

Code No: R05320801

R05**Set No. 2****III B.Tech II Semester Examinations, December 2010****MASS TRANSFER OPERATIONS-II****Chemical Engineering****Time: 3 hours****Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

- Explain the working of Higgin's contactor with a neat sketch.
 - Distinguish between fluidized and teeter beds. [8+8]
- What are the various factors to be considered for the choice of solvent for extraction operations?
 - It is required to extract picric acid from a dilute aqueous solution containing 0.1 mole picric acid per litre of solution using benzene as solvent with a recovery of 80% of the picric acid originally present. Determine
 - The minimum quantity of benzene required per litre of aqueous solution and
 - Number of transfer units for a solvent rate of 1.3 times the minimum. The equilibrium data for benzene picric acid water system at 25 °C is given by:

$C_B \times 10^2 :$	0.0932	0.225	1	2	5	10	18
$m = C_B/C_A :$	2.23	1.45	1.075	0.505	0.32	0.24	0.187

Where C_B and C_A are the equilibrium concentrations of picric acid in benzene and aqueous phases respectively in mole/litre. [6+10]

- A tower packed with 1- in rings is to be designed to absorb SO₂ from air by scrubbing the gas with water. The entering gas is 20% SO₂ by volume, and the leaving gas is to contain not more than 0.5% SO₂ by volume. The entering H₂O is SO₂ - free. The temperature is 25 °C and the total pressure is 2 atm. The water flow rate is to be twice the minimum. The air flow rate (SO₂ - free basis) is to be 976 Kg/m²-h. What depth of packing is required? The mass transfer coefficient $K_y a$ is 5.21 mol/ft³h (molfriction) and the equilibrium date at 25 °C is as follows: [16]

x_{SO_2} mole fraction :	0.00127	0.00237	0.00338	0.00439	0.00538
p_{SO_2} atm	0.04	0.08	0.12	0.16	0.20

- Write short notes on ideal and non-ideal solutions.
 - What is absorption factor? How is this related to stripping factor?
 - Discuss what factors should be considered in the selection of a solvent for absorption. [6+4+6]
- Explain about negative solute adsorption in case of adsorption of concentrated solution.

Code No: R05320801

R05**Set No. 2**

- (b) An aqueous solution containing a valuable solute is colored by small amounts of an impurity which is to be removed by a single stage contact with the absorbent carbon, which adsorbs insignificant amount of principle solute. Color intensity is proportional to the concentration of colored substance. It is desired to reduce color to 5% of its original value, the original value being 19.6 units. Determine the quantity of fresh carbon required per 1000 kg of solution in a two stage counter current operation. The equilibrium data could be represented by:

$$Y^* = 8.91 \times 10^{-5} X^{1.66}$$

Where Y^* = equilibrium color, units/kg of solution X = adsorbate concentration, units/kg carbon. [6+10]

6. A distillate containing 45 wt% isopropyl alcohol, 50 wt% diisopropyl ether and 5 wt% water is obtained from the heads column of an isopropyl alcohol finishing unit. The company desires to recover the ether from this stream by liquid-liquid extraction in a counter current column, with water, as the solvent. Ether should not contain no more than 2.5 wt% alcohol and to obtain the extracted alcohol at a concentration of at least 20 wt%. The unit will operate at 25 °C and 1 atm. Find how many theoretical stages are required. [16]

Ether phase			Water phase		
Wt % alcohol	Wt % Ether	Wt % water	Wt % alcohol	Wt % Ether	Wt % water
2.4	96.7	0.9	8.1	1.8	90.1
3.2	95.7	1.1	8.6	1.8	89.6
5.0	93.6	1.4	10.2	1.5	88.3
9.3	88.6	2.1	11.7	1.6	86.7
24.9	69.4	5.7	17.5	1.9	80.6
38.0	50.2	11.8	21.7	2.3	76.0
45.2	33.6	21.2	26.8	3.4	69.8

7. (a) Comment of the nature of equilibrium data generally used in solid-liquid extraction.
- (b) Oil from fish livers is to be continuously and counter current extracted using ethyl ether as solvent. The quantity of solution retained by the granulated livers is given below :

Kg. oil/kg. soln. :	0.00	0.10	0.20	0.30	0.40	0.50	0.65	0.72
Kg. soln./kg.oil-free liver :	0.205	0.242	0.286	0.339	0.405	0.489	0.672	0.810

The liver contains 0.257 mass fraction oil. If 95% of the oil is to be extracted and the strong solution obtained from the system is to contain 0.70 mass fraction oil, determine.

- The quantity and composition of the discharge solids.
- Kg. of oil-free ether required per 100kg. of fresh liver.
- The number of ideal stages required.

