CEN 212 FLUID MECHANICS

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OVERALL ENERGY BALANCE

- Apart from mass and momentum balance the third property to be considered in flow systems is energy.
- The energy conservation equation is combined with the first law of thermodynamics to obtain the final overall energy-balance equation.

$$\Delta E = Q - W$$

where E: total energy per unit mass of fluid

Q: heat absorbed per unit mass of fluid

W: work of all kinds done per unit mass of fluid upon the surroundings.

OVERALL ENERGY BALANCE

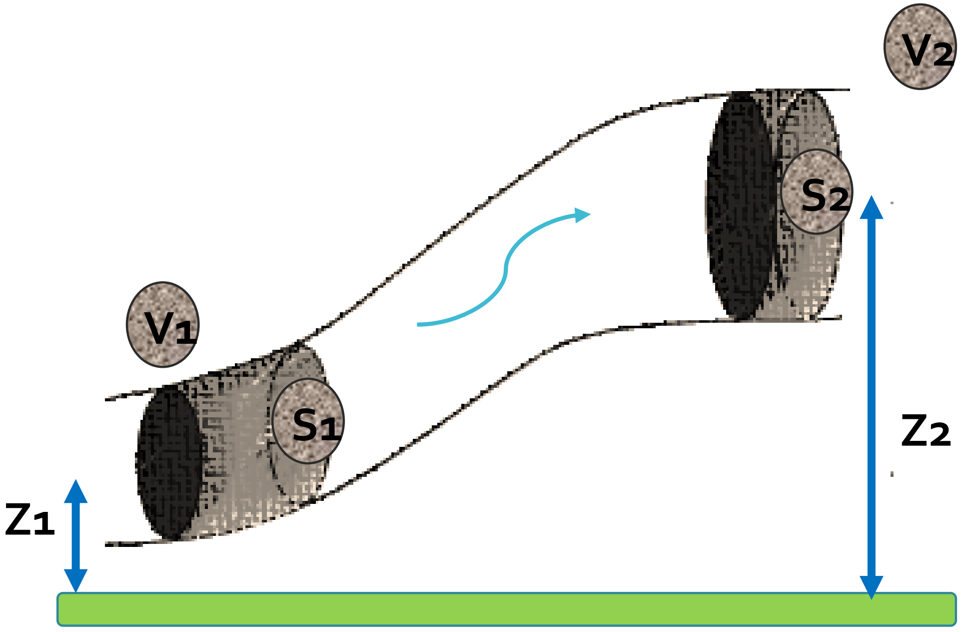
- Overall Energy Balance for Flow Systems;

Rate of energy entering the system – Rate of energy leaving the system + ~~Rate of energy Produced/consumed the system~~ =O (no rxn in the system)

= Rate of energy accumulation the system

OVERALL ENERGY BALANCE

- BERNOULLI EQUATION is a particular form of a mechanical energy balance to describe the frictionless flow of an incompressible fluid along a streamline at steady state.



$$\frac{P_2}{\rho} + \frac{V_2^2}{2\alpha} + Z_2\, g = \frac{P_1}{\rho} + \frac{V_1^2}{2\alpha} + Z_1\, g$$

BERNOULLI EQUATION WITHOUT FRICTION

OVERALL ENERGY BALANCE

- $$\frac{P_2}{\rho} + \frac{V_2^2}{2\alpha} + Z_2\, g + W_s + h_f = \frac{P_1}{\rho} + \frac{V_1^2}{2\alpha} + Z_1\, g$$

BERNOULLI EQUATION WITH FRICTION

Skin friction; is generated in unseperated boundary layers
Form friction; is generated when boundary layers seperate and form wakes.
The term hf includes both of them.

OVERALL ENERGY BALANCE

- FRICTION FROM CHANGES IN VELOCITY or DIRECTION

a. Friction loss form sudden contraction of cross section
b. Friction loss from suddedn expansion of cross section
c. Effect of fittings and valves

OVERALL ENERGY BALANCE

- Total friction loss in mechanical energy balance:

Skin friction $4f\frac{L}{D}\frac{V}{2\alpha}^2$

Contraction loss $K_c\ \frac{V_b^2}{2\alpha}$

Expansion loss $K_e\ \frac{V_a^2}{2\alpha}$

Fitting loss $K_f\ \frac{V_a^2}{2\alpha}$