# Mass Transfer Operations-I

**Chemical Engineering Department**

**L.E.COLLEGE-MORBI**

## List of Experiments

| Exp. No. | Objective | CO Mapped |
|---|---|---|
| 1 | To evaluate the diffusivity of Carbon Tetrachloride in stagnant air at room temperature. | 3150501.1 |
| 2 | To evalaute the diffusivity of Carbon Tetrachloride at elevated temperature. Analyse the results for room temperature and elevated temperature. | 3150501.1 |
| 3 | To evaluate the mass transfer co-efficient of liquid-water and air system | 3150501.1 |
| 4 | To evaluate efficiency for single stage liquid-liquid extraction of acetic acid from the mixture of acetic acid and water. | 3150501.3<br>3150501.4 |
| 5 | To evaluate efficiency for multi- stage liquid-liquid extraction of acetic acid from the mixture of acetic acid and water. Compare and Analyse the results for single stage and multi-stage operation. | 3150501.3<br>3150501.4 |
| 6 | To evaluate mass transfer coefficient of the given absorption system. | 3150501.1<br>3150501.2 |
| 7 | To evaluate the stage efficiency and overall recovery of NaOH for single stage cross current leaching operation for leaching NaOH from mixture of NaOH and calcium carbonate using water as a solvent. | 3150501.1 |
| 8 | To evaluate the stage efficiency & overall recovery of NaOH for multistage cross current leaching operation for leaching NaoH from mixture of NaoH & $CaCO_3$ using water as solvent. Compare and Analyse the results for single stage and multi-stage operation. | 3150501.3<br>3150501.4 |
| 9 | To determine crystal yield without seeding. | 3150501.3<br>3150501.4 |
| 10 | To determine crystal yield with seeding. | 3150501.3<br>3150501.4 |

**Experiment No: 1** **Date:**

## DIFFUSIVITY OF LIQUID IN STAGNANT AIR

**Objective**

To evaluate the diffusivity of Carbon Tetrachloride in stagnant air at temperature T .

**Apparatus**

Beaker, Scale, Measuring cylinder, thermometer.

**Chemicals**

Carbon Tetrachloride

**Theory:** Student should write theory their own.

**Procedure**

- Take clean 250 ml beaker.
- Add 100 ml ______________ in the beaker.
- Measure the height of the given sample in the beaker $Z_1$ and keep the beaker for _________ hour for diffusion of ___________ in air.
- Determine the loss of __________ by marking the height.
- Measure the height $Z_2$.

**Observation**

Initial volume of ________ in the beaker = ________

Final volume of ________ in the beaker = ________

Temp = ________ $^0$ C

Mass = Density x volume

Vapour pressure of ___________ = __________

$N_A$ = _____________

$$D_{AB} = \frac{N_A \times R \times T \times Z}{p_t \ln \frac{p_t - P_{A2}}{p_t - P_{A1}}}$$

= _____________ $m^2$ / sec

1) Initial height of liquid in beaker $Z_1$ = ________ cm
Diameter of beaker = __________ cm
$V_1$ =Pi /4 $(d)^2$ $(Z_1)$ = ________ $(cm)^3$
= ________ (ml)

2) Final height of liquid in beaker $Z_2$ = ________ cm

Final volume

$V_2$ = (Pi /4)$(d)^2$ $(Z_2)$ = ________ $(cm)^3$

= ________ ml

3) Temperature = _________ $^0$ C
4) Vapour pressure of ___________at __________ mmHg
5) Density of __________ at __________ temp __________ $Kg/m^3$
6) Molecular weight of Carbon Tetrachloride=________kg/kmol
7) Time duration = _________
8) Difference in height of ________ in beaker due to diffusion

$=Z_1-Z_2$ = _______ cm

Loss of ___________ Pi /4 $(d)^2$ $(Z)^2$ = ________ $(cm)^3$

= ________ ml

## Calculation

1) Total concentration

$C_T$= (1*273.15)/(22.4*T)

Concentration of Carbon tetrachloride,

$C_A = C_T$*V/P

$C_{B1}$=273.15 / (22.4*T)

