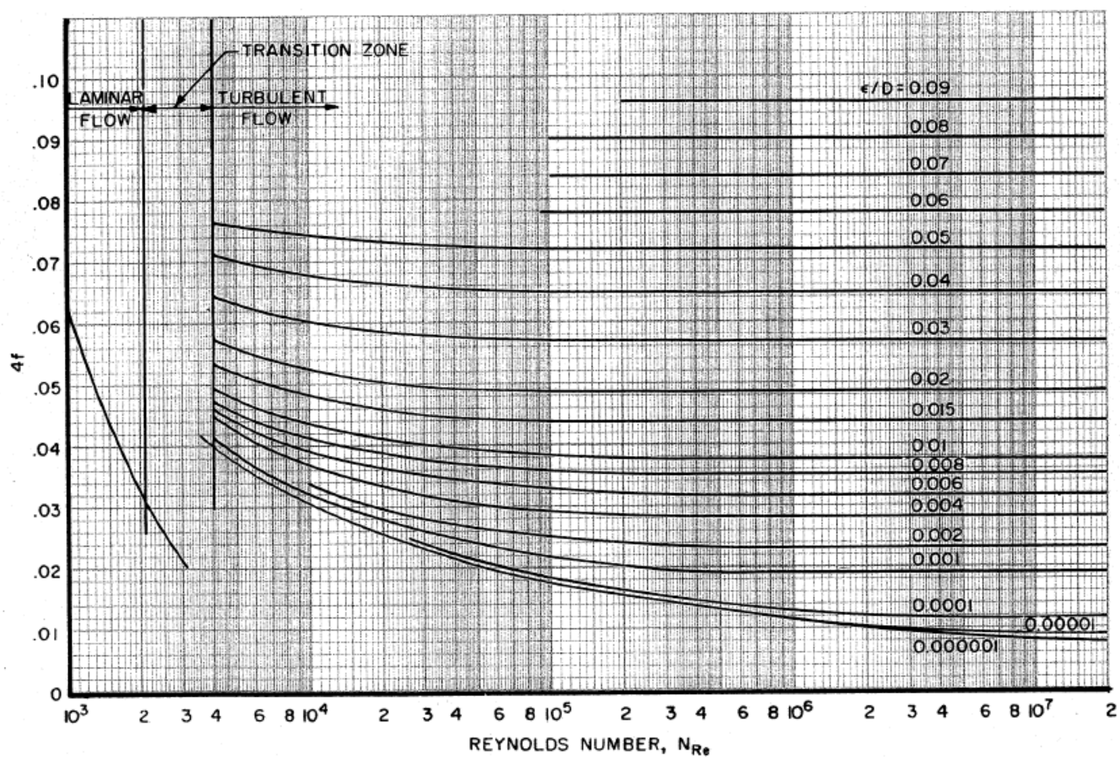


Fig. 1A-5—Friction factor versus Reynolds number

Fig. 1A-5 shows variation in friction factor, f, with Reynolds number, Re, and relative roughness, ε/D.

Here f = Fanning Friction Factor ($4f$ = Darcy Friction Factor)

K_t *Losses for 90° Bends (Circular Pipe)*

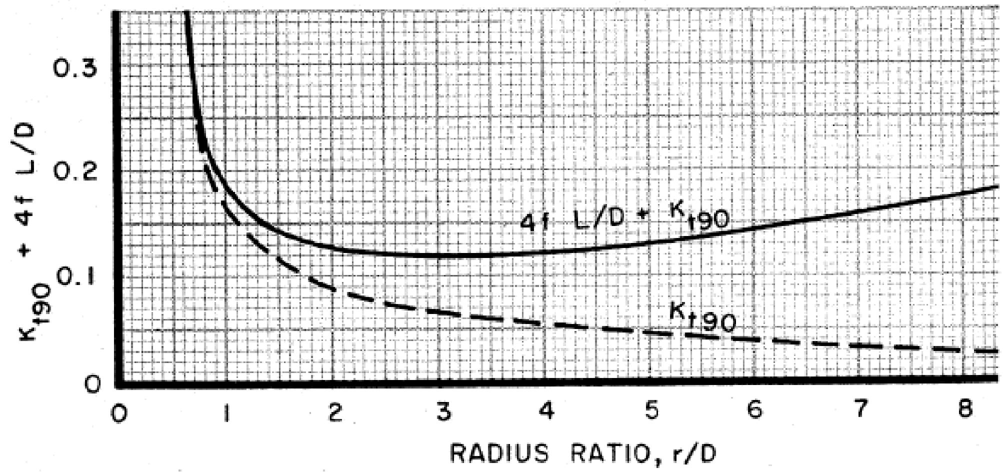


Fig. 1A-9—Bend Loss

Fig. 1A-9 shows combined effect of friction and K_t loss in a 90° elbow for $Re = 10^6$. Note minimum loss at bend radius to pipe diameter ratio, r/D, of approximately 3.

