Uva Wellassa University of Sri Lanka
Faculty of Science and Technology
Department of Science and Technology
300 level 1st Semester Examination – Jul. / Aug. 2016
SCT 363 - 2 Food Process Engineering

Uva Wellassa University

Instructions to candidates

Duration: (Two) hour

Number of questions: Four (04)

Mark allocation: 100

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. (07 Mark)

b. A wide-gap rotational viscometer with a spring constant of 7,187 dynes.cm is used to measure a viscosity (cps; %) of a tomato sauce. The outer radius (R_c), spindle radius (R_b) and height (L) of cylindrical spindle are 2.70 cm, 0.15 cm and 5.0 cm respectively. Determine the K and n? Calculate also the apparent viscosity (μ_{app}) of tomato sauce in N.s/m^2 at spindle speed of 35 rpm. Measurement values are given below. (1 dynes = 10^{-5} N)

Device readings for spindle speeds are given are follows,

Spindle speed (N)	Device reading; cps (% scale)
20 rpm	29
50 rpm	44
100 rpm	60

$$\tau = \frac{A}{2\pi L R_b^2} \; ; shear\ stress\ (\tau)\ at\ the\ wall\ of\ the\ spindle$$

$$\gamma = \frac{4\pi N}{n} \; ; strain\ rate\ for\ large\ gap$$

$$\gamma = \frac{2\omega}{1 - (R_b/R_c)^2} \; ; Strain\ rate\ for\ small\ gap$$

(17) (5)

$A = Torque$

$L = Height\ of\ the\ cylinder$

$N = Speed\ of\ spindle$

$n = Flow\ behavior\ index$

$R_b = Spindle\ radius$

$R_c = Outer\ radius$

$\omega = Angular\ velocity\ of\ the\ spindle$

(18 Marks)

2.

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

(10 Mark)

b. 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 negligible thickness. The inner diameter of the outer tube (the shell) is 3.3 cm. Water flows through the tube at a rate 0.45 kg/s, and the oil through the shell at a rate of 0.8 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 $Wm^{-1}{}^{\circ}C^{-1}$, $\upsilon = \mu/\rho = 0.602\ x\ 10^{-6}\ m^2/s$ and Properties of Oil at 70 °C ρ = 852 kgm^{-3}, Pr = 490, k = 0.138 $Wm^{-1}{}^{\circ}C^{-1}$, $\upsilon = \mu/\rho = 37.5x\ 10^{-6}\ m^2/s$.
($Nu = 0.023\ Re^{0.8}Pr^{0.4}$; $Nusslts\ no - Nu$)

(15 Mark)

3.

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

   I. Hydrodynamically developing flow,

   II. Hydrodynamically fully developed region (05 Mark)

b. A liquid food at 50 °C is to be pumped at the rate of 0.05 m^3min^{-1} 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 4 cm nominal diameter and 4.6 x10^{-5} m surface roughness . The pump is 1 m above the liquid level in tank **A** and the discharge in tank **B** is 4 m above the pump. If the length of the pipe in the suction line is 2 m, the discharge line 10 m, and there were 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 $kgm^{-1}s^{-1}$ and 1110 kg/m3 respectively. The efficiency of the pump is 65% and the efficency of the motor 70%. 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) (20 Mark)

4.

a. Write a short dscription about saturated steam considering its properties and advantages.

(12.5 Mark)

b. What are the disadvantages of using superheated steam.

(12.5 Mark)