[4+12]

Code No: R05320801

R05**Set No. 2**

8. A solute is recovered from an aqueous solution containing 20% of the solute by weight using kerosene as the solvent. The distribution of the solute in water and kerosene may be described by $x=60.45y$ where x is the kg of solute per kg of water and y is the kg of solute per kg of kerosene. Calculate the final concentration in the final raffinate if the extractions done in 3 simple equilibrium contacts using 5kg solvent per kg of initial solution in each stage. [16]

FIRSTRANKER

Code No: R05320801

R05**Set No. 4**

III B.Tech II Semester Examinations, December 2010

MASS TRANSFER OPERATIONS-II

Chemical Engineering

Time: 3 hours

Max Marks: 80

Answer any FIVE Questions
All Questions carry equal marks

- Write short notes on ideal and non-ideal solutions.
 - What is absorption factor? How is this related to stripping factor?
 - Discuss what factors should be considered in the selection of a solvent for absorption. [6+4+6]
- A solute is recovered from an aqueous solution containing 20% of the solute by weight using kerosene as the solvent. The distribution of the solute in water and kerosene may be described by $x=60.45y$ where x is the kg of solute per kg of water and y is the kg of solute per kg of kerosene. Calculate the final concentration in the final raffinate if the extractions done in 3 simple equilibrium contacts using 5kg solvent per kg of initial solution in each stage. [16]
- Explain about negative solute adsorption in case of adsorption of concentrated solution.
 - An aqueous solution containing a valuable solute is colored by small amounts of an impurity which is to be removed by a single stage contact with the absorbent carbon, which adsorbs insignificant amount of principle solute. Color intensity is proportional to the concentration of colored substance. It is desired to reduce color to 5% of its original value, the original value being 19.6 units. Determine the quantity of fresh carbon required per 1000 kg of solution in a two stage counter current operation. The equilibrium data could be represented by:

$$Y^* = 8.91 \times 10^{-5} X^{1.66}$$
Where Y^* = equilibrium color, units/kg of solution X = adsorbate concentration, units/kg carbon. [6+10]
- A distillate containing 45 wt% isopropyl alcohol, 50 wt% diisopropyl ether and 5 wt% water is obtained from the heads column of an isopropyl alcohol finishing unit. The company desires to recover the ether from this stream by liquid-liquid extraction in a counter current column, with water, as the solvent. Ether should not contain no more than 2.5 wt% alcohol and to obtain the extracted alcohol at a concentration of at least 20 wt%. The unit will operate at 25 °C and 1 atm. Find how many theoretical stages are required. [16]

Code No: R05320801

R05**Set No. 4**

Ether phase			Water phase		
Wt % alcohol	Wt % Ether	Wt % water	Wt % alcohol	Wt % Ether	Wt % water
2.4	96.7	0.9	8.1	1.8	90.1
3.2	95.7	1.1	8.6	1.8	89.6
5.0	93.6	1.4	10.2	1.5	88.3
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24.9	69.4	5.7	17.5	1.9	80.6
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45.2	33.6	21.2	26.8	3.4	69.8

5. (a) What are the various factors to be considered for the choice of solvent for extraction operations?
- (b) It is required to extract picric acid from a dilute aqueous solution containing 0.1 mole picric acid per litre of solution using benzene as solvent with a recovery of 80% of the picric acid originally present. Determine
- The minimum quantity of benzene required per litre of aqueous solution and
 - Number of transfer units for a solvent rate of 1.3 times the minimum. The equilibrium data for benzene picric acid water system at 25 °C is given by:

$C_B \times 10^2$:	0.0932	0.225	1	2	5	10	18
$m = C_B/C_A$:	2.23	1.45	1.075	0.505	0.32	0.24	0.187

Where C_B and C_A are the equilibrium concentrations of picric acid in benzene and aqueous phases respectively in mole/litre. [6+10]

6. (a) Comment of the nature of equilibrium data generally used in solid-liquid extraction.
- (b) Oil from fish livers is to be continuously and counter current extracted using ethyl ether as solvent. The quantity of solution retained by the granulated livers is given below :

Kg. oil/kg. soln. :	0.00	0.10	0.20	0.30	0.40	0.50	0.65	0.72
Kg. soln./kg.oil-free liver :	0.205	0.242	0.286	0.339	0.405	0.489	0.672	0.810

The liver contains 0.257 mass fraction oil. If 95% of the oil is to be extracted and the strong solution obtained from the system is to contain 0.70 mass fraction oil, determine.

