Prince of Songkla University
Faculty of Engineering

Exam: Final Exam: Semester II **Academic Year: 2015**
Date: 4 May 2016 **Time: 09:00 – 12:00**
Subject: 230-630 Advanced Transport Phenomena **Room: A202**

- Only a text book (Transport Phenomena, BSL) is allowed.
- All calculator models are allowed.
- Use of pencil is allowed.
- The total page numbers are 9 pages, including first page.

Name.....Student ID.....

ทุจริตในการสอบโทษขั้นต่ำคือ ปรับตกในรายวิชาที่ทุจริต และพักการเรียน 1 ภาคการศึกษา

Problem No.	Points	Scores
1	30	
2	30	
3	30	
4	30	
Total	120	

Exam prepared by

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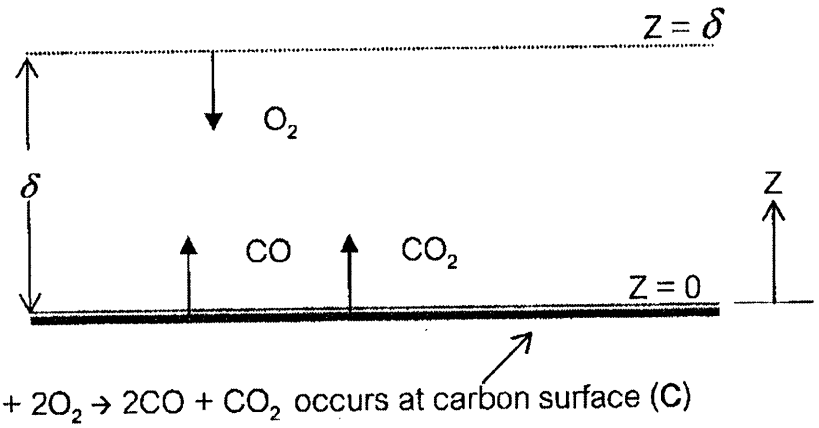
25 April 2016

1. (30 points) Consider at the catalyst surface, the reaction $3C + 2O_2 \rightarrow 2CO + CO_2$ occurs instantaneously and the product $CO + CO_2$ then diffuse back through the gas film. Imagine that each catalyst particle is surrounded by a stagnant film thickness, δ, which O_2 has to diffuse in order to arrive the catalyst surface. Determine the expression for the molar flux of O_2, ($N_{A,O2}$), to the concentration gradient, $\left(\frac{dx_{O_2}}{dz}\right)$.

   (Note: You can make the assumptions that can simplify this problem.)



(This page is for Problem 1)

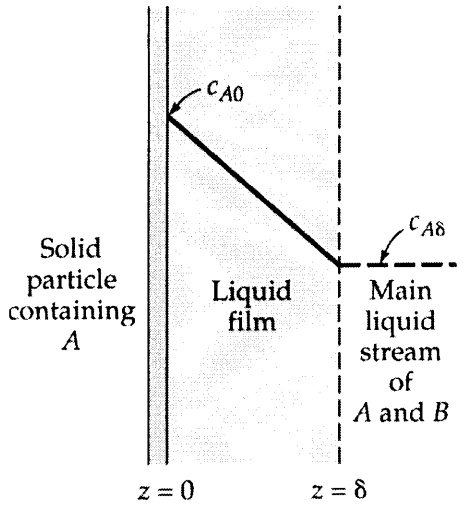
2. (30 points) The rate of leaching of a substrate A from solid particles by a solvent B, we may postulate that the rate-controlling step is the diffusion of A from the particle surface through a stagnant liquid film thickness δ out into the main stream. The molar solubility of A in B is C_{A0}, and the concentration in the main stream is $C_{A\delta}$.

(a) Obtain a differential equation for C_A as a function of z by making a mass balance on A over a thin slab of thickness Δz. Assume that D_{AB} is constant and that A is only slightly soluble in B. Neglect the curvature of the particle.

(b) Show that, in the absence of chemical reaction in the liquid phase, the concentration profile is linear.

