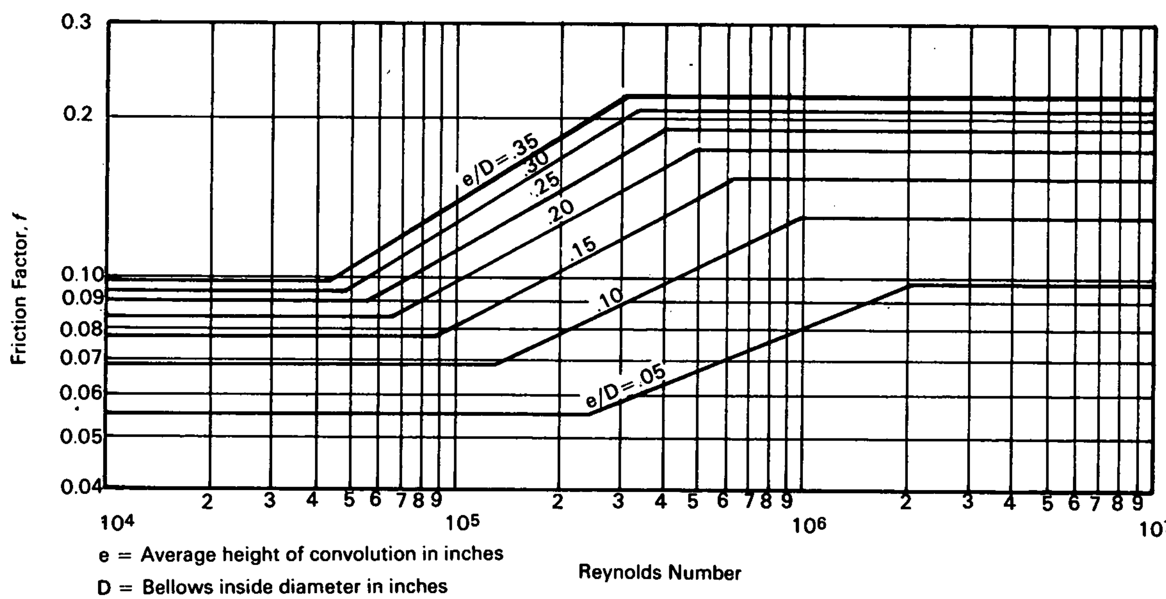
NASA TECH BRIEF

Method for Predicting Frictional Loss in Metal Bellows and Flexible Hose



Although it is known that the frictional pressure loss to fluids flowing in unsleeved bellows and flexible hose is considerably higher than in comparable diameter rigid tubing, specific quantitative data has been lacking. Because of the wide usage of flexible hose and bellows in the fluid systems of space launch vehicles, and the relatively high fluid velocities involved, an investigation is made and test data obtained concerning frictional losses in straight and curved sections.

Friction factors for straight flexible sections as a function of the flow parameter, Reynolds number, and the relative roughness of the internal diameter are illustrated in the figure. These friction factors are used in conjunction with the Darcy-Weisbach pressure loss equation:

$$\Delta P = (f_{AVG})(L/D)(V^2/2g_c)(\rho/144)$$

where:
- P = Pressure loss in psi
- f = Darcy-Weisbach friction factor
- L = Bellows length in inches
- D = Bellows diameter in inches
- V = Fluid velocity in fps
- g = Acceleration of gravity (32.2 fps^2)
- ρ = Fluid density in lb/cu ft

Using the value of the relative roughness e/D, and the Reynolds number, the value of the friction factor f is read from the figure. Direct substitution permits solving for the pressure loss.

(continued overleaf)

The difference between straight and bent lengths of bellows is taken as the inertia loss of the bend, which is equal to the bend loss constant times the velocity head. Similar to straight bellows friction factors, the bend loss constants show an increase with increasing Reynolds number until a maximum is reached. To remove the variation of loss constants due to Reynolds number and hose geometry, the data are reduced to an equivalent bend length by multiplying the bend loss constant by the bellows diameter and then dividing by the straight bellows friction factor at the same Reynolds number.

Notes:

1. These data should be useful in the design of fluid systems where high delivery velocities are involved and flexible hose or bellows must be employed.
2. Inquiries concerning this innovation may be directed to:

   Technology Utilization Officer
   Marshall Space Flight Center
   Huntsville, Alabama 35812
   Reference: B66-10662

Patent status:

No patent action is contemplated by NASA.

Source: C. M. Daniels and J. R. Cleveland
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