Uva Wellassa University, Sri Lanka
End Semester Examination – March 2011
SCT 363-2 Food Process Engineering

Time: Two (02) hours

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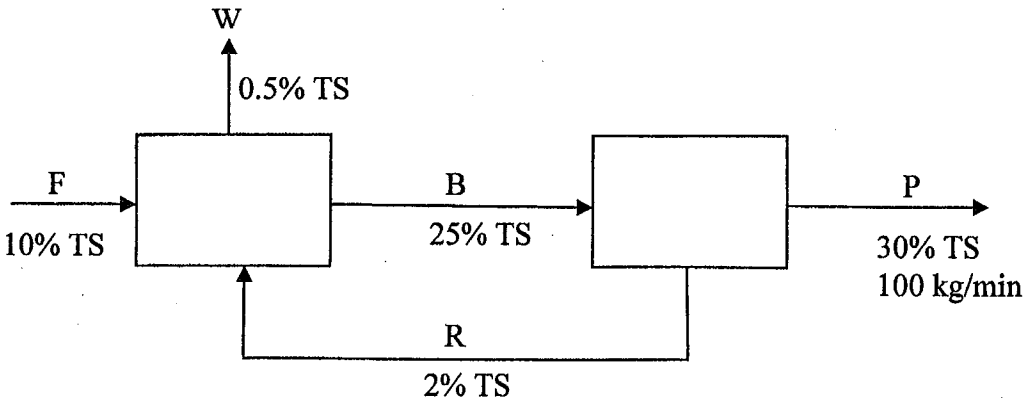
Total 04 questions
Answer **all** questions
Clearly state any assumptions made
You can assume any missing data
Tables of properties will be provided

01) I. Briefly discuss the importance of doing material and energy balance calculations for a processing industry.

(10 marks)

II. A membrane separation system is used to concentrate total solids (TS) in a liquid food from 10% to 30%. The concentration is accomplished in two stages with the first stage resulting in release of a low total solids liquid stream. The second stage separates the final concentration product from a low total solids stream, which is returned to the first stage. Determine the magnitude of the recycle stream when the recycle contains 2% TS, the waste stream contains 0.5% TS, and the stream between stages 1 and 2 contains 25% TS. The process should produce 100 kg/min of 30% TS.



(15 marks)

02) I. Briefly discuss the mechanical separation methods used in food industry.

(08 marks)

II. The 100 m^3 air in a room has a pressure of 1 atm, dry-bulb temperature of 24°C and wet-bulb temperature of 17°C. Determine the following using a Psychrometric chart,

a) Specific humidity

b) Enthalpy

c) Relative humidity

d) Dew-point temperature

e) Mass of dry air

f) Mass of vapour

g) Specific volume

(12 marks)

III. Calculate the settling velocity of a dust particle having diameter of 50 μm. Assume that the particles are spherical and of density 1280 kgm^{-3}, and that the viscosity of air is 1.8×10^{-5} Nsm^{-2} and density of air is 1.2 kgm^{-3}.

(05 marks)

03) I. Describe the type of pumps commonly used in food industry

(10 marks)

II. A pump is being used to transport a liquid food product (density 1000 kg/m^3 and 1.5×10^{-3} Ns/m^2) from a holding tank to a filling machine at a mass flow rate of 2 kg/s. The liquid level in the holding tank is 10 m above the pump, and the filling machine is 15 m above the pump. There is 100 m of 2 inch nominal diameter sanitary pipeline (galvanized iron) between the holding tank and the filling machine, with one open glove valve and four regular 900 flanged elbows in the system. The product is being pumped through a heat exchanger with 100 kPa of pressure drop due to friction before filling. Determine the theoretical power requirement for the pump. (Friction loss coefficient for globe valve 10, regular 900 flanged elbow 0.3 and contraction 0.5)

(15marks)

04) I. Water is flowing at 0.5 ms^{-1} across a 10 cm diameter sausage at 74°C. If the bulk water temperature is 24°C, estimate the heat-transfer coefficient.

Data:

- Properties of water : c_p = 4.186 kJ $kg^{-1}°C^{-1}$, k = 0.64 J m^{-1} $s^{-1}°C^{-1}$, $\mu = 5.6 \times 10^{-4}$ N s m^{-2}, ρ = 1000 kg m^{-3}.
- (Re) = ($\rho vD/\mu$); (Pr) = ($c_p \mu/k$)
- (Nu) = (hcD/k) = $0.26(Re)^{0.6}(Pr)^{0.3}$

(10 marks)

II. Milk is flowing into a pipe cooler and passes through a tube of 3 cm internal diameter at a rate of 0.5 kg s^{-1}. Initial temperature of milk is 49°C and it is to be cooled to 20°C using a stirred bath of constant 10°C water round the pipe. What length of pipe would be required? Assume that the overall coefficient of heat transfer from the bath to the milk is 900 J m^{-2} s^{-1} $°C^{-1}$, and the specific heat of milk is 3890 J kg^{-1} $°C^{-1}$.