$C_{B2}= C_{B1}$* (P-V) / P

$C_{BM}$ = ( $C_{B1}$- $C_{B2}$) / ln($C_{B1}$/ $C_{B2}$)

2) $D_{AB}$= (P * $C_{BM}$) / (2*MA* $C_A$* $C_T$*S)

= _____________ $m^2$/sec

Experimental $D_{AB}$ = __________ $m^2$ /sec

**Result:**

Experimental $D_{AB}$ = ___________ $m^2$ /sec
Theoretical $D_{AB}$ = ___________ $m^2$ /sec

**Conclusion:**

**Marks:** **Signature:**

**Experiment No: 2** **Date:**

## DIFFUSIVITY WITH RESPECT TO TEMPERATURE

**Objective**
To evalaute the diffusivity of Carbon Tetrchloride at elevated temperature. Analyse the results for room temperature and elevated temperature.

**Apparatus:** Beaker, Scale, Measuring cylinder.

**Chemical:** Toluene, Acetone, Benzene

**Theory:** Student should write theory their own.

**Procedure:**

- Take clean 250 ml beaker.
- Take 100 ml__________ in beaker. Measure the initial height ($Z_1$).
- Heat it up to $50^0$ C & maintain the temperature of $50^0$ C for 20 min.
- Measure the volume & height ($Z_2$) of _________ in beaker after 20 min.

**Observation:**

1) Initial volume of ________ in the beaker = ________ ml
2) Initial height $Z_1$ = ________ cm
3) Final height $Z_2$ = ________ cm
4) Temperature = = _______ $^0$ C
5) Difference in height of ________ in beaker due to diffusion

   $=Z_1-Z_2$ = _______ cm
6) Vapour pressure of ___________at ___________ mmHg
7) Density of __________ at ______ Temp. __________ $Kg/m^3$
8) Time duration = _________

**Calculation:**

1) Total concentration

   $C_T= (1*273.15)/(22.4*T)$

   Concentration of Carbon tetrachloride,

   $C_A = C_T*V/P$

$C_{B1}$=273.15 / (22.4*T)

$C_{B2}$= $C_{B1}$* (P-V) / P

$C_{BM}$ = ( $C_{B1}$- $C_{B2}$) / ln($C_{B1}$/ $C_{B2}$)

2) $D_{AB}$= (P * $C_{BM}$) / (2*MA* $C_A$* $C_T$*S)

= ______________ $m^2$/sec

Experimental $D_{AB}$ = ___________ $m^2$ /sec

**Result**

Experimental $D_{AB}$ = ___________ $m^2$ /sec
Theoretical $D_{AB}$ = ___________ $m^2$ /sec (From Perry's handbook)

**Conclusion**

**Marks:** **Signature:**

**Experiment No: 3** **Date:**

## MASS TRANSFER COEFFICIENT

**Objective**

To evaluate the mass transfer co-efficient of Carbon tetrachloride and air system

**Apparatus**

Beaker, heating mantle, Thermometer.

**Chemical**

Water

**Theory**

The rate at which a component is transferred from one phase to the other depends up on the mass-transfer rate or mass transfer coefficient. The mass transfer coefficient for the various components in a given phase will differ from each other, but the difference is not really large, where molecular diffusion prevails. Under conditions of turbulence, the mass transfer coefficients for all components become nearly alike.

Thus, due to difference in mass transfer coefficients of the components the degree of separation obtained is small. The separation depends entirely upon the difference concentration, which exist at equilibrium and not upon the difference in transfer co efficients.

F-type mass transfer coefficient is defined for particular location on the Phase interface, or boundary and flux $N_A$ is defined as

$$N_A = \frac{N_A}{N_A + N_B} . F . \ln\left[\frac{N_A / N_A + N_B - C_{A_2} / C}{N_A / N_A + N_B - C_{A_1} / C}\right]$$

Where, $F = \dfrac{D_{AB} \cdot C}{Z}$

Flux = (coefficient) (concentration difference)

**Procedure**

- Rinse and clean all the glassware with water. Now measure the diameter of the beaker.
- Take 100 ml water in the beaker and put it in the heating mantle. Measure the initial height of the water level.
- Heat the water for 30 minutes at constant temperature (i.e. $60^0$C) and during heating note down the dry bulb and wet bulb temperature.
- After 30 minutes note down the final height of the water level in the beaker.
- Also measure the volume of water.

