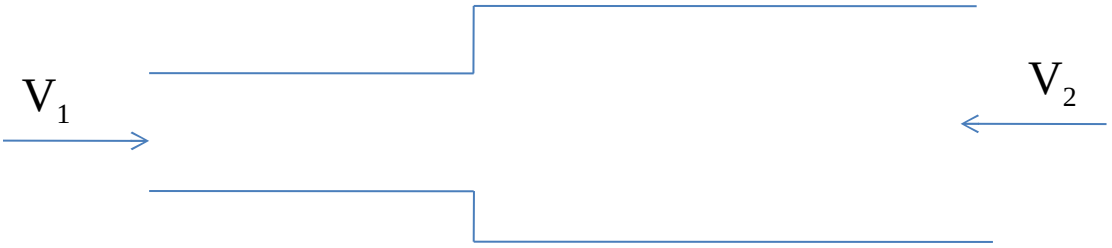
Minor Energy Losses

This is due to:

- Sudden expansion of pipe
- Sudden contraction of pipe
- Bend in pipe
- Pipe fittings etc.
- An obstruction in pipe

1. Sudden expansion in pipe:



Due to sudden change in diameter of pipe, the liquid flowing from smaller pipe is not able to follow the abrupt change of boundary. This causes the flow separation from boundary and turbulent eddies are formed in larger pipe. The loss of head (energy) takes place due to formation of eddies and given by formula

$$\mathbf{h_f} = \frac{(V¿¿1-V_2)^2}{2g}¿$$

2. Sudden contraction in pipe:

As the liquid flow from larger pipe to smaller pipe, the area of flow goes on decreasing and minimum at section called Vena- contracta. After Vena- contracta, a sudden enlargement of area takes place. The loss of head (energy) due to sudden contraction is actually due to sudden enlargement from Vena- contracta to smaller pipe and given by formula

$$h_c = \frac{V_2^2}{2g}\left[\frac{1}{C_c} - 1\right]^2$$

$$h_c = \frac{KV_2^2}{2g} \qquad \text{where } k = \left[\frac{1}{C_c} - 1\right]^2$$

Assumed $C_c = 0.62$ then $k = \left[\frac{1}{0.62} - 1\right]^2 = 0.375$

Then h_c becomes as

$$h_c = \frac{0.375V_2^2}{2g}$$

If value of C_c is not given then head loss due to sudden contraction is given by

$$h_c = \frac{0.5V_2^2}{2g}$$

3. Loss of Head at the entrance of pipe:

This loss of head (energy) occurs when a liquid enters a pipe which is connected to a large tank or reservoir. This loss of head is similar as loss of head due to sudden contraction and given by

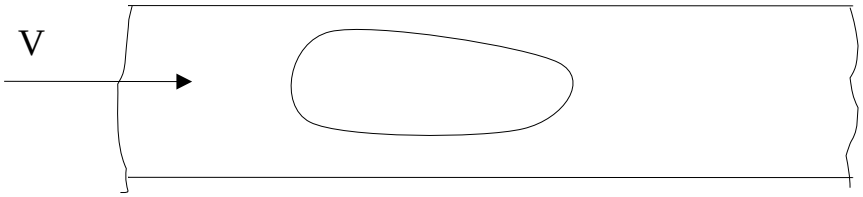
$h_i = \frac{0.5V^2}{2g}$ where V is velocity of fluid in pipe

4. Loss of Head at the exit of pipe:

This loss of head (energy) occurs due to velocity of liquid at the outlet of pipe which is dissipated in the form of free jet or lost in the tank (if pipe is connected to the tank) and given by

$h_o = \frac{V^2}{2g}$ where V is velocity of liquid at outlet of pipe

5. Loss of head due to sudden obstruction in pipe:



Let a = Maximum are of obstruction

A= Area of Pipe

V = Velocity of liquid in pipe , C_c = Coefficient of contraction

Head loss due to obstruction is give by

$$\frac{V^2}{2g}\left[\frac{A}{C_c(A-a)}-1\right]^2$$

6. Loss of Head due to bend in pipe:

Due to bend in pipe, velocity of fluid changes, due to which separation of fluid from boundaries and also eddied formation takes place. This are the reasons for losses in bends and given by

$$h_b = \frac{KV^2}{2g}$$

where h_b = Loss of head due to bend , V = Velocity of flow & K = Coefficient of bend which depends on angle of bend, radius of curvature of bend & diameter of pipe

7. Loss of Head due to various pipe fittings:

The loss of head due to various pipes fitting like couplings, elbows, sockets etc. are given by

$\frac{KV^2}{2g}$ Where V is velocity of flow & K is coefficient of pipe fittings

Numerical:

1. The rate of flow through a horizontal pipe is 0.3m^3/s. The diameter of pipe is suddenly enlarged from 250mm to 500mm. The pressure intensity in the smaller pipe is 13.734 N/cm^2. Determine (i) Loss of head due to sudden enlargement (ii) Pressure intensity in the larger pipe (iii) Power lost due to enlargement
2. A horizontal pipe of diameter 400mm is suddenly contracted to 200mm diameter. The pressure intensity in the larger pipe is 14.715 N/cm^2 and in the smaller pipe is 12.753 N/cm^2. If C_c= 0.62 find the head loss & fate of flow (discharge) in the pipe.
3. Determine the rate of flow of water through a pipe of diameter 10cm and length 60cm when one end of the pipe is connected to the tank and other end of the pipe is open to atmosphere. The height of the water in the tank is 5cm from the centre of the pipe. Pipe is horizontal and f = 0.01. Consider minor losses.
4. Water is flowing through a pipe of diameter 300 mm at a velocity of 4m/s. A solid circular plate of diameter 200mm is placed in the pipe to obstruct the flow. If C_c = 0.62, determine the losses due to obstruction in pipe.