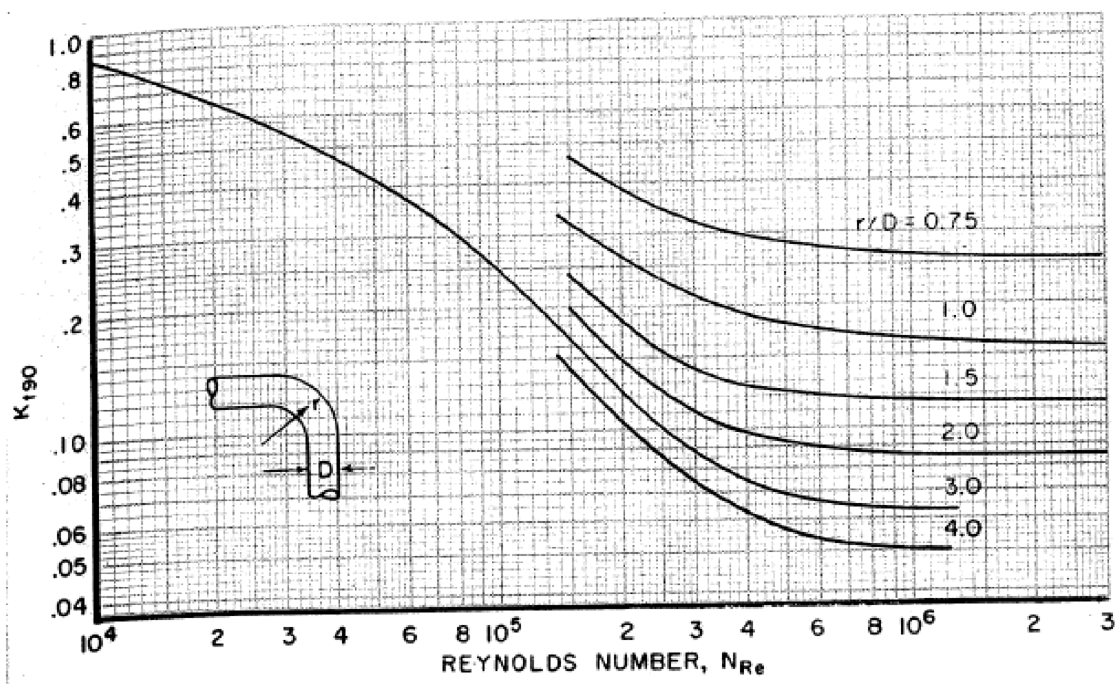


Fig. 1A-10—Loss coefficient versus Reynolds number for 90 deg radius bends, circular ducts. (Data for $N_{Re} > 10^5$ from Ref. 1, for $N_{Re} < 10^5$ from Ref. 28)

Fig. 1A-10 shows effects of *Re* and *r*/*D* on K_t for 90° bend (K_{t90}).

K_t Losses for Bends of Arbitrary Angle (Circular Pipe)