**Observations**

1. Diameter of beaker = _______ cm.
2. Volume of water (before heating) =________ ml
3. Height of water level in beaker $Z_1$= _________ cm

**After heating**

1. Height of water level in beaker = _________ cm
2. Volume of water =________ cm
3. Dry bulb Temperature=__________$^0$ C
4. Wet bulb Temperature=__________$^0$ C

**Calculations**

$$N_A = \frac{D_{AB} Pt}{RTZp_{BM}}(P_{Ai} - P_{AG})$$

1)

= $F/p_{BM}$ ( $p_{BG}$ - $p_{Bi}$)

Where,

$p_{Ai}$ = Vapour pressure of water (A) at interface = ___________

$p_{AG}$ = Partial pressure of water vapour (A) in bulk air________

P = Vapour pressure at 60 $^0$ C

Pt = 1 atm. , $p_{BG}$ = Pt - $p_{AG}$ , $p_{Bi}$ = Pt - $p_{Ai}$

$p_{BG}$ = Pt - $p_{AG}$

$p_{Bi}$ = Pt - $p_{Ai}$

$$p_{BM} = \frac{(p_{BG} - p_{Bi})}{\ln \frac{p_{BG}}{p_{Bi}}}$$

4)
$$N_A = \frac{(V_1 - V_2) \times \rho_{H_2O}}{M_{H2O} \times Area \times time}$$

= ______________ kmol/m$^2$.sec

5) $N_A = K_G (p_{Ai} - p_{AG})$

$\therefore$ $K_G$ = ___________ kmol/m$^2$.sec.KPa

6) $$N_A = \frac{F(p_{Ai} - p_{AG})}{p_{BM}}$$

F = ________

**7) Result:**

$K_G$ = ______________

**F=** ______________

**Marks:** **Signature:**

**Experiment No: 4** **Date:**

## SINGLE STAGE EXTRACTION

### Objective
To evaluate efficiency for single stage liquid-liquid extraction of acetic acid from the mixture of acetic acid and water.

### Apparatus
Glass beaker (500 ml), Glass rod, Measuring Cylinder, Wt. Box, Separating funnel, Titration set, etc.

### Chemicals
Acetic Acid, NaOH, Water, Phenolphthalein Indicator, Ethyl Acetate.

### Procedure

- Rinse and clean all the glass apparatus with water.
- Note down room Temp.
- Take 60ml water & 10 ml acetic acid as a feed in Separating funnel & mix well.
- Add 30-ml Ethyl Acetate as a solvent ($S_1$) in first stage & shake the mixture vigorously.
- Allow the mixture to settle for 30 min. by keeping on stand.
- Separate the two layers in different beakers.
- Measure volume & mass of both the layers.
- Analyze diluted solution with std. NaOH using phenolphthalein as indicator.

### Observation

1. Room temperature: _____ °C
2. Volume of Feed: __________ ml (Water - 60 ml (A) and Acetic acid-10 ml (C))
3. Volume of solvent: __________ ml (Ethyl Acetate-30 ml (B))

Density at room Temp.

Ethyl Acetate = ___________ gm/cc
Acetic acid = ___________ gm/cc
Water = ___________ gm/cc

**Observation table :**

| Sr.No. | Solvent Added ml | Extract Layer ml | Raffinate Layer ml | Burette Reading ml |
|---|---|---|---|---|
| | | | | |

**Calculation**

1. Volume of sample = __________ ml.
2. **Extract phase analysis**

   Normality = (Normality of NaOH* burette rediang )/ (volume of sample)
   = ___________ N

   Moles of acetic acid= normality * volume of extract
   =____________ gm moles
   Wt. Of acetic acid= moles of acetic acid* molecular weight.
   = __________ gm

