ME 262
Basic Fluid Mechanics

GENERAL ENERGY EQUATION

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Fluid flow system
Types of devices and components of fluid flow system

**Pumps:** Mechanical device that adds energy to a fluid.

**Fluid Motors:** Devices that take energy from a fluid and deliver it in the form of work, causing rotation of a shaft or the linear movement of a piston.

**Fluid Friction:** A fluid in motion offers resistance to flow. Resistance causes energy loss and the magnitude of the energy loss is dependent on the properties of fluid, flow velocity, pipe size and smoothness of the pipe wall and length of the pipe.

Energy loss is called “FRICTION LOSS”, “MAJOR LOSS”

**Valves and Fittings:** Elements that control the direction or flowrate of a fluid in a system.
\[ E'_1 + h_A - h_R - h_L = E'_2 \]
\[ E_1 = \frac{P_1}{g} + z_1 + \frac{V_1^2}{2g} \]

\[ E_2 = \frac{P_2}{g} + z_2 + \frac{V_2^2}{2g} \]

- Energy at section 1
- Energy addition, removal and losses
- Energy at section 2

22.10.2012 - Assist. Prof.
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\( h_A \) = Energy added to fluid with a mechanical device such as pump.

\( h_L \) = Energy losses from the system due to friction in pipes or Minor losses due to valves and fittings.

\( h_R \) = Energy removed from the fluid by a mechanical device.

**Energy Loss**

- **Major Loss (Friction Loss)**
- **Minor Loss (bends, turns, valves, change of c/s area etc.)**

The magnitude of energy losses in the system directly proportional to velocity head;

\[
h_L = R \times \frac{V^2}{2g}
\]

\( R \) = resistance coefficient
\[ E_1 = \frac{P_1}{\gamma} + \frac{V_1^2}{2g} + z_1, \quad E_2 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + z_2 \]

\[ \frac{P_1}{\gamma} + \frac{V_1^2}{2g} + z_1 + h_A - h_L - h_R = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + z_2 \]

\[ \frac{P_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + z_2 - h_A + h_L + h_R \]
Application of energy equation & calculation of energy losses in a pipeflow system

**Example 21.1** (Example Pr. 7.1, Mott, R. L, 1999, Page 198).
Water flows from a large reservoir at a rate of 1.20 cfs. Calculate the total amount of energy lost in the system because of valves and elbows, pipe entrance and fluid friction.
Application of energy equation & calculation of energy losses in a pipeflow system

Example 21.2 (Example Pr. 7.2, Mott, R. L, 1999, Page 199). The volume flowrate through the pump is 0.014 m³/s. The fluid being pumped is oil with a specific gravity of 0.86. Calculate the energy delivered by the pump to the oil per unit weight of oil flowing in the system. Energy losses = 1.86 N.m/N