Expt. No. 01 Date

Aim of the Experiment:-

To determine the surface tension of acetic acid solutions at different concentrations and construction of graph.

Requirements:-

1) Stalagmometer
2) Beakers
3) Acetic acid
4) Specific gravity bottle
5) Rubber tube
6) Distilled water

Principle and Theory:-

Surface tension is the tendency of liquid surfaces at rest to shrink into the minimum surface area possible.

The principle of the drop weight method is that weight of a drop of liquid which falls from a capillary tube is directly proportional to the surface tension of the liquid.

Let 'w' be the weight of a drop of liquid whose surface tension is γ, then

$$\gamma \propto w$$

Similarly, for two different liquids having surface tension γ_1 and γ_2, we may write—

$$\frac{\gamma_1}{\gamma_2} = \frac{w_1}{w_2}$$

Teacher's Signature

Date

Expt. No. 01 Page No. 06

Let the volume 'V' of a liquid 'A' in the stalagmometer form n_1 drops when allowed to fall. If ρ_1 is the density of liquid then weight of a single drop of liquid A is given by —

$$\omega_1 = \frac{V \times \rho_1}{n_1} \quad \text{—— (i)}$$

Similarly, for liquid B we have —

$$\omega_2 = \frac{V \times \rho_2}{n_2} \quad \text{—— (ii)}$$

Again, we have —

$$\frac{\gamma_1}{\gamma_2} = \frac{\omega_1}{\omega_2}$$

$$\Rightarrow \frac{\gamma_1}{\gamma_2} = \frac{\frac{V \times \rho_1}{n_1}}{\frac{V \times \rho_2}{n_2}} \quad [\text{From eq}^n \text{ (i) \& (ii)}]$$

$$\Rightarrow \frac{\gamma_1}{\gamma_2} = \frac{n_2 \times \rho_1}{n_1 \times \rho_2}$$

Procedure:—

(1) Preparation of solutions — Prepare acetic acid solutions of different concentrations: 0%, 20%, 40%, 60%, 80% and 100%.

Teacher's Signature

② Calibration with water –

(i) weight the empty specific gravity bottle (w_0 = 10.881 g)

(ii) Fill the specific gravity bottle with distilled water and weigh it (w_w)

(iii) Using the stalagmometer, measure the number of drops (n_w) for a known volume of water.

③ Measurement for Acetic acid solutions – Fill the specific gravity bottle with each acetic acid solution and weigh it.

④ Measurement of no. of drops – Measure the no. of drops for each concentration of acetic acid.

Observation:–

Conc. of acetic acid	Number of drops			Average no. of drops
	1st trial	2nd trial	3rd trial	
0%	51.725	51.000	51.580	51.435
20%	82.232	81.290	82.174	81.899
40%	102.203	104.058	103.174	103.145
60%	124.087	126.087	129.029	126.401
80%	174.500	175.319	173.807	174.542
100%	245.312	244.989	245.293	245.198

Weights of Solutions:-

Concentration of Acetic acid	Weight of solution(g)
0%	30.769
20%	33.702
40%	33.911
60%	34.090
80%	34.269
100%	34.473

Calculation:-

① Calculate densities – We can calculate the densities of different concentration of acetic acid by using the formula,

$$d_i = \frac{w_i - w_0}{w_w - w_0}$$

Therefore,

Density of 20% acetic acid, $d_1 = \frac{w_1 - w_0}{w_w - w_0}$

$$= \frac{33.702 - 10.181}{30.769 - 10.181}$$

$$= 1.14 \ g/cm^3$$

Density of 40% acetic acid, $d_2 = \frac{w_2 - w_0}{w_w - w_0}$

$= \frac{33.911 - 10.181}{30.769 - 10.181}$

$= 1.15\ g/cm^3$

Density of 80% acetic acid, $d_4 = \frac{w_4 - w_0}{w_w - w_0}$

$= \frac{34.269 - 10.181}{30.769 - 10.181}$

$= 1.17\ g/cm^3$

Density of 60% acetic acid, $d_3 = \frac{w_3 - w_0}{w_w - w_0}$

$= \frac{34.090 - 10.181}{30.769 - 10.181}$

$= 1.16\ g/cm^3$

Density of 100% acetic acid, $d_5 = \frac{w_5 - w_0}{w_w - w_0}$

$= \frac{34.473 - 10.181}{30.769 - 10.181}$

$= 1.18\ g/cm^3$

② Calculate surface tension — We can calculate the surface tension of different concentration