3. Wt. of Acetic acid in feed = ________ gm
4. % Extraction = (Wt. of Acetic acid in extract / Wt. of A.A in feed) * 100
   = ________ %

**Result**

Recovery of acetic acid= ___________

**Conclusion**

**Marks:** **Signature:**

**Experiment No: 5** **Date:**

## MULTI STAGE CROSS CURRENT EXTRACTION

**Objective**

i. To evaluate efficiency for multi- stage liquid-liquid extraction of acetic acid from the mixture of acetic acid and water.
ii. Compare and Analyse the results for single stage and multi-stage operation.

**Apparatus**

Glass beaker (500 ml), Glass rod, Measuring Cylinder, Wt. Box, Separating funnel, Titration set, etc.

**Chemicals**

Ethyl Acetate, Acetic acid, NaOH , Water, Phenolphthalein Indicator, Oxelic Acid.

**Procedure**

- Rinse and clean all the glass apparatus with water.Note Room Temp.
- Take 60-ml water & 10 ml Acetic Acid as a feed in separating funnel & mix well.
- Add 30-ml Ethyl Acetate as a solvent ($S_1$) , in first stage & shake the mixture vigorously.
- Allow the mixture to settle for 30 min. by keeping on stand.
- Separate the two layers in different beakers.Measure volume & mass of both the layers.
- Analyzed diluted solution with std. NaOH using phenolphthalein as indicator.
- Take raffinate of stage in separate funnel as feed to repeat the whole procedure up to total 3 stages.

**Observation**

1. Room temperature: _______ $^0$C
2. Volume of Feed: _________ ml
   Water : 60 ml (A)
   Acetic Acid 10 ml (B)
   Ethyl Acetate 30 ml (C)
3. Density at room temp.
   Ethyl Acetate - 0.875 gm/cc
   Water - 1.0 gm/cc;
   Acetic acid - 1.048 gm/cc

**Observation table**

| Stage | Feed(ml) | Solvent Added ml | Extract Layer ml | Raffinate Layer ml | Burette Reading ml |
|---|---|---|---|---|---|
| 1 | | | | | |
| 2 | | | | | |
| 3 | | | | | |

## Practical calculation

**$1^{ST}$ Stage**

1. Volume of raffinate = __________ ml.
   Volume of extract = __________ ml.
2. **Extract layer analysis**
   Density of Extract = _________ gm/cc
   Wt. of extract (E) = _________ gm
   Final burette reading = __________ ml
   Normality of water layer = _________ ml

Mass of A.A. in water layer = (Normality x Eq. Wt. of A.A. x Vol. of Layer) /1000
= ___________ gm

3. **Raffinate layer analysis:**
   Density of raffinate = _________ gm/cc
   Wt. of raffinate (R) = _________ gm/cc
4. Wt. of Acetic acid in feed = ________ gm
5. % Extraction = Wt. of Acetic acid in extract / Wt. of A.A in feed * 100
   = ________ %

- **Follow same calculation steps for $2^{nd}$ and $3^{rd}$ stage and find out % extraction and % overall efficiency.**

## Result

| Stage | % Extraction of Aectic Acid |
|---|---|
| 1 | |
| 2 | |
| 3 | |

**Conclusion:**

**Marks:** **Signature:**

**Experiment No: 6** **Date:**

## Wetted Wall Column

**Objective:** To evaluate mass transfer coefficient of the given absorption system.

**Theory:**

A thin film of liquid falling down the inside of a vertical pipe through which the gas flows, constitutes a wetted wall column. Wetted wall columns have been used as absorbers for Hydrochloric acid, Ammonia, Acetone, Benzene and other volatile liquids. They have also been studied for theoretical studies for mass transfer because the interfacial surface between the phases is kept under control and is measurable.

The height of wetted wall column required for mass transfer operations is excessive and consequently this is not widely used, where large quantities of liquid or gas have to be handled, it would be necessary to arrange many vertical pipes in parallel and this leads to difficulties in the distribution of liquid into the inner surface of the tubes. The gas pressure drop for this is confined to skin friction effects, with few or no expansion or contraction losses.

