Assignment 2

Heat Exchanger

1) Hot liquid is to be cooled in a double pipe heat exchanger from 80°C to 50°C. Cooling water enters the tube at 30°C and exits at 45°C. For constant properties of the liquid and same overall heat transfer coefficient in co-current and countercurrent flow, estimate the percentage saving in heat transfer area for counter current with respect to co current flow.

2) Oil with flow rate of 1000 kg/hr is to be cooled using water in a double pipe heat exchanger from temperature of 70°C to 40°C. Water enters the exchanger at 25°C and leaves at 40°C. The overall heat transfer coefficient is 0.2 kW/m^{2}K. Estimate the minimum heat exchanger area in m^2. Assume specific heat of oil and water as 2kJ/kg (K) and 4.2kJ/kg (K) respectively.

3) In a counter flow double pipe heat exchanger, oil with mass flow rate of 2kg/s and specific heat of 2.1kJ/kg (K) is cooled from 90°C to 40°C by water having a mass flow rate of 1 kg/s and specific heat of 4.2 kJ/kg (K). Water at 10°C enters the inner tube of radius of 3cm and length of 5m. Neglecting wall resistance, estimate the overall heat transfer coefficient based on inner radius

One dimensional heat transfer through fins

1) A steady state circumferential fin of rectangular profile (k = 43 W/m. °C) is installed on a tube of diameter 3.0 cm. The outer radius of the fin is 4.0 cm and its thickness is 10 mm. The inner tube is maintained at 250°C and the assembly is exposed to a convection environment having $T\infty$ = 35°C and h = 45W/m^2. °C. Estimate the heat lost by the fin.

2) A thin horizontal rod of length L has its two ends connected to two vertical walls maintained at temperatures T_1 and T_2, respectively. The rod loses heat to the environment at T_∞ by convection. Derive an expression for (a) the temperature distribution in the rod and (b) the total heat lost by the rod.

3) A 30cm long copper rod of 12.5 mm diameter is connected firmly to two walls maintained at 200°C and 95°C. Air is blown across the rod so that a heat-transfer coefficient of 17 W/m^2. °C is maintained. The temperature of the air is 38°C. Estimate the net heat loss by the rod.

4) An aluminum rod 2.0 cm in diameter and 12 cm long protrudes from the wall that is maintained at 250°C. The rod is exposed to an environment at 15°C. The convection heat-transfer coefficient is 12 W/m2. °C. Calculate the heat lost by the rod.

5) A long, thin copper rod 5 mm in diameter is exposed to an environment at 20°C. The base temperature of the rod is 120°C. The heat-transfer coefficient between the rod and the environment is 20 W/m^2. °C. Calculate the heat lost by the rod and the temperature profile along the rod.

6) A 5 mm long, 2.5 mm thick circumferential fin of rectangular profile surrounds a 2 cm diameter tube. The fin is constructed of mild steel. If air blows over the fin so that a heat-transfer coefficient of 25 W/m^2. °C is experienced and the temperatures of the base and air are 260°C and 93°C, respectively, calculate the heat transfer from the fin.

7) A 1.5 mm diameter, 12 mm long stainless steel rod (k = 19 W/m. °C) protrudes from a wall maintained at 45°C. The environment temperature is 20°C and the convection heat-transfer coefficient is 500 W/m^2. °C. Calculate the temperature at the tip of the rod.

8) Calculate the effectiveness of a fin of 1 m diameter when the thermal conductivity is 4 W/m K and the convective heat-transfer coefficient is 10 W/m^2K

9) Evaluate the effectiveness of a fin (k=500 W/m K) of 10 mm diameter and 300 mm length. The fin is adiabatic at the end and the heat-transfer coefficient is 250W/m^2K

10) Derive a relationship between fin effectiveness and fin efficiency. Estimate the effectiveness for a 50% efficient fin having length 5 m and diameter 1 m.