Teacher's Signature

of acetic acid by using the relation —

$$\gamma_i = \frac{m_w \times d_i}{m_i \times d_w} \times \gamma_w$$

Therefore,

Surface tension of 20% acetic acid,

$$\gamma_1 = \frac{m_w d_1}{m_1 d_w} \times \gamma_w = \frac{51.435 \times 1.14}{81.899 \times 1} \times 72.8$$

$$= 52.121 \text{ dyn/cm}$$

Surface tension of 40% acetic acid,

$$\gamma_2 = \frac{m_w d_2}{m_2 d_w} \times \gamma_w = \frac{51.435 \times 1.15}{103.145 \times 1} \times 72.8$$

$$= 41.748 \text{ dyn/cm}$$

Surface tension of 60% acetic acid,

$$\gamma_3 = \frac{m_w d_3}{m_3 d_w} \times \gamma_w = \frac{51.435 \times 1.16}{126.401 \times 1} \times 72.8$$

$$= 34.363 \text{ dyn/cm}$$

Surface tension of 80% acetic acid,

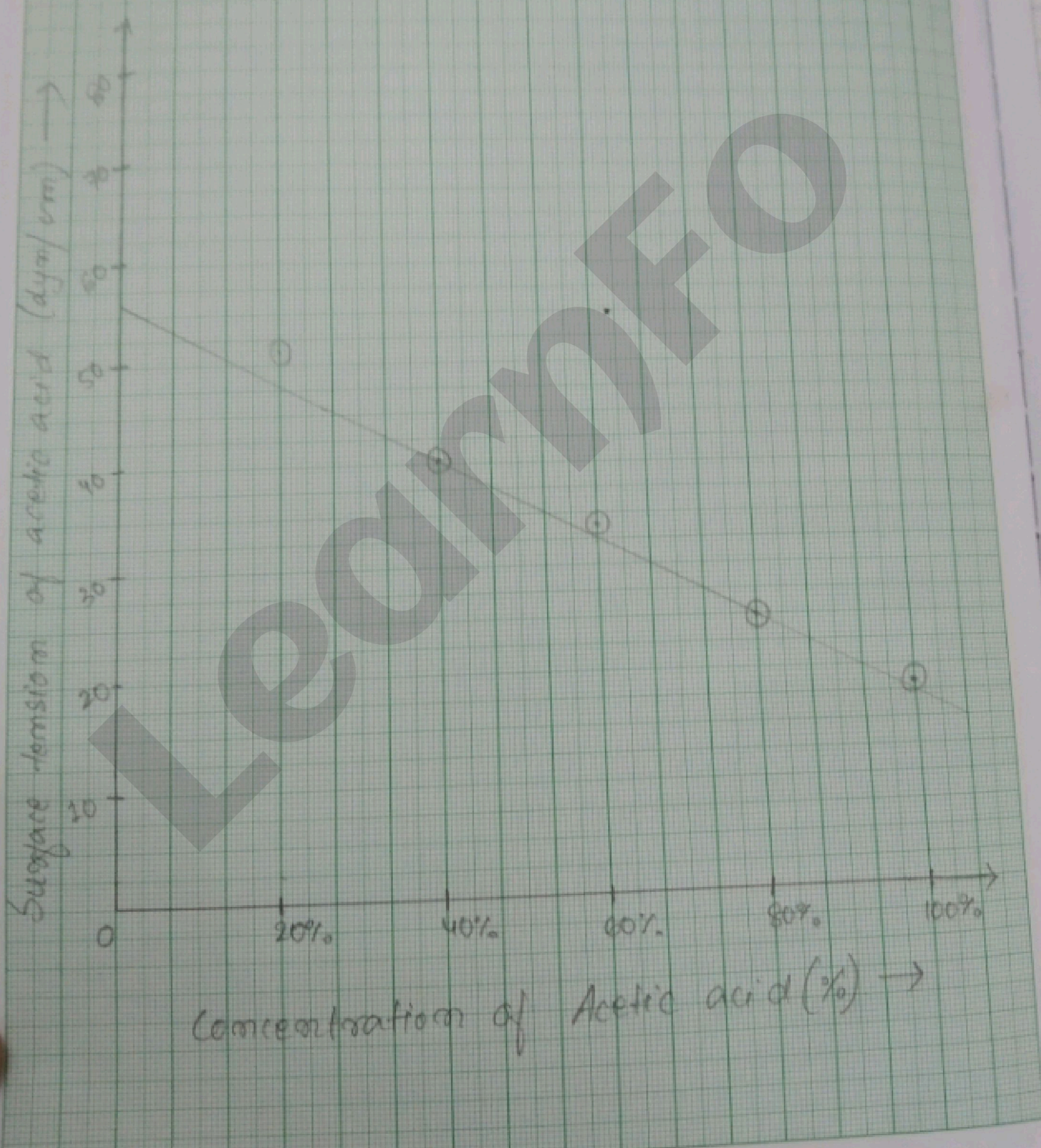
$$\gamma_4 = \frac{m_w d_4}{m_4 d_w} \times \gamma_w = \frac{51.435 \times 1.17}{174.542 \times 1} \times 72.8$$