Mass transfer rates for fluids flowing through pipes have been studied more completely than other cases. The rates of diffusion into gases flowing through pipes have been studied in wetted wall columns. A volatile liquid is submitted to flow down the inside surface of a circular tube, while a gas flows upward or downward through the center of the pipe. Measurement of the rate of evaporation of a liquid into the gas stream over known surface permits calculation of mass transfer coefficient for the diffusion of vapor into gas stream. Since the liquid is pure, the concentration gradient for diffusion exists entirely within the gas phase, the mass transfer coefficient Kg may be calculated.

**Procedure:**

1. Feed 10 liter of 0.1N NaOH solution in the feed tank.

2. Start the pumps.

3. Maintain the flow rate of NaOH at 1LPM.

4. Start the Air flow and maintain the air flow rate about 80LPM.

5. Similarly maintain $CO_2$ Flow rate about 4LPM.

6. System is allowed to run at steady state and flow rates of NaOH, air and $CO_2$ are obtained

7. Samples of Liquid at bottom and air + $CO_2$ mixtures are obtained for the analysis.

8. Same experiment is repeated for various flow rate keeping one parameter fixed and other variable.

**Observation:**

1. Concentration of NaOH feed
2. NaOH flow rate = ______LPM
3. Flow rate of $CO_2$ =______LPM
4. Flow rate of Air = ______LPM
5. Flow rate of outlet ( Air + $CO_2$ )mixture= ______
6. Flow rate of NaOH (inlet) = ______LPM =_________$m^3$/sec
7. d = Column diameter = 7.62mm
8. T = thickness of film = 2mm
9. L=Length of column=1 m
10. A= area of film inside the column= $\pi$ x d x l= 23.93 x $10^{-3}$
11. V = total volumne of film inside the column = $\pi$ x d x l x T = 4.78 x $10^{-5}$ $m^3$

| Sr. No. | Air Flow Rate(LPM) | Buretter reading | Conc. of NaOH in Outlet |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

**calculations:**

To calculate Molar Flow rate of NaOH
Initial concentration of NaOH (calculated as under)
Titrating 0.1N HCL against 10ml NaOH sample

Normality of NaOH in feed = ________N
Initial concentration of NaOH,
Ci= ________
Initial concentration of NaOH (calculated as under)
Titrating 0.1N HCL against 10ml NaOH sample

Similarly at outlet N of NaOH = _______N
Final concentration of NaOH
Co=___________
Molar flow rate of NaOH feed = Ci = Initial concentration of NaOH x Flow rate
= ____Kmol/$m^3$ x _______$m^3$/sec

=_________ Kmol/sec
Molar flow rate of NaOH outlet = Co = Final concentration of NaOH x Flow rate
= ____ Kmol/$m^3$ x _______$m^3$/sec
=_________ Kmol/sec
Molar Flux of NaOH,
$N_A$= Molar flow rate of NaOH/ Area of column

Now,
$N_A$= $K_{La}$ * (Ci- Co)

**Mass Transfer Coefficient** is given by
$K_{La}$ = $N_A$ / (Ci- Co)

**Result :** The Liquid side Mass Transfer Coefficient, $K_{La}$ =_________

**Marks:** **Signature:**

**Experiment No: 7** **Date:**

## SINGLE STAGE LEACHING

### Objective
To evaluate the stage efficiency and overall recovery of NaOH for single stage cross current leaching operation for leaching NaOH from mixture of NaOH and calcium carbonate using water as a solvent.

### Apparatus
Glass beaker (500 ml), Glass rod, Measuring Cylinder, Wt. Box, Separating funnel, Titration set, etc.

### Chemicals
Calcium carbonate powder (B), NaOH (C), Water (A), Std.HCl solution, Phenolphthalein Indicator.

### Procedure

- Rinse and clean all the glass apparatus with water.
- Take a mixture of 5 gm of NaOH and 35 gm of $CaCO_3$ in glass beaker.
- Add 200 ml water to the beaker.
- Stir the solution for about 5 minute continuously.
- After 20 min. collect the over flows & titrate it against 0.5N HCl.
- Separate the clear solution from settled sludge and measure its volume.
- Notedown all readings & calculate % recovery ,stage efficiency using standard data available.