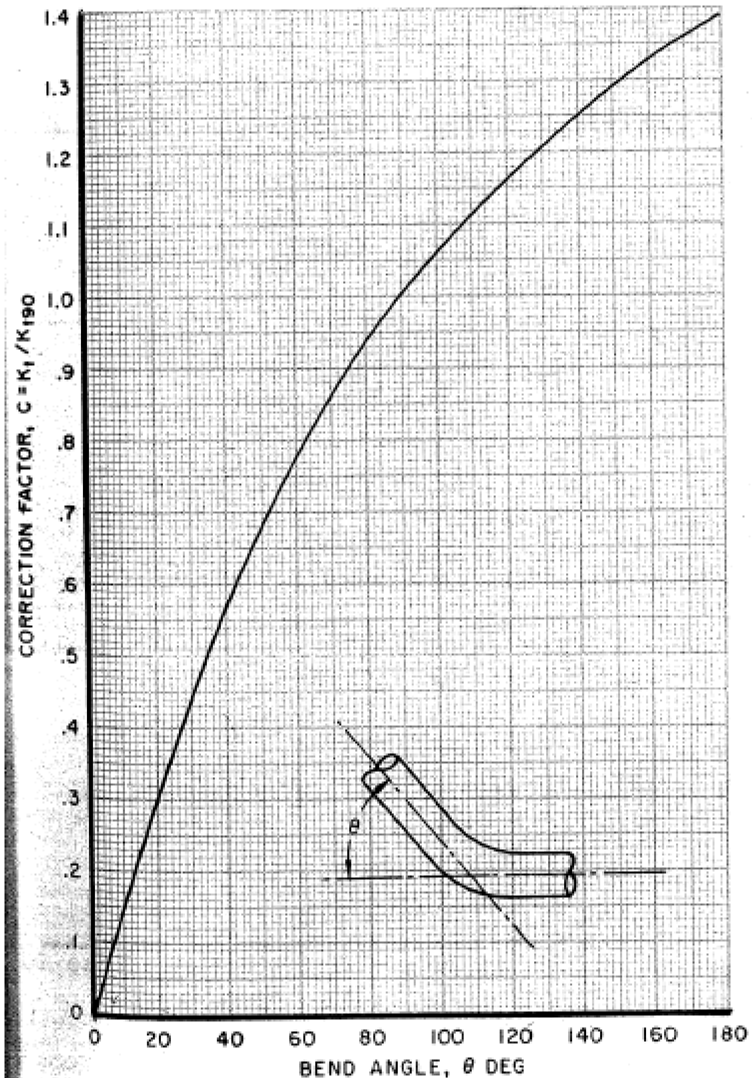


Fig. 1A-11—Correction factor for bends other than 90 deg for ducts. (From Ref. 12, Fig. 16

Fig. 1A-11 shows effects of bend angle, θ, on K_t in terms of a correction factor, C. C is defined as the ratio of K_t, for bend angle θ, to K_{t90}.

K_t *Losses for Gradual and Sudden Contractions (Circular Pipe)*

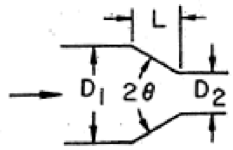


Table 1A-5 Angular Displacement Versus Loss Coefficient*

2θ, deg	K_t
0–30	0
30–45	0.05
45–180	Sudden contraction from A_1 to A_2, as shown in Par. 3.3.1.

*Ref. 27, p. 115.

Table 1A-5 shows effects of contraction angle, θ, on K_t.
For total included angles, 2θ, greater that 45° use Fig. 1A-39 below.

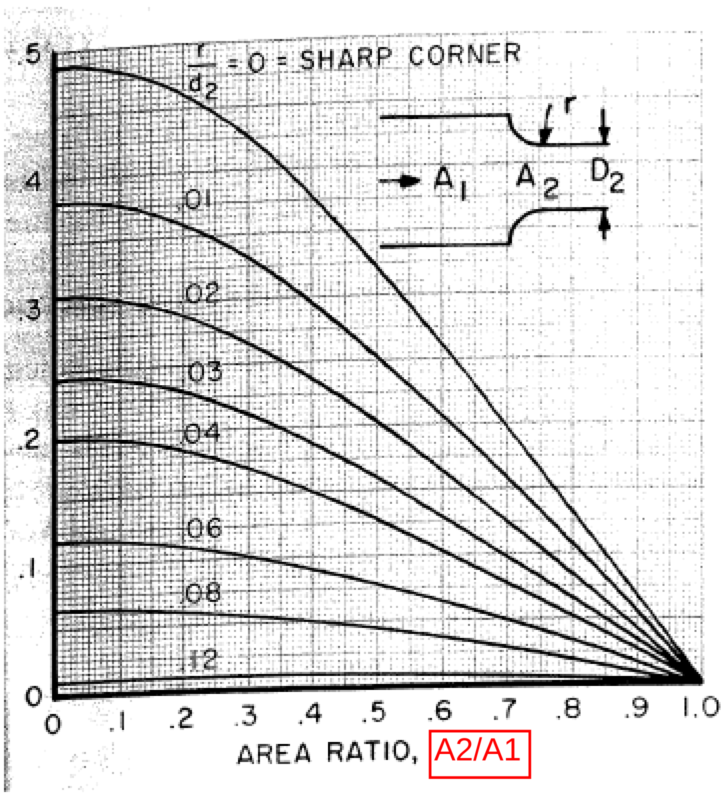


Fig. 1A-39 — Loss coefficient of a sudden contraction

Fig. 1A-39 plots the loss coefficient, K_t, for a sudden contraction as a function of area ratio, A2/A1 and entrance radius to diameter ratio, r/d_2.
When calculating loss use dynamic pressure in smaller section, q_2.