(c) Show that the rate of leaching is given by

$$N_{AZ} = D_{AB}(c_{A0} - c_{A\delta})/\delta$$

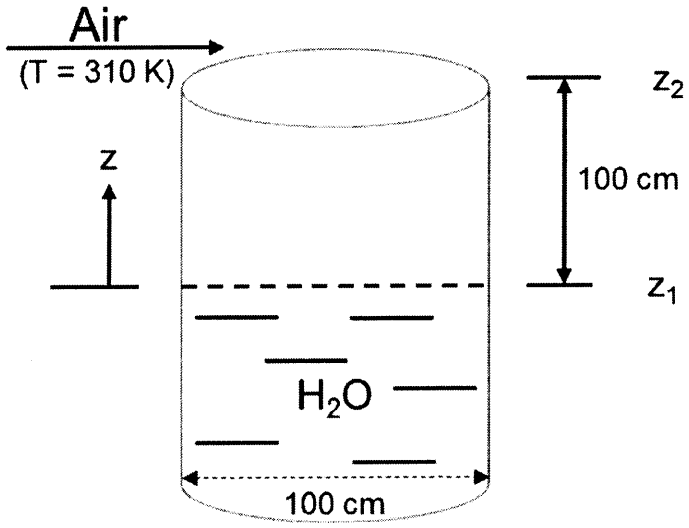


(This page is for Problem 2)

3. (30 points) From this Figure, please find the rate of evaporation of water (A) in unit of mole/hr. Air (B) is blowing across this tube. The diameter of this tube is 100 cm. The diffusivity coefficient (D_{AB}) is 0.276 cm^2/sec. The boundary conditions are given as the followings:

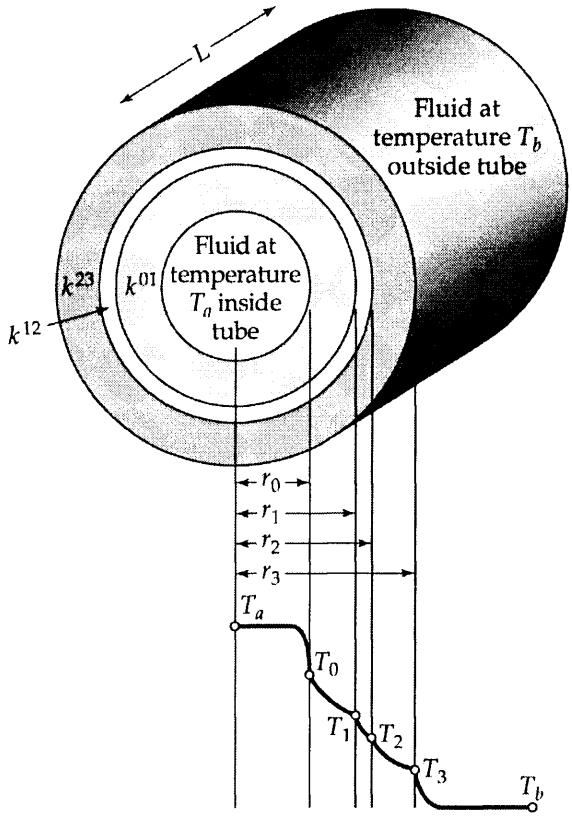
At $z = z_1$; $x_A = x_{A1} = 0.0608$

At $z = z_2$; $x_A = x_{A2} = 0$



(This page is for Problem 3)

4. (30 points) Estimate the heat loss per hour per foot of pipe. A steel pipe is carrying steam and it is insulated with 2 in. of magnesia covered in turn with 2 in. of cork. A steel pipe has an inside diameter of 2.067 in. and a wall thickness of 0.154 in. The inner surface of the pipe is 250 °F and the outer surface of the rock is at 90 °F. The thermal conductivities (Btu/hr.ft.°F) of the substances concerned are 26.1 (Steel), 0.04 (Magnesia) and 0.03 (Cork).



(This page is for Problem 4)