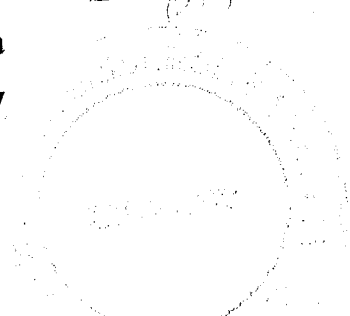


Uva Wellassa University, Sri Lanka
B.Tech Degree Programme 2006/07
End Semester Examination - Semester 1
January 2009
ENG 335-2 Food Process Engineering

**Instructions**

Answer for All questions

No. of questions: Four (04)

No. of pages: Two (02)

Time: Two hours

Clearly state any assumptions made.

You can assume any missing data.

Tables of properties are provided in the exam hall

Question 01

- (a) Skim milk is prepared by the removal of some of the fat from whole milk. This skim milk is found to contain 90.5% water, 3.5% protein, 5.1% carbohydrate, 0.1% fat and 0.8% ash. If the original milk contained 4.5% fat, calculate its composition assuming that fat only was removed to make the skim milk and that there are no losses in processing. (40%)
- (b) If the wet-bulb temperature in a particular room is measured and found to be 20°C in air whose dry-bulb temperature is 25°C (that is the wet-bulb depression is 5°C) estimate the relative humidity, the enthalpy and the specific volume of the air in the room. (30%)
- (c) If the air in part (b) is then to be heated to a dry-bulb temperature of 40°C, calculate the rate of heat supply needed for a flow of 1000 m³ h⁻¹ of this hot air for a dryer, and the relative humidity of the heated air. (30%)

Question 02

- (a) Write short notes on the following topics
1. Centrifugal separations
 2. Filtration
 3. Filtration Equipment
- (75%)
- (b) Calculate the settling velocity of dust particles of (a) 60 mm and (b) 10 mm diameter in air at 21°C and 100 kPa pressure. Assume that the particles are spherical and of density 1280 kg m⁻³, and that the viscosity of air = 1.8 x 10⁻⁵ N s m⁻² and density of air = 1.2 kg m⁻³. (25%)

Question 03

- (a) It is desired to design a cooler in which the tubes are 4 cm diameter, to cool 10,000 kg of milk per hour from 20°C to 3°C. Calculate how many tubes would be needed in parallel to give a Reynolds number of 4000. Assume the density of milk is 1035 kg/m³ and viscosity is 0.001 Nsm⁻². (30%)
- (b) In an evaporator, the internal pressure is read by means of a U-tube containing a liquid hydrocarbon of specific gravity 0.74. If on such a manometer the pressure is found to be below atmospheric by 83 cm, calculate (a) the vacuum in the evaporator and estimate (b) the boiling temperature of water in the evaporator by using the steam tables (40%)
- (c) Air at 0°C is flowing through a duct in a chilling system. A Pitot-static tube is inserted into the flow line and the differential pressure head, measured in a micromanometer, is 0.8 mm of water. Calculate the velocity of the air in the duct. The density of air at 0°C is 1.3 kg m⁻³. (30%)

Question 04

- (a) Calculate the overall heat-transfer coefficient from air to a product packaged in 3.2 mm of solid cardboard (Thermal conductivity 0.07 J m⁻¹ s⁻¹ °C⁻¹), and 0.1 mm of celluloid (thermal conductivity 0.21 J m⁻¹ s⁻¹ °C⁻¹), if the surface air heat transfer coefficient is 11 J m⁻² s⁻¹ °C⁻¹. (30%)
- (b) A thick soup is being boiled in a pan and because of inadequacy of stirring a layer of soup builds up on the bottom of the pan to a thickness of 2 mm. The hot plate is at an average temperature of 500°C, the heat-transfer coefficient from the plate to the pan is 600 J m⁻² s⁻¹ °C⁻¹, and that from the soup layer to the surface of the bulk soup is 1400 J m⁻² s⁻¹ °C⁻¹. The pan is of aluminum (thermal conductivity 220 J m⁻¹ s⁻¹ °C⁻¹) 2 mm thick. Find the temperature between the layer of soup and the pan surface. Assume the thermal conductivity of the soup layer approximates 0.68 J m⁻¹ s⁻¹ °C⁻¹. (40%)
- (c) Calculate the rate of convection heat loss to ambient air from the side walls of a cooking vessel in the form of a vertical cylinder 0.9 m in diameter and 1.2 m high. The outside of the vessel insulation, facing ambient air, is found to be at 49°C and the air temperature is 17°C. (Hint: use the equation $h_c = 1.8\Delta T^{0.25}$ where h_c = convection heat transfer coefficient, ΔT = temperature difference) (30%)