$$= 25.100 \text{ dyn/cm}$$

Surface tension of 100% acetic acid,

Teacher's Signature

(horizontal line) 3cm = 1 unit
(vertical line) 2cm = 1 unit



$$\gamma_s = \frac{n_w \times d_s}{n_s \times d_w} \times 72.8 = \frac{51.435 \times 1.18}{245.198 \times 1} \times 72.8$$

$$= 18.020 \text{ dyn/cm}$$

Plotting the Graph:- To visualize the relationship between concentration and surface tension, plot a graph with the concentration of acetic acid solutions along x-axis and the corresponding surface tension values along y-axis.

Use the following data points for the plot —

(i) (20%, 52.121) (ii) (40%, 41.748) (iii) (60%, 34.363)
(iv) (80%, 25.100) (v) (100%, 18.020)

Precautions:- ① Clean apparatus — Ensure all equipments clean and dry.
② Accurate measurement — Calibrate the stalagmometer properly.
③ Temperature control — Maintain a constant room temperature.
④ Avoid Air Bubbles — Ensure no air bubbles in the stalagmometer.
⑤ Multiple Trials — Perform multiple trials for each concentration.

Conclusion:- The surface tension of acetic acid soln decreases as the conc. of acetic acid increases. This trend confirms that acetic acid molecule the cohesive forces at surface more effectively than water.

Aim of the Experiment:-
To determine the viscosity of acetic acid solutions at different concentrations and construction of graph.

Requirements:-
1) Acetic acid
2) Distilled water
3) Ostwaldmeter
4) Specific gravity bottle
5) Beaker
6) Weighing machine
7) Rubber tube
8) Stopwatch

Theory:- Viscosity is a measure of a fluid's resistance to flow.

In the streamlined motion, the dragging force due to internal resistance is porpotional to the viscosity gradient, dy/dx and to the area of contact A, between the moving layers of the liquid.

i.e. $F \propto A \frac{dy}{dx}$

$\Rightarrow F = \eta A \frac{dy}{dx}$ where η = coefficient of viscosity.

The volume 'V' of a liquid flowing through a capillary tube which passes a section of the tube in time 't' seconds is given by the

Poiseuille's equation —

$$V = \frac{\pi r^4 t P}{8 l \eta}$$

where r = radius of the tube
l = length of the tube
P = constant pressure difference at the two ends of the tube.