### Observation

Room temperature: _____ $^0$C
Feed: $CaCO_3$ powder + NaOH flakes
F = ____ gm + ____ gm = ____ gm.
Solvent: Water, R = ____ ml

### Analysis of solution
V1 = Sol. Taken for titration = _______ ml
N2 = Normality of HCL = _______ ml
V2 = Vol. Of HCL consumed= _______ ml

### Calculations

- Analysis of clear solution:
  Sample volume, V1 = _____ ml
  Burette reading, V2 = _____ ml
  Normality of Std. HCl solution, N2 = _____N

- Normality of clear solution = $\dfrac{N2 \times V2}{V1}$

= ________ N

- Amount of NaOH in clear solution = Normality of clear solution × Volume of the clear solution × Eq. Weight of NaOH

  = ( _____ ) × ( _____ ) × ( _____ ) /1000

  W1 = _____ gm

  W = Amount of NaoH in feed = ___________ gm

$$\text{Percentage Recovery} = \frac{W1}{W} \times 100$$

$$= \frac{(\ \_\_\_\_\_\ )}{(\ \_\_\_\_\_\ )} \times 100$$

= ______ %

**Result**

% Recovery (Practically) = _______________%

**Conclusion**

**Marks:** **Signature:**

**Experiment No: 8** **Date:**

## MULTI STAGE CROSS CURRENT LEACHING

**Objective**

i. To evaluate the stage efficiency & overall recovery of NaOH for multistage cross current leaching operation for leaching NaoH from mixture of NaoH & $CaCO_3$ using water as solvent.
ii. Compare and Analyse the results for single stage and multi-stage operation

**Apparatus**

Glass beaker (500 ml), Glass rod, Measuring Cylinder, Wt. Box, Separating funnel, Titration set, etc.

**Chemicals**

Calcium carbonate Powder (B), NaOH (C), Water (A), Std.HCl solution, Phenolphthalein Indicator.

**Procedure**

- Rinse and clean all the glass apparatus with water.
- Take a mixture of 5 gm of NaOH and 35 gm of CaCO3 in glass beaker.
- Add 195 gm water to the beaker.
- Stir the solution for about 5 minute continuously.
- After 20 min. collect the over flows & analyze.
- Separate the clear solution from settled sludge and measure its volume.
- Notedown all readings & calculate % recovery, stage efficiency using standard data available .
- Add water as a solvent to 2$^{nd}$ stage with same volume as clear solution withdraw from 1$^{st}$ stage.

**Observation**

- Room temperature: _____ °C
- Feed: CaCO3 powder + NaOH flakes
- F = ____ gm + ____ gm = ____ gm.
- Solvent: Water, R = ____ gm

**Analysis of solution**

- V1= Sol. Taken for titration = _______ ml
- N2= Normality of HCL = _______ ml
- V2= Vol. Of HCL consumed= _______ ml

**Practical calculation for stage-I:**

Analysis of clear solution:

Clear liquid volume = ______________ ml
Sample volume V1 = ______________ ml
Burette reading V2 = ______________ ml
Normality of Std. HCL solution, N2 = ___ N

- Normality of clear solution = $\frac{N_2 \times V_2}{V_1}$

  = ________ N
- Amount of NaoH in clear solution = Normality of clear solution x Volume of the clear solution x Eq. Weight of NaoH

  = ____________ x ____________ x __________ /1000

  W1 = ___________ gm

  W = Amount of NaoH in feed = __________gm

% Recovery = $\frac{W1}{W} \times 100$

= ___________%

- Follow same calculation steps for 2nd stage and find out % recovery and overall efficiency.

