ABE – 20100 Fall 2016

Homework Set 9
Due Wednesday 10/12 at beginning of class

1. (5 pts) Liquid water is fed to a boiler at 24ºC and 10 bar is converted at constant pressure to saturated steam. Use the steam tables to calculate ΔH (kJ/kg) for this process, and then calculate the heat input required to produce 15,000 m^3/h of steam at the exiting conditions. Assume that the kinetic energy of the entering liquid is negligible and that the steam is discharged through a 15-cm ID pipe.

2. (7.5 pts) Steam at 260ºC and 7.00 bar absolute is adiabatically expanded through a nozzle to 200ºC and 4.00 bar. The velocity of the steam entering the nozzle is negligible. The specific enthalpy of steam is 2974 kJ/kg at 260ºC and 7 bar and 2860 kJ/kg at 200ºC and 4 bar. Use the open-system energy balance to calculate the exit steam velocity.

3. (7.5 pts) Steam produced in a boiler is frequently "wet"–that is, it is a mist composed of a saturated water vapor and entrained liquid droplets. The **quality** of a wet steam is defined as the fraction of the mixture by mass that is vapor.

A wet stream at a pressure of 5.0 bar with a quality of 0.85 is isothermally "dried" by evaporating the entrained liquid. The flow rate of the dried steam is 52.5 m^3/h.

(a) Use the steam tables to determine the temperature at which this operation occurs, the specific enthalpies of the wet and dry steams, and the total mass flow rate of the process stream.

(b) Calculate the heat input (kW) required for the evaporation process.