Uva Wellassa University of Sri Lanka
Faculty of Science and Technology
Department of Science and Technology
300 level 2nd Semester Examination – Jan. / Feb. 2016
SCT 363-2 Food Process Engineering

Uva Wellassa University

Instructions to candidates

Duration: 02 hour

Number of questions: Four (04)

Mark allocation: 100 marks

Answer all questions

1.

a. Write the overall energy balance equation for a system between inlet and exist. Define all the notations you have used. (10 Marks)

b. 2000 kg/h of milk is sterilized in a steam infusion sterilizer. The milk is heated to 145°C by introducing it into the steam infusion chamber **H** and then is cooled quickly by flashing in the flash vessel **F**. The vapor that flashes off in the vessel **F** is condensed in the condenser **C** by direct contact of the vapor with cooling water. To avoid dilution of the milk, the pressure in the vessel **F** must be such that the rate at which vapor flashes off in the vessel **F** is equal to the steam that is added in the vessel **H**. Calculate the cooling water flow rate in the condenser that will give the required pressure in the flash vessel. Following data are given: The temperature of the milk at the inlet of **H** is 40°C, the temperature of the cooling water at the inlet of the condenser is 20°C, the steam introduced into the chamber H is saturated at 475.8 kPa Pressure, and the heat capacity of the milk is 3.8 kJ/kg°C at the inlet of the infusion chamber and 4 kJ/k°C at the exit if the infusion chamber.

(15 Marks)

2.

a. Write short descriptions about below given topics related to the Heat exchangers (Use diagrams or sketches where necessary)

i. Compact heat exchanger

ii. Fouling Factor

(05 Marks)

17

b. Deduce a fomula step by step for orverall heat transfer coefficient in the a double pipe heat exhanger with usal notation. (Note that hardness of water in the area is also high)

(08 Marks)

c. Hot oil is to be cooled in a double-tube counter-flow heat exchanger. The copper inner tubes have a diameter of 2.5 cm and a negligible thickness. The inner diameter of the outer tube (the shell) is 3.3 cm. Water flows through the tube at a rate of 0.45 kg/s, and the oil through the shell at a rate of 0.78 kg/s. Taking the average temperatures of the water and the oil to be 35°C and 70°C respectively, determine the overall heat transfer coefficient of this heat exchanger. Properties of water at 35°C ρ = 990 kgm^{-3}, Pr = 3.91, k = 0.637 $Wm^{-1}°C^{-1}$, $\upsilon = \mu/\rho = 0.602\ x\ 10^{-6}\ m^2/s$ and Properties of Oil at 70 °C ρ = 852 kgm^{-3}, Pr = 490, k = 0.138 $Wm^{-1}°C^{-1}$, $\upsilon = \mu/\rho = 37.5x\ 10^{-6}\ m^2/s$.

(12 Marks)

3.

a. Define the terms given below and use a diagram to illustrate them.

I. Velocity boundary layer

II. Boundary layer region

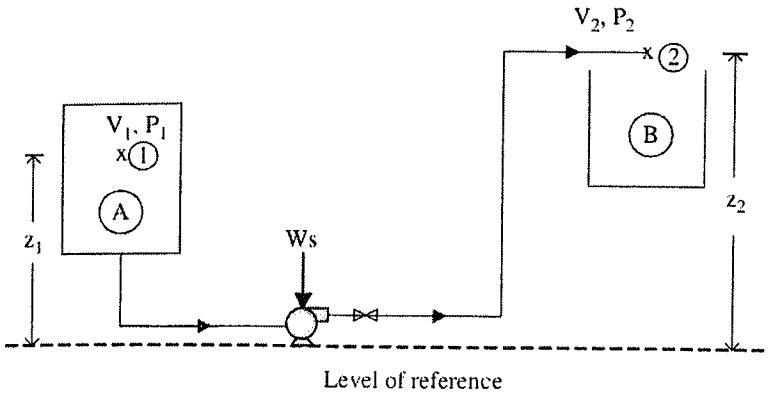
III. Hydrodynamic entrance region

IV. Hydrodynamically developing flow

V. Hydrodynamically fully developed region (10 Marks)

b. A liquid food at 50°C is to be pumped at the rate of 3 m^3/h from a tank **A**, where the absolute pressure is 12350 Pa, to a tank **B**, where the absolute pressure is 101325 Pa, through a sanitary pipe 0.03561 m nominal diameter and 4.6 $x10^{-5}$m surface roughness . The pump is 1 m below the liquid level in tank **A** and the discharge in tank **B** is 3.3 m above the pump. If the length of the pipe in the suction line is 2 m, the discharge line 10 m, and there are one 90°elbow in the suction line, two 90° elbows in the discharge line, and one globe valve in the discharge line, calculate required pump head, shaft power and electrical power, The viscosity and the density of the liquid are 0.003 mPas and 1033 kg/m^3 respectively. The efficiency of the pump and motor are 65% and 87% respectively. Assume

that the level in tank **A** is constant. (K values for 90° Elbow = 0.3, Gloge Valve = 1.06, entrance = 0.2 and Exit = 0.5)



(15 Marks)

4.

a. Write a short dscription about saturated steam considering its properties and advantages. (10 Marks)

b. The wall of an oven consists of two metal sheets with insulation in between. The temperature of the inner wall surface is 200°C and that of the outer surface is 50°C. The thickness of each metal sheet is 2 mm, the thickness of the insulation is 5 cm, and the thermal conductivity is 16 W/m °C and 0.055 W/m°C respectively. Calculate the total resistance of the wall to heat transfer and the heat transfer losses through the wall per m^2 of wall area. (15 Marks)