UNIVERSITY COLLEGE TATI

UNIVERSITY COLLEGE TATI (UCTATI)

FINAL EXAMINATION QUESTION BOOKLET	
COURSE CODE	: DTC 2143
COURSE	: TRANSPORT PROCESS
SEMESTER/SESSION	: 1-2023/2024
DURATION	: 3 HOURS

Instructions:

1. This booklet contains 4 questions. Answer **ALL** questions.
2. You are allowed to bring **a sheet A4 Paper** (Formula and notes only).
3. All answers should be written in answer booklet.
4. Write legibly and draw sketches wherever required.
5. If in doubt, raise your hands and ask the invigilator.

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO

THIS BOOKLET CONTAINS 4 PRINTED PAGES INCLUDING COVER PAGE

QUESTION 1

a) State and briefly describe three (3) type of pressure. (6 marks)

b) Explain what is gas law (2 marks)

c) Goodday cows' milk (4536 kg/h) at 4.4°C is being heated in a heat exchanger to 54.4°C by hot water. Predict how much heat is needed? (6 marks)

d) A heavy hydrocarbon oil which has C_{pm} = 2.30 kJ/kg·K is being cooled in a heat exchanger from 371.9 K to 349.7 K and flows inside the tube at a rate of 3630 kg/h. A flow of 1450 kg water/h enters at 288.6 K for cooling and flows outside the tube. The streams are countercurrent.

i. Calculate the water outlet temperature (5 marks)

ii. Calculate ΔT_{lm} (3 marks)

iii. Calculate heat-transfer area if the overall U_i = 340 W/m^2·K (3 marks)

QUESTION 2

a) State and explain 3 mechanisms of heat transfer (6 marks)

b) Describe cold air theory and where is the freezer compartment put in a fridge? (Clarify your answer with appropriate sketch) (6 marks)

c) A 1-2 heat exchanger containing one shell pass and two tubes passes heats 2.52 kg/s of water from 21.1°C to 54.4°C by using hot water under pressure entering at 115.6°C and leaving at 48.9°C. The outside surface area of the tubes in the exchanger is A_0 = 9.30 m^2.

i. Calculate log mean temperature difference ΔT_{lm} (5 marks)

ii. Calculate the mean temperature difference ΔT_m in the exchanger (5 marks)

iii. Calculate the overall heat –transfer coefficient U_o (3 marks)

QUESTION 3

a) Describe double pipe, shell and tube and cross flow heat exchangers (clarify your answers with appropriate sketches) (9 marks)

b) The gas hydrogen at 17°C and 0.010 atm partial pressure is diffusing through a membrane of vulcanized neoprene rubber 0.5 mm thick. The pressure of H_2 on the other side of the neoprene is zero. Calculate the steady-state flux, assuming that the only resistance to diffusion is in the membrane. The solubility S of H_2 gas in neoprene at 17°C is 0.051 m^3 (at STP of 0°C and 1 atm)/m^3 solid· atm and the diffusivity D_{AB} is $1.03X10^{-10}$ m^2/s at 17°C.

(16 marks)

QUESTION 4

a) Explain molecular diffusion (2 marks)

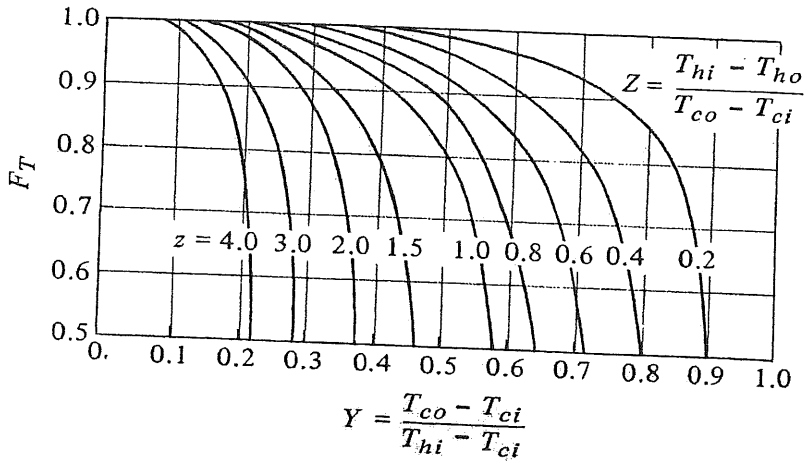
b) A sphere of naphthalene having a radius of 2.0 mm is suspended in a large volume of still air at 318 K and 1.01325 x 10^5 Pa (1 atm). The surface temperature of the naphthalene can be assumed to be at 318 K and its vapor pressure at 318 K is 0.555 mm Hg. The D_{AB} of naphthalene in air at 318 K is 6.92 x 10^{-6} m^2/s. Calculate the rate of evaporation of naphthalene from the surface.

(10 marks)

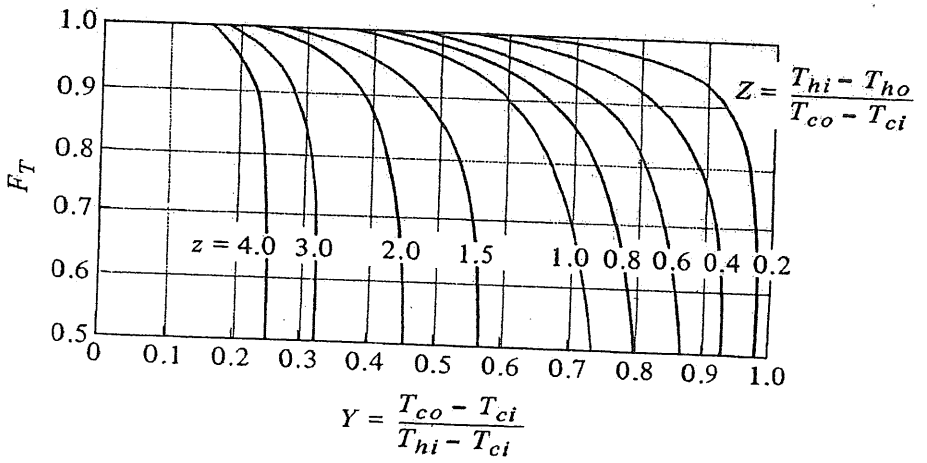
c) An ethanol (A)-water *(B)* solution in the form of a stagnant film 2.0 mm thick at 293 K is in contact at one surface with an organic solvent in which ethanol is soluble and water is insoluble. Hence, N_B = O. At point 1 the concentration of ethanol is 16.8 wt % and the solution density ρ_1 = 972.8 kg/m^3. At point 2 the concentration of ethanol is 6.8 wt % and ρ_2 = 988.1 kg/m^3. The diffusivity of ethanol is 0.740 x 10^{-9} m^2/s. Calculate the steady-state flux N_A. (Molecular weight for ethanol is 46 kg/kmol and water is 18 kg/kmol) (13 marks)

----------End of question----------

Appendix



(a)



(b)

FIGURE 4.9-4. *Correction factor F_T to log mean temperature difference: (a) 1–2 and 1–4 exchangers, (b) 2–4 exchangers. [From R. A. Bowman, A. C. Mueller, and W. M. Nagle, Trans. A.S.M.E., 62, 284, 285 (1940). With permission.]*