ASSIGNMENT 1

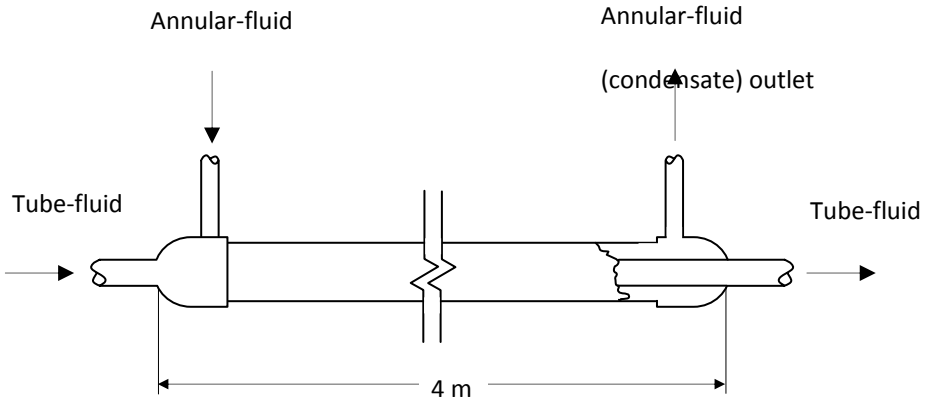
HEAT TRANSFER (CONVECTION PROBLEM)

DEADLINE: FRIDAY 25th FEBRUARY 2011

Problem 7.2

A figure below illustrates a device customarily known as a double-pipe heat exchanger. It consists of a tube within a tube. One fluid flows through the annular space and a second fluid through the inner tube. The outside of the outer tube is well insulated, and with the fluids at different temperatures there is a net heat transfer through the wall of the inner tube.

Water is heated in a double-pipe heat exchanger. Water passes through the inner tube, and steam passes through the annulus. The steam is saturated and condenses at a temperature of 120°C on the outer surface of the inner tube. The water is to be heated from 35°C to an outlet temperature of 90°C. The inner tube is 1 inch standard type M (ID = 2.680 cm, OD = 2.858 cm) copper tubing. The heat exchanger is 4 m long. Calculate the average convection coefficient if the mass flow rate of water is 0.7 kg/sec.



Problem 7.4

Milk (k = 0.6 W/m.K, Cp = 3.85 kJ/kg.K, ρ = 1030 kg/m^3, μ = 2.12$\times$10^{-3} N.s/m^2) is pasteurized in a continuous process where it is to be heated from 20°C to 71.7°C and maintained at this temperature for 15 sec. A hydrodynamically developed flow of milk in a ½ standard stainless steel tube (ID = 1.340 cm, OD = 1.588 cm) moves at and average velocity of 0.1 m/s. An electric resistance heater is placed around the tube and supplies a constant heat flux. Determine the heat flux required to heat the milk for a 6 m heating length. Calculate the entrance length required for the flow to become fully developed hydrodynamically and

thermally. Determine the variation of wall temperature with length up to the point where the flow becomes fully developed.

Problem 7.5

A relatively new design for a water heater consists of 3 m of 1 standard type K copper tubing (ID =2.528, OD =2.858 cm) that is surrounded with a heating element. The element provides a constant heat flux at the tube wall. Water is heated from a temperature of 20°C to 80°C. The volume flow rate of 20°C water to be heat is 20 ml/sec. Determine the power required to do this and the wall temperature at the outlet.

Problem 8.3

A 25 cm-diameter stainless steel ball is removed from the oven at a uniform temperature of 300°C. The ball is then subjected to the flow of air at 1 atm pressure and 25°C with a velocity of 3 m/s. The surface temperature of the ball eventually drops to 200°C. Determine the average convection heat transfer coefficient during this cooling process and estimate how long the process will take.