- The quantity and composition of the discharge solids.
 - Kg. of oil-free ether required per 100kg. of fresh liver.
 - The number of ideal stages required. [4+12]
7. A tower packed with 1- in rings is to be designed to absorb SO_2 from air by scrubbing the gas with water. The entering gas is 20% SO_2 by volume, and the leaving gas is to contain not more than 0.5% SO_2 by volume. The entering H_2O is SO_2 - free. The temperature is 25 °C and the total pressure is 2 atm. The water flow rate is

Code No: R05320801

R05**Set No. 4**

to be twice the minimum. The air flow rate (SO_2 - free basis) is to be $976 \text{ Kg/m}^2\text{-h}$. What depth of packing is required? The mass transfer coefficient $K_y a$ is $5.21 \text{ mol/ft}^3\text{h}$ (molfriction) and the equilibrium data at 25°C is as follows: [16]

x_{so_2} mole fraction :	0.00127	0.00237	0.00338	0.00439	0.00538
p_{so_2} atm	0.04	0.08	0.12	0.16	0.20

8. (a) Explain the working of Higgin's contactor with a neat sketch.
 (b) Distinguish between fluidized and teeter beds. [8+8]

FIRSTRANKER

Code No: R05320801

R05**Set No. 1****III B.Tech II Semester Examinations, December 2010****MASS TRANSFER OPERATIONS-II****Chemical Engineering****Time: 3 hours****Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

- Write short notes on ideal and non-ideal solutions.
 - What is absorption factor? How is this related to stripping factor?
 - Discuss what factors should be considered in the selection of a solvent for absorption. [6+4+6]
- A tower packed with 1- in rings is to be designed to absorb SO_2 from air by scrubbing the gas with water. The entering gas is 20% SO_2 by volume, and the leaving gas is to contain not more than 0.5% SO_2 by volume. The entering H_2O is SO_2 - free. The temperature is 25°C and the total pressure is 2 atm. The water flow rate is to be twice the minimum. The air flow rate (SO_2 - free basis) is to be $976 \text{ Kg/m}^2\text{-h}$. What depth of packing is required? The mass transfer coefficient $K_y a$ is $5.21 \text{ mol/ft}^3\text{h}$ (molfriction) and the equilibrium data at 25°C is as follows: [16]

x_{so_2} mole fraction :	0.00127	0.00237	0.00338	0.00439	0.00538
p_{so_2} atm	0.04	0.08	0.12	0.16	0.20
- Explain the working of Higgin's contactor with a neat sketch.
 - Distinguish between fluidized and teeter beds. [8+8]
- A solute is recovered from an aqueous solution containing 20% of the solute by weight using kerosene as the solvent. The distribution of the solute in water and kerosene may be described by $x=60.45y$ where x is the kg of solute per kg of water and y is the kg of solute per kg of kerosene. Calculate the final concentration in the final raffinate if the extractions done in 3 simple equilibrium contacts using 5kg solvent per kg of initial solution in each stage. [16]
- A distillate containing 45 wt% isopropyl alcohol, 50 wt% diisopropyl ether and 5 wt% water is obtained from the heads column of an isopropyl alcohol finishing unit. The company desires to recover the ether from this stream by liquid-liquid extraction in a counter current column, with water, as the solvent. Ether should not contain no more than 2.5 wt% alcohol and to obtain the extracted alcohol at a concentration of at least 20 wt%. The unit will operate at 25°C and 1 atm. Find how many theoretical stages are required. [16]

Code No: R05320801

R05**Set No. 1**

Ether phase			Water phase		
Wt % alcohol	Wt % Ether	Wt % water	Wt % alcohol	Wt % Ether	Wt % water
2.4	96.7	0.9	8.1	1.8	90.1
3.2	95.7	1.1	8.6	1.8	89.6
5.0	93.6	1.4	10.2	1.5	88.3
9.3	88.6	2.1	11.7	1.6	86.7
24.9	69.4	5.7	17.5	1.9	80.6
38.0	50.2	11.8	21.7	2.3	76.0
45.2	33.6	21.2	26.8	3.4	69.8

6. (a) Explain about negative solute adsorption in case of adsorption of concentrated solution.

- (b) An aqueous solution containing a valuable solute is colored by small amounts of an impurity which is to be removed by a single stage contact with the absorbent carbon, which adsorbs insignificant amount of principle solute. Color intensity is proportional to the concentration of colored substance. It is desired to reduce color to 5% of its original value, the original value being 19.6 units. Determine the quantity of fresh carbon required per 1000 kg of solution in a two stage counter current operation. The equilibrium data could be represented by:

$$Y^* = 8.91 \times 10^{-5} X^{1.66}$$

Where Y^* = equilibrium color, units/kg of solution X = adsorbate concentration, units/kg carbon. [6+10]

7. (a) Comment of the nature of equilibrium data generally used in solid-liquid extraction.

