# PRINCE OF SONGKLA UNIVERSITY
# FACULTY OF ENGINEERING

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| Final Exam | : Semester II | Academic Year | : 2008 |
| Date | : December 25, 2008 | Time | : 9:00-12:00 |
| Subject | : Unit Operations I (230-323) | | |
| Total pages | : 10 (inc. front page) | Room | : หัวหุ่นยนต์ |

NAME ..... STUDENT ID .....

อนุญาตให้นำเอกสารและเครื่องคำนวณทุกชนิดเข้าห้องสอบ

ทุจริตในการสอบโทษขั้นต่ำคือปรับตกในรายวิชาที่ทุจริต

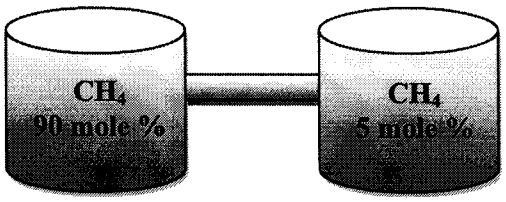
และพักการศึกษา 1 ภาคการศึกษา

| Question # | Total Score | Score |
|---|---|---|
| 1 | 20 | |
| 2 | 25 | |
| 3 | 25 | |
| 4 | 20 | |
| 5 | 20 | |
| **Total** | **110** | |

ดร. พรศิริ แก้วประดิษฐ์

ผู้ออกข้อสอบ

**1.** (20 points), A large tank filled with a mixture of methane and air is connected to a second tank filled with a different composition of methane and air. Both tanks are at 100 $kN/m^2$ and 0°C. The connection between the tanks is a tube of 2 mm inside diameter and 150 mm long. Assume that transport between the tanks is by molecular diffusion. The mass diffusivity of methane in air at 0°C and 100 $kN/m^2$ is $1.57\times10^{-5}$ $m^2/s$.




**1.1.** (5 points), plot concentration gradient of methane

**1.2.** (15 points), calculate the steady-state rate of transport of methane through the tube in mol/s

**2.** (25 points) An open cylindrical tank 7 m in diameter contains ethanol at 25°C exposed to the atmosphere. The air within the tank is stationary and the alcohol is vaporized through an air film 0.5 cm thick. The vapor pressure of ethanol at 25°C is 54.68 mmHg. The concentration of ethanol beyond the film is negligible.

**2.1.** (10 points), estimate diffusion coefficient in $m^2/hr$

**2.2.** (10 points), calculate rate of vaporization in liter/hr, where the specific gravity of ethanol is 0.79

**2.3.** (5 points), if ethanol is worth 24 baht/liter, what is the value of the loss of ethanol from this tank per day.

**3.** (25 points) A wetted-wall column 5 cm in diameter contains air and $CO_2$ flowing at 0.9 m/s. At one point in the column, the $CO_2$ concentration in the air is 0.1 mole fraction. At the same point in the column, the vapor pressure of $CO_2$ at the interface is 8.2 atm. The column operates at 10 atm and 25°C.

**3.1.** (10 points), at this condition the air is turbulent or laminar flow

**3.2.** (10 points), estimate mass-transfer coefficient in kmole/hr.$m^3$, if diffusivity is 0.164 $cm^2$/s at 25°C, 1 atm

**3.3.** (5 points), calculate the flux in kmole/hr.$m^2$

(This page for problem 3)

**4.** (20 points) Calculate the rate of diffusion of acetic acid, $CH_3COOH$ (A) in kmol/s.m$^2$ across a film of non-diffusing water (B) solution 1 mm thick at 17°C when the concentrations on opposite sides of the films are, respectively 9 and 3 wt% acid (Note that density of 9% and 3% solution is 1012 and 1003 kg/m$^3$ respectively). The diffusivity of acetic acid in the solution is $0.95\times10^{-9}$ m$^2$/s.

**5.** (20 points) Calculate the effective film thickness in μm for diffusion from the wall of a 3 cm ID pipe, when the average fluid velocity $u = 1.8$ m/s, $\rho = 1050$ kg/m$^3$, $\mu = 5$ cP and $D_{AB} = 2 \times 10^{-6}$ cm$^2$/s.