**Result**

% Recovery of NaoH

| Stage | Practically |
|---|---|
| 1 | |
| 2 | |
| Over all efficiency for 2 stages | |

**Conclusion**

**Marks:** **Signature:**

**Experiment No: 9** **Date:**

## CRYSTALLIZATION (Without Seeding)

**Objectives :** To determine crystal yield without seeding.

**Apparatus:** Beaker, Heating mental, Stirrer, Conical flask, Filter Paper, Pipette, Thermometer, Weight Box, Burette.

**Chemicals:** Water, Boric acid Acid, .

**Theory:**

Crystallization is the formation of solid particles within a homogeneous phase. It may occur as the formation of solid particles in a vapor as in snow, as solidification from a liquid melt, as in manufacture of large single, crystals or as crystallization from liquid solution. Crystallization from solution is important industrially because of the variety of materials that are marketed in the crystalline form. Its wide use has a two-fold basis.

(a) Crystal formed from an impure solution is itself pure (unless mixed crystals occur).

(b) Crystallization affords a practical method of obtaining pure chemical substances in satisfactory condition for packing & storing.

Crystallization may be analyzed from the standpoints of purity, yield, energy requirements and rates of nucleation and growth. Crystal growth is a diffusion process modified by the effect of the solid surfaces on which the growth occurs. By adding the component self-crystal growth can be accelerated and also amount of crystals will be increased.

**Procedure:**

1. Clean all the Glassware and take 250 ml water in beaker.

2.Heat the water up to 60 °C on a electric heater equipped with a magnetic stirrer and regulate temperature of water at 60 °C the thermostat provided.

3. Add Boric acid acid gradually in water up to extent so solution becomes saturated.

4.Note down the amount of Boric acid Acid added in the water.

5.Take 200 ml saturated solution as a feed and cool it slowly up to the room temp. due to which crystals will be formed. Using the filter paper separate the crystals, dry it and weight it.

**Observation Table:**

| | |
|---|---|
| 1 | Amount of Boric acid acid dissolve in feed = ________ gm. |
| 2 | Volume of feed= ____________ ml. |
| 3 | Weight of crystals = _______gm |

**Calculations:**

1. Crystal without seeding = Wt. Of acid crysatl collected/ Wt. Of acid in feed

**Result:** Crystal without seeding =______________.

**Conclusion:**

**Marks :** **Signature:**

**Experiment No: 10** **Date:**

**CRYSTALLIZATION (With Seeding)**

**Objectives:** To determine crystal yield with seeding.

**Apparatus:** Beaker, Heating mental, Stirrer, Conical flask, Filter Paper, Pipette, Thermometer, Weight Box, Burette.

**Chemicals:** Water, Boric Acid,.

**Theory:**

Crystallization is the formation of solid particles within a homogeneous phase. It may occur as the formation of solid particles in a vapor as in snow, as solidification from a liquid melt, as in manufacture of large single, crystals or as crystallization from liquid solution. Crystallization from solution is important industrially because of the variety of materials that are marketed in the crystalline form. Its wide use has a two-fold basis.

(a) Crystal formed from an impure solution is itself pure (unless mixed crystals occur).

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**Procedure:**

1. Clean all the Glassware and take 250 ml water in beaker.
2. Heat the water up to 60 °C on a electric heater equipped with a magnetic stirrer and regulate temperature of water at 60 °C the thermostat provided.
3. Add Boric acid acid gradually in water up to extent so solution becomes saturated.
4. Note down the amount of Boric Acid added in the water.
5. Add 5 gm of Boric acid as a seed in saturated solution of Boric acid and shake the solution well.
6. Take 200 ml saturated solution as a feed and cool it slowly up to the room temp. due to which crystals will be formed. Using the filter paper separate the crystals, dry it and weight it.

**Observation Table:**

| | |
|---|---|
| 1 | Amount of Boric acid acid dissolve in feed = ________ gm. |
| 2 | Volume of feed= ____________ ml. |
| 3 | Weight of crystals = _______gm |

**Calculations:**

**C**rystal yield = Wt. Of acid crysatl collected/ Wt. Of acid in feed

**Result:** **C**rystal yield with seeding =______________.

**Conclusion:**

**Marks :** **Signature:**