Thus, ratio of the coefficient of viscosities of two liquids in same viscometer is —

$$\frac{\eta_1}{\eta_2} = \frac{P_1 t_1}{P_2 t_2}$$

Procedure :—

① Preparation of Acetic acid solutions :- Prepare acetic acid solutions of different concentrations (e.g. 20%, 40%, 60%, 80%, 100%) by diluting concentrated acetic acid with distilled water.

② Setting up the Viscometer :-
(i) Clean the viscometer thoroughly with distilled water and dry it completely.
(ii) Mount the viscometer vertically and ensure it is stable and properly alligned.

③ Calibration of the Viscometer :-
(i) Before starting the experiment, calibrate the viscometer using a standard liquid (e.g.

distilled water) with a known viscosity.
(ii) Measure the flow time of the standard liquid multiple times to ensure accuracy.
(iii) Use the known viscosity and measured flow times to calculate the calibration factor for the viscometer.

④ Filling the viscometer:- Using a pipette or syringe, fill the viscometer with the first acetic acid solution (e.g. 20%) up to the marked level. Ensure there are no air bubbles in the liquid column.

⑤ Measuring the flow time:-
(i) Allow the liquid to flow through the capillary tube.
(ii) Start the stopwatch as the liquid passes the upper mark on the viscometer.
(iii) Stop the stopwatch when the liquid reaches the lower mark.
(iv) Record the time taken for the liquid to flow between the two marks (t).

⑥ Repeating the measurements:- Repeat each steps atleast three times for each concentration to obtain an average flow time.
Record the average flow time for each concentration.

vivo Y20 2025.02.18 11:28

⑦ <u>Calculate viscosity</u>:- Use the formula,

$$\eta_i = d_i t \eta_w$$

To calculate the viscosity of each solution, where d is the density, t is the flow time and η_w is a constant factor.

⑧ <u>Comparison of Viscosities</u>:- Compare the viscosities of acetic acid solutions of different concentrations.

Plot a graph of viscosity verses concentration to visualize the relationship.

<u>Observations</u>:- All observations are made at a constant temperature of 30°C

Conc. of Acetic acid	Flow time (mm:ss) 1st trial	2nd trial	3rd trial	Average flow time (s)
20%	1:12	1:12	1:12	1:12
40%	1:52	1:53	1:52	1:52
60%	2:01	2:00	2:01	2:01
80%	2:14	2:13	2:14	2:14
100%	2:55	2:56	2:57	2:56

Teacher's Signature

Expt. No. 02 Date Page No. 16

Weights of Solutions:—

Conc. of acetic acid (%)	Weight of solutions (g)
0%	30.769
20%	33.702
40%	33.911
60%	34.090
80%	34.269
100%	34.473

Calculation:—

① Calculate densities — We can calculate the densities of different concentration of acetic acid by using the formula,

$$d_i = \frac{w_i - w_0}{w_w - w_0}$$

Therefore, density of 20% acetic acid,

$$d_1 = \frac{w_1 - w_0}{w_w - w_0} = \frac{33.702 - 10.181}{30.769 - 10.181} = 1.14 g/cm^3$$