- (b) Oil from fish livers is to be continuously and counter current extracted using ethyl ether as solvent. The quantity of solution retained by the granulated livers is given below :

Kg. oil/kg. soln. :	0.00	0.10	0.20	0.30	0.40	0.50	0.65	0.72
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- The quantity and composition of the discharge solids.
 - Kg. of oil-free ether required per 100kg. of fresh liver.
 - The number of ideal stages required. [4+12]
8. (a) What are the various factors to be considered for the choice of solvent for extraction operations?
- (b) It is required to extract picric acid from a dilute aqueous solution containing 0.1 mole picric acid per litre of solution using benzene as solvent with a recovery of 80% of the picric acid originally present. Determine

- The minimum quantity of benzene required per litre of aqueous solution and

Code No: R05320801

R05**Set No. 1**

- ii. Number of transfer units for a solvent rate of 1.3 times the minimum. The equilibrium data for benzene picric acid water system at 25 °C is given by:

$C_B \times 10^2 :$	0.0932	0.225	1	2	5	10	18
$m = C_B/C_A :$	2.23	1.45	1.075	0.505	0.32	0.24	0.187

Where C_B and C_A are the equilibrium concentrations of picric acid in benzene and aqueous phases respectively in mole/litre. [6+10]

FIRSTRANKER

Code No: R05320801

R05**Set No. 3****III B.Tech II Semester Examinations, December 2010****MASS TRANSFER OPERATIONS-II****Chemical Engineering****Time: 3 hours****Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

1. (a) Comment on the nature of equilibrium data generally used in solid-liquid extraction.
- (b) Oil from fish livers is to be continuously and counter current extracted using ethyl ether as solvent. The quantity of solution retained by the granulated livers is given below :

Kg. oil/kg. soln. :	0.00	0.10	0.20	0.30	0.40	0.50	0.65	0.72
Kg. soln./kg.oil-free liver :	0.205	0.242	0.286	0.339	0.405	0.489	0.672	0.810

The liver contains 0.257 mass fraction oil. If 95% of the oil is to be extracted and the strong solution obtained from the system is to contain 0.70 mass fraction oil, determine.

- The quantity and composition of the discharge solids.
 - Kg. of oil-free ether required per 100kg. of fresh liver.
 - The number of ideal stages required. [4+12]
2. A tower packed with 1- in rings is to be designed to absorb SO₂ from air by scrubbing the gas with water. The entering gas is 20% SO₂ by volume, and the leaving gas is to contain not more than 0.5% SO₂ by volume. The entering H₂O is SO₂ - free. The temperature is 25 °C and the total pressure is 2 atm. The water flow rate is to be twice the minimum. The air flow rate (SO₂ - free basis) is to be 976 Kg/m²-h. What depth of packing is required? The mass transfer coefficient K_ya is 5.21 mol/ft³h (molfriction) and the equilibrium data at 25 °C is as follows: [16]
- | | | | | | |
|----------------------------------|---------|---------|---------|---------|---------|
| x _{so2} mole fraction : | 0.00127 | 0.00237 | 0.00338 | 0.00439 | 0.00538 |
| p _{so2} atm | 0.04 | 0.08 | 0.12 | 0.16 | 0.20 |
3. A solute is recovered from an aqueous solution containing 20% of the solute by weight using kerosene as the solvent. The distribution of the solute in water and kerosene may be described by $x=60.45y$ where x is the kg of solute per kg of water and y is the kg of solute per kg of kerosene. Calculate the final concentration in the final raffinate if the extractions are done in 3 simple equilibrium contacts using 5kg solvent per kg of initial solution in each stage. [16]
4. (a) Write short notes on ideal and non-ideal solutions.
- (b) What is absorption factor? How is this related to stripping factor?
- (c) Discuss what factors should be considered in the selection of a solvent for absorption. [6+4+6]

Code No: R05320801

R05**Set No. 3**

5. (a) Explain about negative solute adsorption in case of adsorption of concentrated solution.
- (b) An aqueous solution containing a valuable solute is colored by small amounts of an impurity which is to be removed by a single stage contact with the absorbent carbon, which adsorbs insignificant amount of principle solute. Color intensity is proportional to the concentration of colored substance. It is desired to reduce color to 5% of its original value, the original value being 19.6 units. Determine the quantity of fresh carbon required per 1000 kg of solution in a two stage counter current operation. The equilibrium data could be represented by:
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Code No: R05320801

R05**Set No. 3**

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