Calculating Friction Loss and Elevation Pressure

FRICTION LOSS

Friction Loss defined

- The part of the total pressure lost while forcing water through pipe, fitting, fire hose and adaptors

Causes of Friction loss

- Movement of water molecules against each other
- Lining within the fire hose
- Couplings
- Sharp bends
- Change in hose size or orifice by adaptors
- Improper gasket size

Principals of Friction Loss

1. When all other conditions are the same, friction loss varies directly with the length of the hose or pipe.

   Ex > Hose 1 – 200gpm and 100ft long = 10 PSI friction loss

   Hose 2 – 200gpm and 200ft long = 20PSI friction loss

2. When hoses are the same size, friction loss varies approximately with the Square (X^2) of the increase in the velocity of the flow.

   Ex > A length of 3in hose at 200 gpm = 3.2psi friction loss

   Same hose at 400 gpm = 12.8psi friction loss

   Flow doubled – So, friction loss is square of the doubling ($2^2 = 4$) thus (3.2 x 4 = 12.8)

3. For the same gpm friction loss varies inversely as the fifth power (X^5). This principle proves the advantage of a larger size hose

   Ex > a 3in hose has 0.4 (40%) friction loss of that of a 2.5in hose. So if the 2.5in hose had a friction loss of 10pis the 3in hose would have a friction loss of 4psi.

   $$\frac{2.5^5}{3^5} = \frac{98}{243} = 0.4$$

4. For a given velocity, friction loss is approximately the same, regardless of the pressure on the water.

Determining Friction loss

$FL = CQ^2L$

Where:

FL = Friction loss

C = Friction loss coefficient from table

Q = Flow rate in hundreds of GPM (flow / 100)

L = Length of hose in hundreds of feet (length / 100)

Hose Diameter (inches)	Coefficient
¾ (booster)	1100
1 (booster)	150
1 ¼ (booster)	80
1 ½	24
1 ¾ with 1 ½ couplings	15.5
2	8
2 ½	2
3 with 2 ½ couplings	0.8
3	0.667
3 ½	0.34
4	0.2
4 ½	0.1
5	0.08
6	0.05
STANDPIPES	
4	0.374
5	0.126
6	0.052

Ex > What is the total pressure loss due to friction in 250 feet of 1 ¾ - inch hose with 150 gpm flowing?

C = 15.5

Q = (gpm/100) so (150gpm/100 = 1.5) so (Q = 1.5)

L = (length of hose/100) so (250ft/100 = 2.5) so (L = 2.5)

$FL = CQ^2L$

$FL = (15.5)\ (1.5)^2\ (2.5)$

FL = 87.2 psi total friction loss

ELEVATION PRESSURE

- Water exerts a pressure of 0.434 psi per foot of elevation
- When a nozzle is operating at an elevation higher than the apparatus, pressure is exerted back against the pump (Pressure loss)
- When the nozzle is operating at an elevation lower than the apparatus, pressure is exerted against the nozzle (pressure gain)

In order to simplify the elevation pressure calculations on the fire ground the following formula may be used:

EP = 0.5H
Where:
EP = Elevation pressure in PSI
0.5 = Constant
H = Height in feet

Ex > Calculate the total pressure loss due to elevation for a hoseline operating at the top of a 100ft hill

EP = 0.5H

EP = (0.5) (100)

EP = 50psi loss