PRINCE OF SONGKLA UNIVERSITY
FACULTY OF ENGINEERING

Final Exam : Semester II   Academic Year : 2008

Date : February 20, 2009   Time : 13:30-16:30

Subject : Unit Operations I (230-323)

Total pages : 10 (inc. front page)   Room : R300

NAME .... STUDENT ID ....

อนุญาตให้นำเอกสารและเครื่องคำนวณทุกชนิดเข้าห้องสอบ

<u>ทุจริตในการสอบโทษขั้นต่ำคือปรับตกในรายวิชาที่ทุจริต</u>

<u>และพักการศึกษา 1 ภาคการศึกษา</u>

| Question #	Total Score	Score
1	40	
2	25	
3	30	
4	25	
Total	**120**	

ดร. พรศิริ แก้วประดิษฐ์

ผู้ออกข้อสอบ

1. (40 points), A mixture of benzene and toluene containing 40 mole percent benzene is to be separated to give a product containing 90 mole percent benzene at the top, and a bottom product containing not more than 10 mole percent benzene. The feed enters the column at its boiling point with 100 kmol of feed, the column is operated with an external reflux ratio of 3,

   1.1. (10 points), find the number of theoretical plates needed and the position of entry for the feed by McCabe-Thiele method, if the equilibrium diagram is given as shown in the figure below
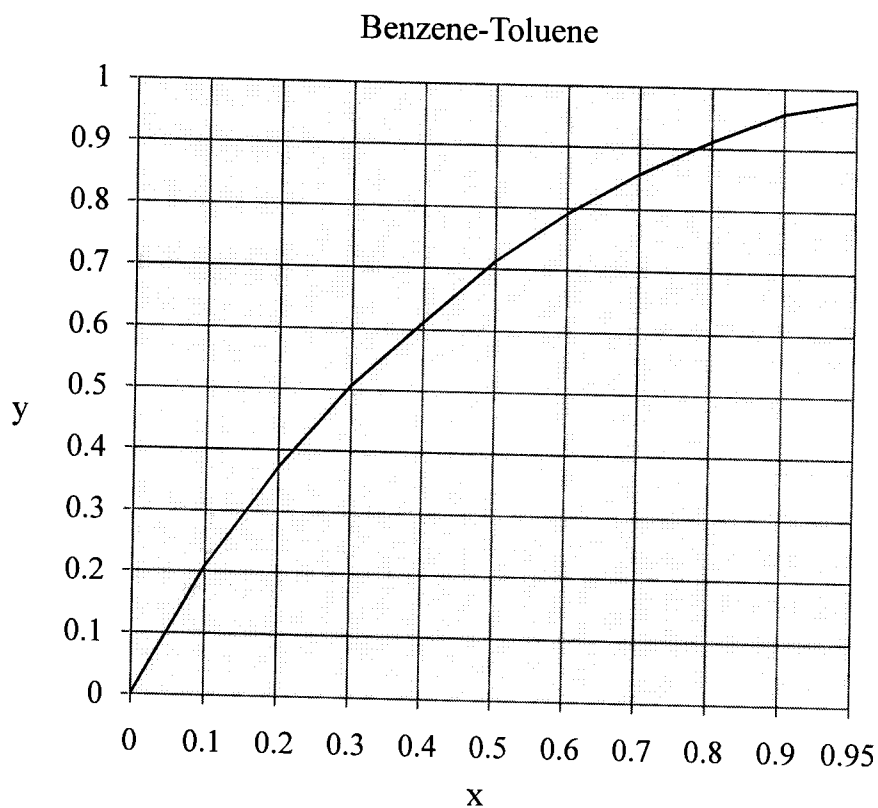
Benzene-Toluene

   1.2. (5 points), determine the operating equation of rectifying section

   1.3. (5 points), determine the operating equation of stripping section

   1.4. (10 points), if the mean volatility of benzene relative to toluene is 2.4, what is the number of plates required at total reflux

   1.5. (10 points), if the feed is liquid at its boiling point, find the minimum reflux ratio

2. (25 points) A separation of O_2/N_2 (tested for air separation) is studied using a hollow fiber membrane, which is operated with feed and permeate pressures of 5.0 and 1.0 atm. At a certain feed rate (F), the membrane system gives 0.19F of 40 percent O_2 as permeate and a residue with 17 percent O_2. The membrane area is 20.8 m^2

  2.1. (10 points), calculate the permeabilities of O_2 and N_2 in liter/min. m^2. atm, when air contains 21 percent O_2

  2.2. (5 points), determine the selectivity

  2.3. (10 points), if the feed pressure is increased to 10 atm, what oxygen concentration could be obtained in permeate (Assume that permeate concentration at residue end is neglected)

3. (30 points)   An absorber is to remove 99.5% of solute A from a gas stream containing 4 mole % A by absorption in water. The absorber is operated at 25°C and 1 atm and the gas and liquid rates are to be 30 and 150 mole/hr. m^2, respectively. Equilibrium data are given as y* = 3.6x at 25°C, assuming isothermal operation and neglecting changes in gas and liquid flow rates

3.1.   (5 points), find overall number of transfer units, N_{Oy}

3.2.   (10 points), if mass-transfer coefficient k_xa and k_ya are 60 and 15 mole/hr. m^3 respectively, calculate total height of the absorber, Z_T (meter)

3.3.   (15 points), if the equilibrium slope is decreased 0.75 times at 2 atm, calculate Z_T (meter)

4. (25 points) An organic solute is to be extracted from a dilute aqueous solution using a solvent with a distribution coefficient of 6.8. For a continuous counter-flow extractor, ratio of solvent flow and solution flow (V/L) is 0.38

4.1. (7 points), what fraction of the solute would be recovered in a single ideal stage

4.2. (8 points), what would be the recovery with 2-stages extraction using fresh solvent in both stages

4.3. (10 points), how many ideal stages are needed if 99% recovery of the solute is required