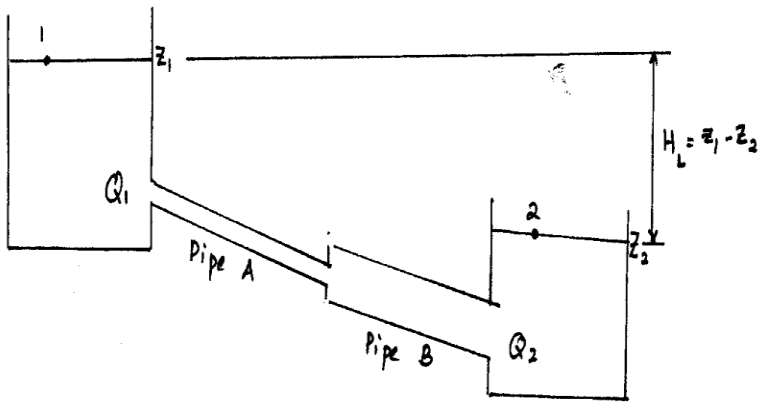
FLUID MECHANICS FOR MECHANICAL ENGINEERING (ME 208F)

Section C:
Flow Through Pipes- II

Pipes in Series

- When two or more pipes of different diameters or roughness are connected in such a way that the fluid follows a single flow path throughout the system, the system represents a series pipeline.
- In a series pipeline the total energy loss is the sum of the individual minor losses and all pipe friction losses.



Pipelines in series

- Referring to pre figure, the Bernoulli equation can be written between points 1 and 2 as follows;

$$\frac{P_1}{\rho g} + z_1 + \frac{V_1^2}{2g} = \frac{P_2}{\rho g} + z_2 + \frac{V_2^2}{2g} + H_{L1-2}$$

where
- $P/\rho g$ = pressure head
- z = elevation head
- $V^2/2g$ = velocity head
- H_{L1-2} = total energy lost between point 1 and 2

Realizing that $P_1=P_2=P_{atm}$, and $V_1=V_2$, then equation reduces to

$$z_1 - z_2 = H_{L1-2}$$

Or we can say that the different of reservoir water level is equivalent to the total head losses in the system.

The total head losses are a combination of the all the friction losses and the sum of the individual minor losses.

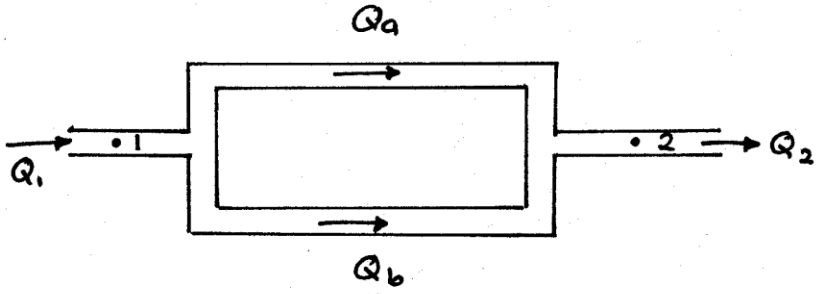
$$H_{L1-2} = h_{fa} + h_{fb} + h_{entrance} + h_{valve} + h_{expansion} + h_{exit}.$$

Since the same discharge passes through all the pipes, the continuity equation can be written as;

$$Q_1 = Q_2$$

Pipes in Parallel

- A combination of two or more pipes connected between two points so that the discharge divides at the first junction and rejoins at the next is known as pipes in parallel. Here the head loss between the two junctions is the same for all pipes.



Pipelines in parallel

- Applying the continuity equation to the system;

$$Q1 = Q_a + Q_b = Q_2$$

- The energy equation between point 1 and 2 can be written as;

$$\frac{p_1}{\rho g} + z_1 + \frac{v_1^2}{2g} = \frac{p_2}{\rho g} + z_2 + \frac{v_2^2}{2g} + H_L$$

- The head losses throughout the system are given by;

$$H_{L1\text{-}2} = h_{La} = h_{Lb}$$

- Equations above are the governing relationships for parallel pipe line systems. The system automatically adjusts the flow in each branch until the total system flow satisfies these equations.