Lect 11 – Thermo I – Conservation of Mass & CV 1\textsuperscript{st} Law

1. Able to explain in words and mathematically the conservation of mass.

2. Able to use conservation of mass to account for all mass flows crossing a control surface.

Finishing Thermo I

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Control Volume Analysis

Control Surface

High-pressure steam
Mass rate of flow
\( m_1 \)

Intermediate-pressure steam

Steam turbine

Shaft connecting the turbine to generator

Low-pressure steam
Mass rate of flow
\( (m_1)_{\text{low pressure steam}} \)

Steam radiator

Condensate
Mass rate of flow
\( (m_1)_{\text{condensate}} \)

\( \dot{Q}_{C.V.} \) = heat transfer rate

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No Mass Flow

Air line

R-12
Mass Flow?

Conservation of Mass
Conservation of Mass at the C.S.

Example Problem 1 - TPS

A windmill takes a fraction of the wind kinetic energy out as power on a shaft. In what manner does the temperature and wind velocity influence the power? Hint: write the power as mass flow rate times specific work.
Example Problem 2

Given a water tank with initially 3000 kg of liquid water. Two inlet pipes deliver 0.8 kg/s and 1.3 kg/s of hot and cold water respectively. Water exits the tank at 2.6 kg/s. Find the amount of water after one hour.

Example Problem 3 – Unsteady Flow

Supplementary Problem 1:
Water flows into a tank at a constant flow rate of 14 kg/s.

Water exits the tank with a mass flow rate proportional to the height of liquid inside: \( m_{\text{dot}_e}=15 \, \text{L} \), where L is the instantaneous liquid height.

The base of the tank is 0.3 \( \text{m}^2 \) (A) and the density of water 1000 kg/m\(^3\).

If the tank is initially empty – plot water height vs time.
Example Problem 3

http://en.wikibooks.org/wiki/Differential_Equations/First_Order_Linear_1