K_t Losses for Sudden Expansions (Circular Pipe)

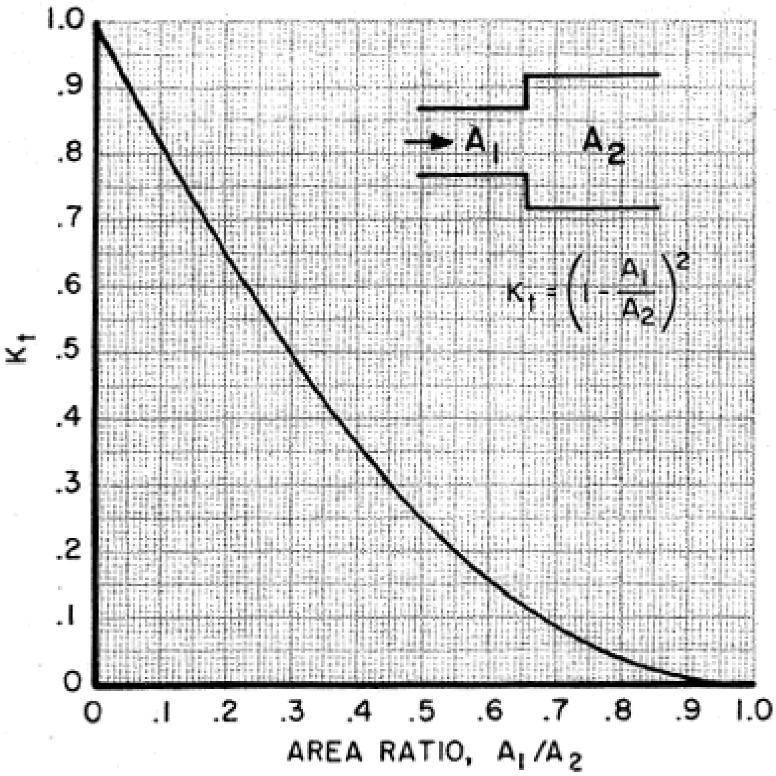
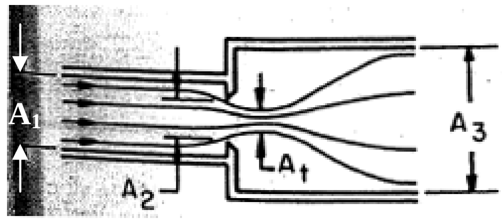


Fig. 1A-38—Loss coe
sudden expansion.
24)

Fig. 1A-38 plots the loss coefficient, K_t, for a sudden expansion as a function of area ratio, A_1/A_2. When calculating loss use dynamic pressure in smaller section, q_1.

K_t Losses for an Orifice in a Duct (Circular Pipe)



Schematic of geometry for an orifice in a duct.

