FLOW THROUGH PIPE

Pipe:

It's a hollow cylinder that is used for conveying fluid.

Energy losses in pipe:

A fluid experiences resistance while flowing through a pipe. This resistance causes loss of energy.

There are two types of loss of energy.

1. **Major loss**- This is due to friction.
2. **Minor loss**- This is due to abrupt changes in flow path. e.g. sudden change in cross section of pipe, bend in pipe, obstruction in pipe, etc.

Loss of energy due to friction:

It's determined using the formulae of Darcy-Weisbach and Chezy.

Darcy-Weisbach Formula:

$$h_f = \frac{4fLV^2}{2gd}$$

Where

h_f= Loss of energy (head) due to friction

f = Coefficient of friction

= $\frac{16}{R_e}$ for $R_e < 2000$

= $\frac{0.079}{R_e^{1/4}}$ for R_e varying from 4000 to 10^6

L= Length of pipe

V= mean velocity of flow

d= Diameter of pipe.

Chezy's formula:

$$\boldsymbol{h_f = \frac{f'P}{\rho g A} LV^2}$$

Where

h_f= Loss of energy (head) due to friction
A= Area of cross section of pipe.
P= wetted perimeter of pipe.
L= Length of pipe.
V= Mean velocity of pipe.

The expression "A/P" is called hydraulic mean depth or hydraulic mean radius. It's denoted by 'm'.

Hydraulic mean depth, m= $\frac{A}{P} = \frac{\frac{\pi}{4}d^2}{\pi d} = \frac{d}{4}$

Now inserting the expression of hydraulic mean radius in above formula, we get

$$h_f = \frac{f'}{\rho g} LV^2 \frac{1}{m}$$

$$\Rightarrow V^2 = h_f \frac{\rho g}{f'} m \frac{1}{L} = \frac{\rho g}{f'} m \frac{h_f}{L}$$

$$\Rightarrow V = \sqrt{\frac{\rho g}{f'}} \sqrt{m \frac{h_f}{L}}$$

Let $\sqrt{\frac{\rho g}{f'}}$ = C, Where 'C' is called Chazy's constant.

$\frac{h_f}{L}$ = i, where 'i' is called loss of head per unit length of pipe.

Substituting the above expressions we get

$$\boldsymbol{V = C\sqrt{mi}}$$

The above expression is called Chazy's formula.

Hydraulic gradient line:

It's defined as the line joining the points that represent the sum of pressure head and datum head along the length of pipe in which the fluid flows.

Total gradient line:

It's defined as the line joining the points that represent the sum of pressure head, datum head and kinetic head along the length of pipe in which the fluid flows.