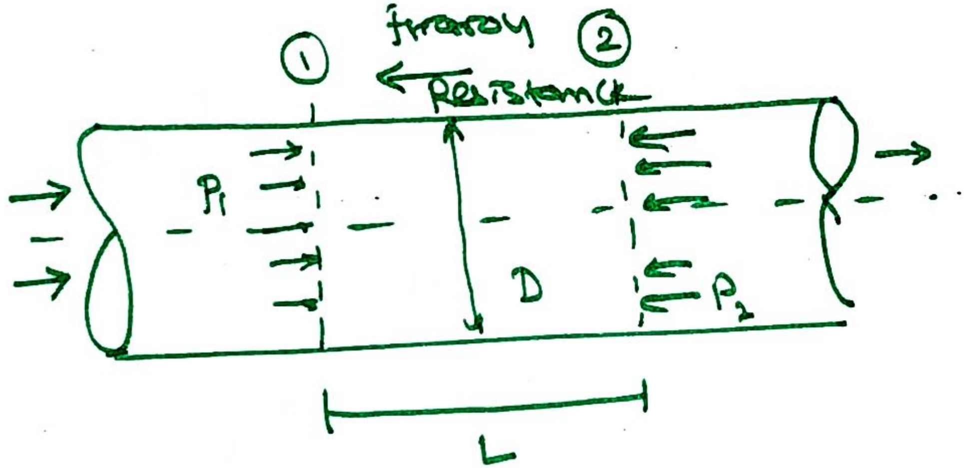
LOSS OF HEAD DUE TO FRICTION IN PIPE FLOW

DARCY WEISBACH EQUATION

Viscous friction associated with fluid are proportional to

1) length of pipe (L)
2) wetted Perimeter (P)
3) V^n V is average velocity

n is index 1.5 to 2 ≈ 2



P_1 = intensity of pressure at section 1

P_2 = " " " at section 2

L = length of pipe betw section 1 & 2

P = wetted perimeter of pipe

$= \pi D$

A_c = c/s area of pipe $= \pi/4 D^2$

A_s = wetted surface area $= Pl = \pi Dl$

Pressure force at section 1 $= P_1 \times A_c$

Pressure force at section 2 $= P_2 \times A_c$

Net pressure force in direction of flow

Propelling force $= P_1 A_c - P_2 A_c$

$= (P_1 - P_2) A_c$

frictional Resistance $\propto V^2$

$\propto A_s$

$= f' A_s V^2$

$f' =$ Constant

Now for the equilibrium force

Propelling force = frictional force

$$(P_1 - P_2) A_c = f' A_s V^2 \quad \text{— I}$$

Bernoulli's equation betn sect 1 & 2

$$\frac{P_1}{\rho g} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + z_2 + h_f$$

$$z_1 = z_2, \quad V_1 = V_2$$

$$\frac{P_1}{\rho g} = \frac{P_2}{\rho g} + h_f$$

$$\frac{P_1 - P_2}{\rho g} = h_f \Rightarrow P_1 - P_2 = h_f \rho g$$

By Putting value of $P_1 - P_2$ in eqn I

$$h_f \cdot \rho g A_c = f' A_s V^2$$

$$h_f = \frac{f' A_s V^2}{\rho g A_c} \qquad A_c = \pi/4 \, D^2 \qquad A_s = \pi D l$$

$$= \frac{f'}{\rho g} \cdot \frac{A_s}{A_c} \cdot V^2$$

$$= \frac{f'}{\rho g} \cdot \frac{\pi D l}{\pi/4 D^2} \cdot V^2$$

$$= \frac{2f'}{\rho g} \cdot \frac{4l}{D} \cdot \frac{V^2}{2} \qquad \rho g = \omega$$

$$= \frac{2f'}{\omega} \cdot \frac{4lg}{D} \cdot \frac{V^2}{2g} \qquad f = \frac{2gf'}{\omega}$$

= Darcy's friction coeffn

$$= f \cdot \frac{4l}{D} \cdot \frac{V^2}{2g}$$

$$\boxed{h_f = \frac{4flV^2}{2gD}}$$