Open System

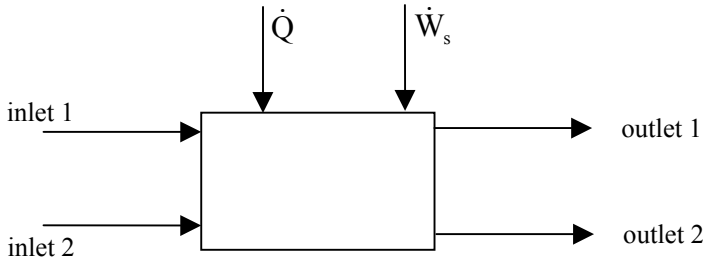
We developed an equation for energy balance on an open system:

$$\Delta(\dot{m}H) = \dot{Q} + \dot{W}_s$$

where the 'Δ' denotes _____ – _____. We have neglected _____ terms.

The shaft work is not the same as work as defined before, i.e. $\dot{W}_s \neq$ _____

General Approach on Open System



All streams have their own mole flow rate ($\dot{n}_i$), temperature (T_i), pressure (P_i), etc.

1) Material balance: _____

2) 1st Law: _____

3) 2nd Law: _____

4) If the inlet and outlet streams are fluids, we can relate _____ using EOS.

Application of 1st Law on Open Systems
(Turbines and compressors and valves, oh my…)

True / False For a system that undergoes a reversible process, $\Delta S_{system} = 0$.

True / False A turbine with 100% efficiency is one that runs on an ideal gas.

True / False One cannot design a Carnot engine that utilizes a throttle valve.

True / False The work of a reversible compressor is the maximum work required to run it.

Example Problem:

Tetrafluoroethane (CF_3CFH_2) is a refrigerant; see handout or Fig G.2 of textbook.

A.
1 lb_m/hr of saturated liquid tetrafluoroethane at 100 psia is throttled to 20 psia.

1) What phase is the outlet?

2) What is the exiting temperature?

3) How much vapor is produced?

B.
Tetrafluoroethane enters a well-insulated (adiabatic) turbine at 300 psia and 260^{o}F.
It exits at 20 psia and 140^{o}F.

1) How much work is produced?

2) What is the efficiency of the turbine?