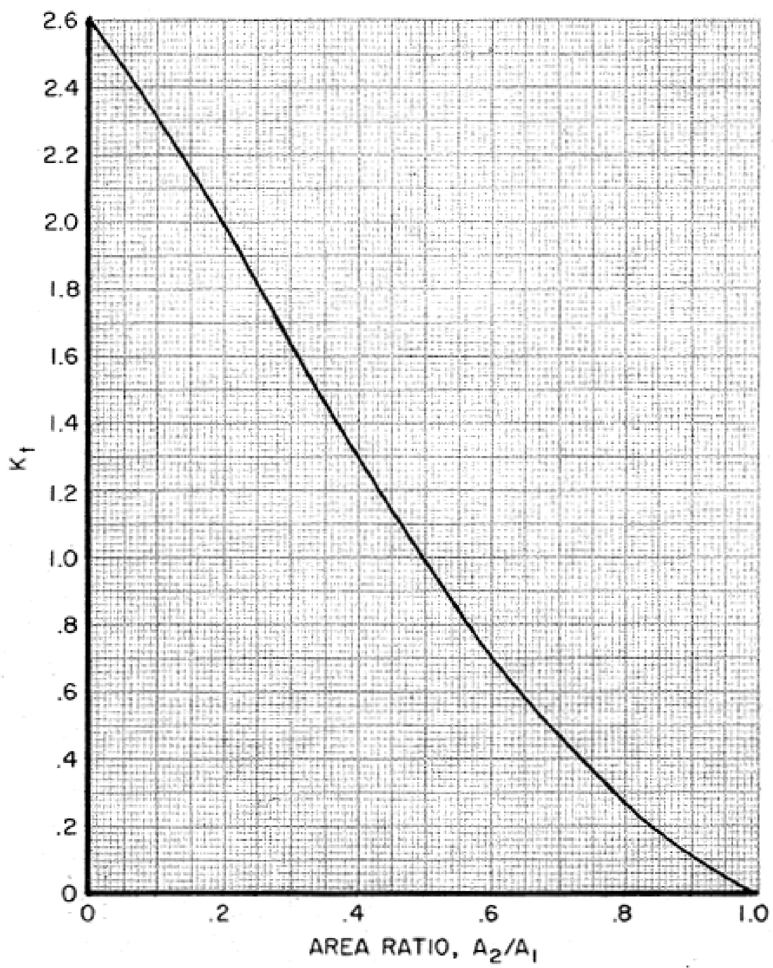


Fig. 1A-44—Loss coefficient for an orifice in a duct: $A_1 = A_3$. (From Ref. 45, Table 11)

Fig. 1A-44 shows K_t for orifice in a duct when $A_1 = A_3$ based on area ratio, A_2/A_1. When calculating loss use dynamic pressure in orifice, q_2.

K_t Losses for an Orifice in a Duct (Circular Pipe)

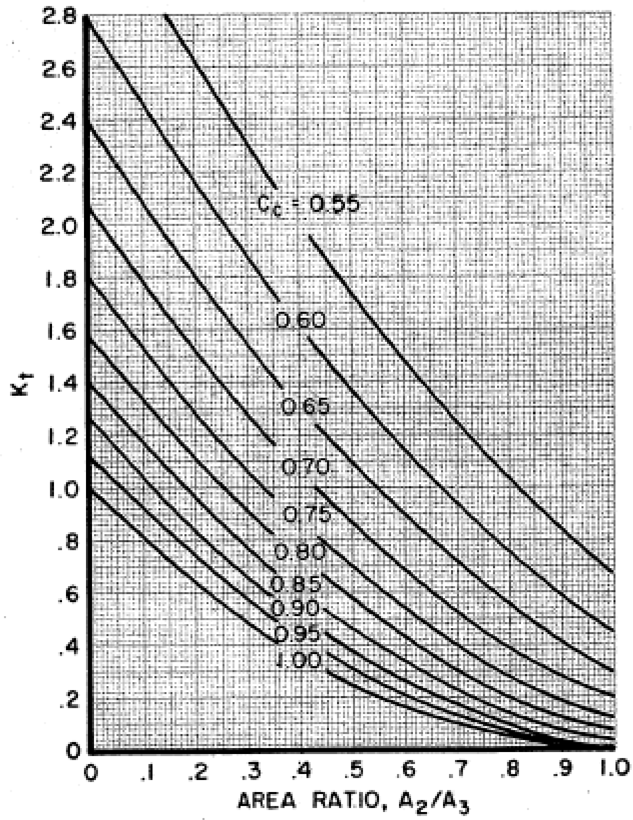


Fig. 1A-45—Loss coefficient for an orifice in a duct: $K_t = [(1/C_c) - (A_2/A_3)]^2$

Fig. 1A-44 shows K_t for orifice in a duct when $A_1 \neq A_3$ based on area ratio, A_2/A_3, and the contraction coefficient, C_c, which can be found from Fig. 1A-46 below.
When calculating loss use dynamic pressure in orifice, q_2.