(15 marks)

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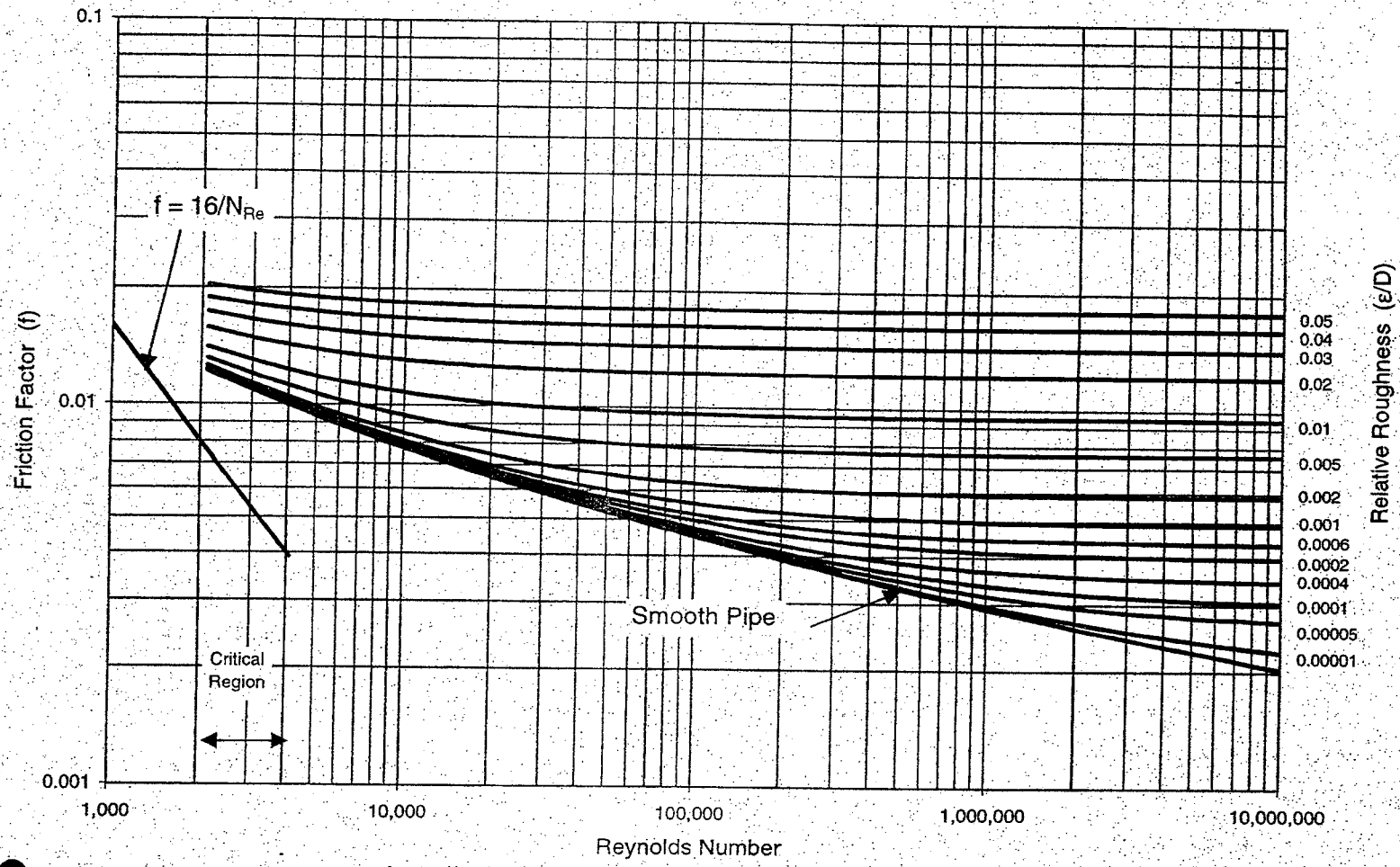

Figure 2.16 The Moody diagram for the Fanning friction factor. Equivalent roughness for new pipes (ε in meters): cast iron, 259×10^{-6}; drawn tubing, 1.5235×10^{-6}, galvanized iron, 152×10^{-6}; steel or wrought iron, 45.7×10^{-6}. (Based on L.F. Moody, 1944. *Trans ASME*, **66**, 671.)