

# ADD FRICTION from system flow resistance TO "A.H." figure

Also known as "Viscous drag" "Scrubbing action" "Rotary flow" "Reynolds effect".

Mathcad file by Yuri Vladimirovich Gerasimov.

## 1. INPUT DATA

### Example

GPM	<b>Q gpm :=</b>	<b>41</b>
Steady state		
mm	<b>D :=</b>	<b>38</b>
m <sup>2</sup> /sec	<b>v :=</b>	<b>1,9 × 10<sup>-6</sup></b>
m	<b>L :=</b>	<b>218</b>
kg/m <sup>3</sup>	<b>ρ :=</b>	<b>980</b>

Volumetric flow rate	
Inside diameter of the pipe	
Kinematic viscosity	— (Approximation cP "centiPoise" to m <sup>2</sup> /sec, multiply by 1 million (for water))
Length of the pipe	
Density (SG, Specific Gravity x 1000)	

### Pipe Fitting Component

- Round the corner of a Tee
- Past a side opening of a Tee
- Back into line from a side opening in a Tee
- Rounded corner 90° elbow (Long Rad. or L.R. 90)
- Abrupt 90° elbow ("Hard" 90 or Machined "L")
- Gentle 45° elbow (Bends & or "5D" 90)

### Fittings

<b>T1 :=</b>	<b>1</b>
<b>T2 :=</b>	<b>3</b>
<b>T3 :=</b>	<b>1</b>
<b>E1 :=</b>	<b>2</b>
<b>E2 :=</b>	<b>9</b>
<b>E3 :=</b>	<b>2</b>

### Estimating : dP @ peak of Flow Fluctuations

To find the increase in pulsation from flow fluctuation, assume max. fluctuation from simplex pump is 3.25 x steady state Q. Divide 3.25 Q by "F" nbr. for your pump type. Add the result to your steady state Q. Run the formula with your increased Q. Deduct steady state dP from this new dP. The difference is pulsation dP.

## Effective Length of Pipe System

$$L_{eff} := L + (0.0667 \times D \times T1) + (0.0209 \times D \times T2) + (0.0667 \times D \times T3) + (0.0327 \times D \times E1) + (0.0681 \times D \times E2) + (0.0144 \times D \times E3)$$

figures applied for E and T are averages from tests

## 2. CALCULATIONS

2.1. Velocity V of the flow in the pipe:

$$Q1 := \frac{Q \text{ gpm} \times 3.7853}{60} \quad (\text{l/sec}) \quad Q1 = 2.587$$

$$F := \frac{0.7854 \times D^2}{10^6} \quad (\text{m}^2) \quad F = 0.001$$

$$V := \frac{Q}{F} \quad (\text{m/sec}) \quad V = 2.281$$

$$(\text{l/sec}) \quad Q := \frac{Q1}{1000} \quad Q = 0.003$$

$$(\text{m}^2) \quad Dm := \frac{D}{10^3} \quad Dm = 0.038$$

2.2. Reynolds Number:

$$Re := \frac{V \times Dm}{v} \quad Re = 4.561 \cdot 10^4$$

2.3. Friction factor: (cold drawn pipe)

$$\lambda := 0.3164 \times Re^{-0.25} \quad \lambda = 0.022$$

2.4. Pressure loss:

$$DP_{pa} := \lambda \times \frac{L_{eff}}{Dm} \times \frac{\rho \times V^2}{2} \quad (\text{Pa})$$

$$DP_{pa} = 3.664 \cdot 10^5 \quad (\text{Pa})$$

$$dP := \frac{DP_{pa}}{10^5} \quad (\text{Convert Pa to bar})$$

$$dP = 3.664 \quad (\text{bar - loss})$$

$$dP_{psi} := dP \times 14.51 \quad (\text{Convert Bar to psi})$$

**ESTIMATED**  
**dPpsi = 53.167** (psi - loss)

### Scientific Units

- Pa = Pascals
- Q = Mass Flow
- Cubic Meters
- d = delta
- difference
- Dm = Diameter Meters



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