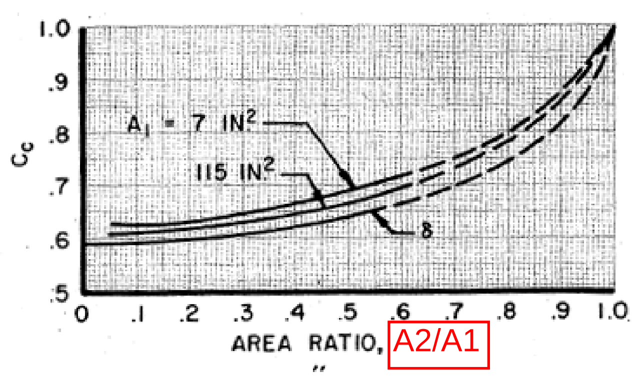


Fig. 1A-46—Contraction coefficient of an orifice. (From Ref. 45, Tables 8 and 13)

Fig. 1A-45 shows C_c for an orifice based on area ratio A2/A1 Note as A2/A1 goes toward zero C_c tends toward 0.6.

K_t Losses for a Diverging Duct (Circular Pipe)

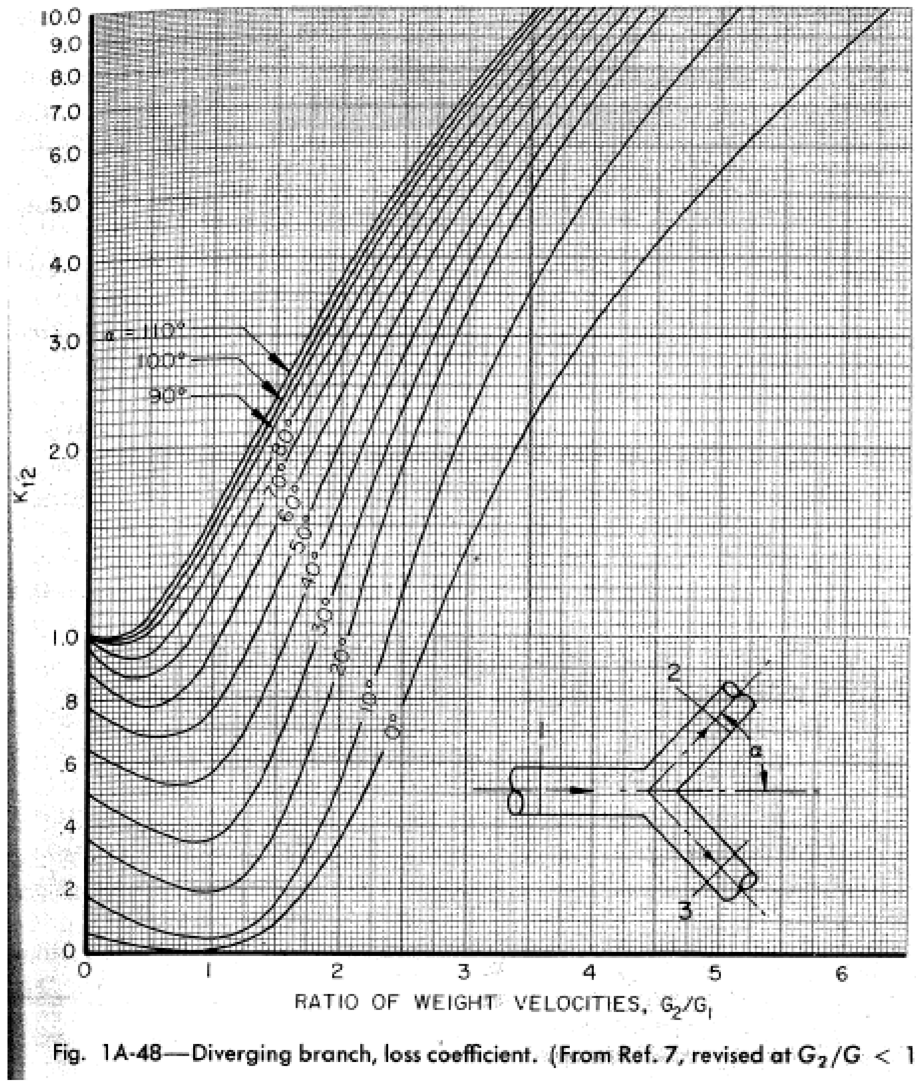


Fig. 1A-48—Diverging branch, loss coefficient. (From Ref. 7, revised at $G_2/G < 1$)

Fig. 1A-48 shows K_t for a diverging duct based on divergence half angle, α, and the weight velocity ratio, G_2/G_1. Where G = mass flow rate/cross-sectional area. When calculating loss use dynamic pressure in entrance, q_1.