CHE 482
2a - LIQUID-LIQUID EXTRACTION

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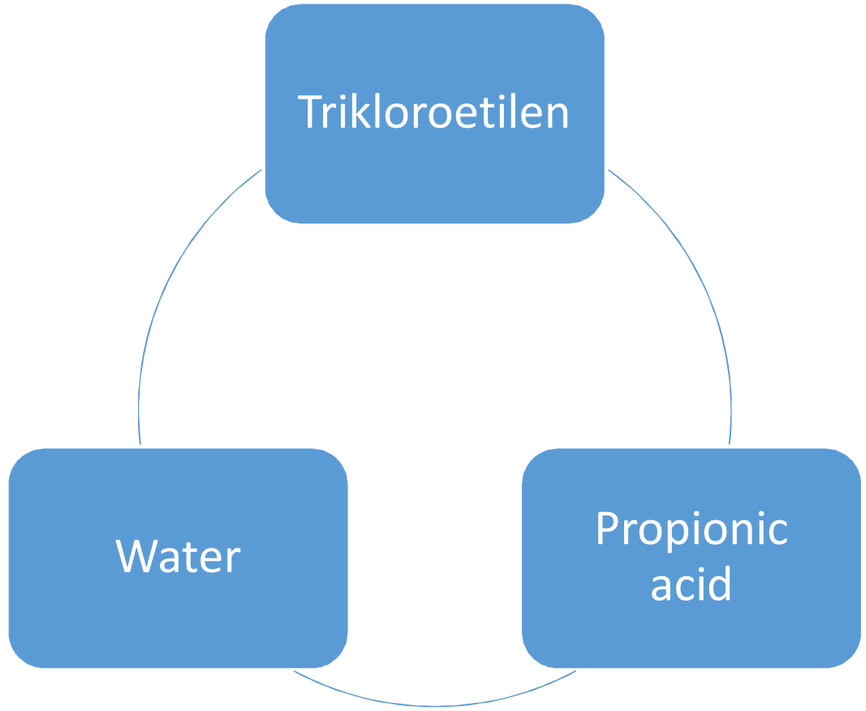
Purpose

Performing mass balance, determination of the mass transfer coefficient (MTC)

Purpose

The experiment is carried out in a packed column using the trichloroethylene-propionic acid-water system. Propionic acid is passed into the water by ensuring that the trichloroethylene-propionic acid mixture given over the filled column is in contact with the water supplied from the bottom of the column.



Chemicals

Trichloroethylene

Propionic acid

What is Liquid Liquid Extraction ?

The process of removing one or more components in a solution by bringing this solution into contact with a suitable solvent is called liquid-liquid extraction.

Choosing Solvents for Liquid Liquid Extraction

In liquid liquid extraction, it is very important to choose the appropriate solvent according to the substance to be separated from the mixture. For this solvent,

- The boiling point should be low,
- It should be easy to separate from the mixture,
- It should not be poisonous,
- It should not dissolve items other than the desired substance,
- It should be cheap and easily available.

Factors Effecting Liquid Liquid Extraction Efficiency

Factors effecting liquid liquid extraction efficiency are as follows.

- Contact surface area
- Contact time
- Packing material volume
- The height of the column
- Feed, extract and raffinate flow rates
- Distribution coefficient

Mass Balance for Trichloroethylene-Propionic acid-Water System

System: Trichlorethylene - Propionic acid -Water

Amount of propionic acid from organic phase (Rafinate) = $V_0 (X_1-X_2)$

Acid amount extracted to the water phase (Extract) = $V_w (Y_1-0)$, $V_0(X_1-X_2) = V_w(Y_1-0)$

Here, V_w :water flow rate (1/sec)

V_0: Trichlorethylene flow rate (1/sec)

X: Concentration of propionic acid (P_A) in the organic phase (kg/l)

Y: Concentration of propionic acid (P_A) in water phase (kg/l)

Subindexes: 1- Column top 2- Column bottom

Mass Transfer Coefficient

Mass Transfer Coefficient, MTC (Based on raffinate phase)

$$MTC = \frac{\text{Acid Transfer Rate}}{(\text{Packed volume})(\text{Aver.Driv.Power})}$$

$$\text{LogAvg.Driving Force} = \frac{\Delta X_1 - \Delta X_2}{\ln \frac{\Delta X_1}{\Delta X_2}} = \frac{(X_0 - 0) - (X_1 - X_1^*)}{\ln \frac{(X_0 - 0)}{(X_1 - X_1^*)}}$$

Here;

ΔX_1 ; The driving force at the top of the column (X_2-0)

ΔX_2 ; Driving force under the column (X_1- X_1^*)

Distribution Coefficient

X_1 * is the concentration of organic that will be in equilibrium with the water phase with a concentration of Y_1. Calculate the equilibrium values using the distribution coefficient (K) data from the literature.

$$K = \frac{Y}{X} = \frac{\text{Distrubuted material concentration in extract phase}}{\text{Distrubuted material concentration in rafinate phase}}$$

Experimental Study

- By operating the water pump, the column is filled with water by keeping rotameter fully open. The flow rate is adjusted after water begins to flow into the extract drum.
- Sample is taken from the extract for 1 minute and the flow rate is determined by measuring its volume.
- The rafinate pump is started and the rafinate flow rate is adjusted by a valve under the column so as not to interrupt the extract flow.
- Wait 10 minutes for the system to be stable.
- Samples are taken from the extract and rafinate streams for 1 minute. Flow rates and densities are determined by measuring all volumes.
- The samples are titrated with 0.1 M NaOH and the results are recorded.

Calculations

Record the amount of NaOH spent for titration of the feed, raffinate and extract phases in the table below.

Flow rate of water phase		
Flow rate of organic phase		
	Spent amount of 0.1 M NaOH (ml)	Propionic acid concentration (kg/l)
Feed		
Rafinate		
Extract		
Propionic acid amount from organic phase		
Propionic acid amount extracted to water phase		
Mass transfer coefficient		

Calculations

Using data obtained as a result of acid-base titration,

- Calculate the propionic acid concentrations of the feed, rafinate and extract phases.
- Calculate mass transfer coefficient by determining propionic acid amount from organic phase and propionic acid amount extracted to water phase.
- Calculate HOE and NOE based on the extract phase.
- Calculate HOR and NOR based on the rafinate phase
- Find the required height of the extraction column using the values you find above (H and N).

References

1. Uysal B. Z., “Kütle Transferi”, Gazi Kitapevi, Ankara, 2019.
2. Gazi University Department of Chemical Engineering CHE482 Liquid liquid Extraction Experiment Sheet

Thank you for listening.