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PRINCE OF SONGKLA UNIVERSITY

FACULTY OF ENGINEERING

Final Examination Semester I Academic Year: 2003

Date: October 2, 2003 Time: 9.00 – 12.00 น.

Subject: 230-592 Special Topics in Chemical Engineering II Room: R 300

(Basic Laws of Transport Phenomena for Chemical Engineering)

คำสั่ง

- ตอบคำถามทุกข้อโดยอ่านคำถามให้เข้าใจ ละเอียดถี่ถ้วนก่อนทำ
- **ห้าม**นำหนังสือหรือเอกสารใดๆ ที่นอกเหนือจากที่อนุญาตเข้าห้องสอบ
- **ห้าม**หยิบยืมเอกสารใดๆ และพูดคุยกับนักศึกษาอื่นขณะทำข้อสอบ

อนุญาต

- นำสมุดโน๊ตและเอกสารประกอบการเรียนที่เป็นลายมือตัวเองเข้าห้องสอบได้
- นำหนังสือเรียน Transport Phenomena (Bird, Stewart & Lightfoot) เข้าห้องสอบได้
- นำเครื่องคิดเลขทุกรุ่นเข้าห้องสอบได้
- ใช้ดินสอทำข้อสอบได้
- กระดาษไม่พอให้เขียนหน้าหลังได้

ข้อสอบ มี 10 □□□ (□□□□□)

ชื่อ ..... **รหัส** .....

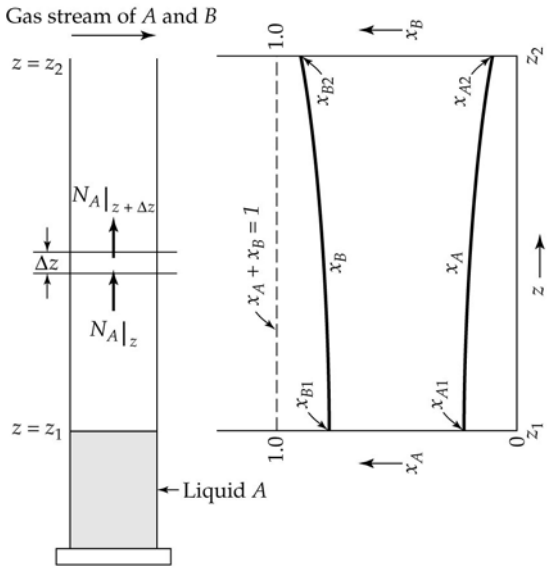
ข้อ	1	2	3	4	รวม
คะแนนเต็ม	30	30	30	30	120
ทำได้					

ดร. ชญานุช แสงวิเชียร ผู้ออกข้อสอบ

22 กันยายน 2546

Problem 1 (30points)

For the system as shown in this Figure, what is the evaporation rate in g/hr of CCL_3NO_2 (chloropicrin) into air at 25 °C? Make the customary assumption that air is a "pure substance."

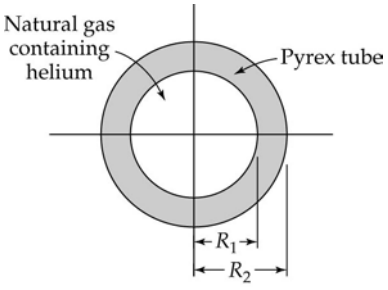


Additional Information:

Total pressure	770 mm Hg
Diffusivity (CCl_3NO_2-air)	0.088 cm^2/s
Vapor pressure of CCl_3NO_2	23.81 mm Hg
Distance from liquid level to top of tube	11.14 cm
Density of CCl_3NO_2	1.65 g/cm^3
Surface area of liquid for evaporation	2.29 cm^2

Problem 2 (30 points)

Diffusion of helium through pyrex tubing is used in a method for separating helium from natural gas. Pyrex glass is almost impermeable to all gases but helium. For example, the diffusivity of He through pyrex is about 25 times the diffusivity of H_2 through pyrex, hydrogen being the closet "competitor" in the diffusion process.

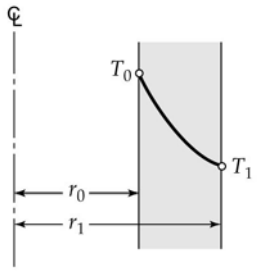


Suppose a natural gas mixture is contained in a pyrex tube with dimensions shown in the Figure and the length of tubing is L. Show that an expression for the rate at which helium will "leak" out of the tube, in terms of the diffusivity of helium through pyrex, the interracial concentration of the helium in the pyrex, and the dimensions of the tube is:

$$W_{He} = 2\pi L \frac{D_{He-Pyrex}\left(C_{He,1} - C_{He,2}\right)}{\ln(R_1 / R_2)}$$

Problem 3 (30 points)

Heat Conduction in an annulus.



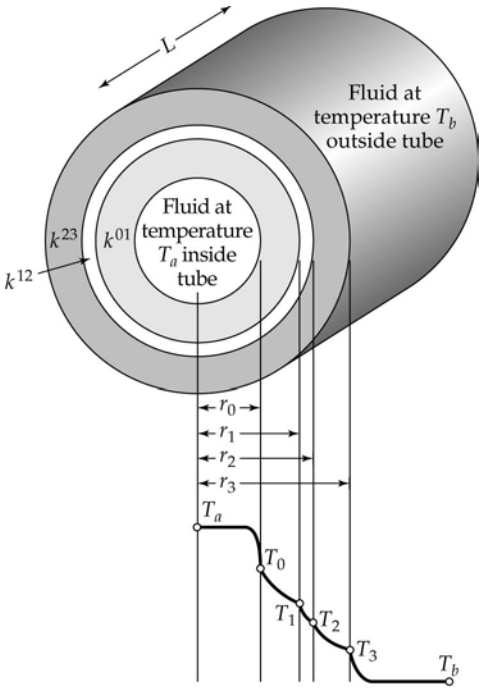
(a) Heat is flowing through an annulus wall of inside radius r_o and outside r_1. The thermal conductivity varies linearly with temperature from k_0 at T_0 to k_1 at T_1.

$$k = k_0 + (k - k_0)\left(\frac{T - T_0}{T_1 - T_0}\right)$$

Develop an expression for the heat flow through the wall (at $r = r_o$).

(b) Show how the expression in (a) can be simplified when $(r_1-r_o)/ r_o$ is very small. (Use Taylor's series expansion ln(1+x) = x + … when x is very small.)

Problem 4 (30 points)



BIRD: *Transport Phenomena, 2e*
Fig. 10.6-2 W-151

A standard schedule 40, 2-in. steel pipe (inside diameter 2.067 in. and wall thickness 0.154 in.) carrying steam is insulated with 2 in. of magnesia covered in turn with 2 in. of cork. The inner surface of the pipe is at 250 °F and the outer surface of the cork is at 90 ° F. The thermal conductivities (in Btu/hr.ft.°F) of the substances concerned are: 26.5, 0.03 and 0.02 for steel, magnesia and cork respectively. **Calculate the heat loss per hour per foot of pipe.**