ENSC 388

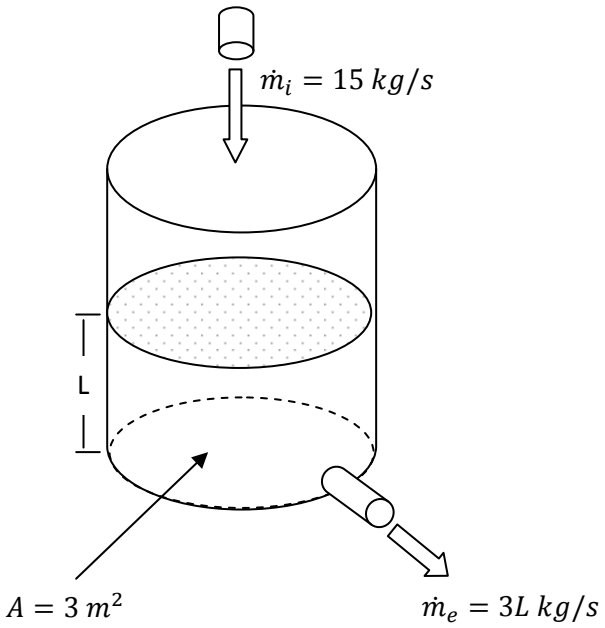
Assignment #4

Assignment date: Wednesday Oct. 7, 2009

Due date: Thursday Oct. 14, 2009

Problem 1

Water flows into the top of an open barrel at a constant mass flow rate of 15 kg/s. Water exits through a pipe near the base with a mass flow rate proportional to the height of liquid inside: $\dot{m}_e = 3L$, where L is the instantaneous liquid height, in m. The area of the base is 3 m^2, and the density of water is 1000 kg/m^3. If the barrel is initially empty, find and plot the variation of liquid height with time and comment on the result.



Problem 2

An industrial process discharges $2 \times 10^5\ ft^3/min$ of gaseous combustion products at 400 °F, $1\ atm$. As shown in the figure, a proposed system for utilizing the combustion products combines a heat-recovery steam generator with a turbine. At steady state, combustion products exit the steam generator at 260 °F, $1\ atm$ and a separate stream of water enters at $40\ lbf/in^2, 102$°F with a mass flow rate of $275\ lb/min$. At the exit of the turbine, the pressure is $1\ lbf/in^2$ and the quality is 93%. Heat transfer from the outer surfaces of the steam generator and turbine can be ignored, as can the changes in kinetic and potential energies of the flowing streams. There is no significant pressure drop for the water flowing through the steam generator. The combustion products can be modeled as air as an ideal gas.

a) Determine the power developed by the turbine, in Btu/min.
b) Determine the turbine inlet temperature, in °F.
c) Evaluating the power developed at $\$0.08\ per\ kW.h$, which is a typical rate for electricity, determine the value of the power, in $\$/year$, for 8000 hours of operation annually.