Teacher's Signature

Density of 40% acetic acid, $d_2 = \frac{w_2 - w_0}{w_w - w_0}$

$= \frac{33.911 - 10.181}{30.769 - 10.181}$

$= 1.15\ g/cm^3$

Density of 60% acetic acid, $d_3 = \frac{w_3 - w_0}{w_w - w_0}$

$= \frac{34.090 - 10.181}{30.769 - 10.181}$

$= 1.16\ g/cm^3$

Density of 80% acetic acid, $d_4 = \frac{w_4 - w_0}{w_w - w_0}$

$= \frac{34.269 - 10.181}{30.769 - 10.181}$

$= 1.17\ g/cm^3$

Density of 100% acetic acid, $d_5 = \frac{w_5 - w_0}{w_w - w_0}$

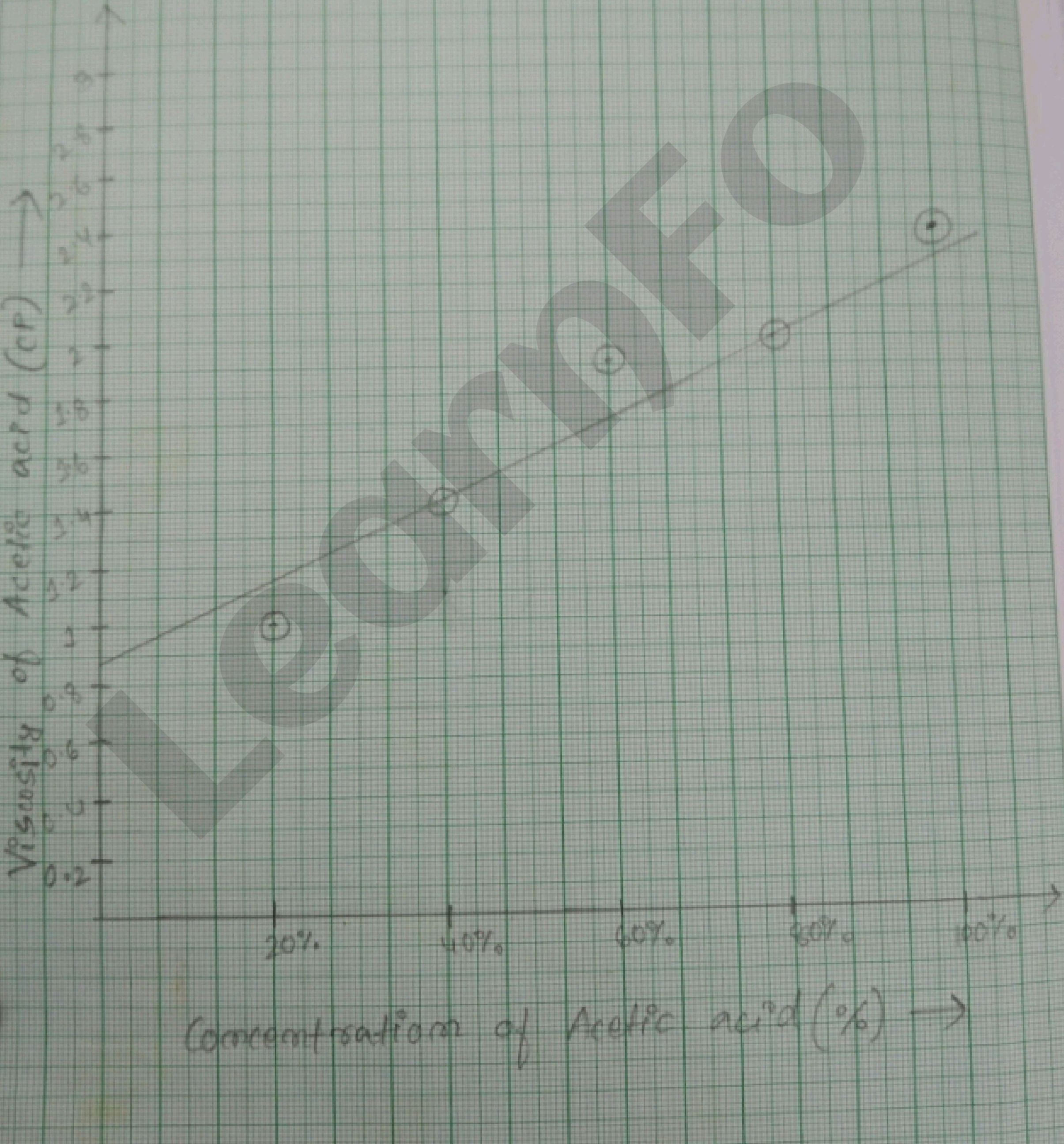
$= \frac{34.473 - 10.181}{30.769 - 10.181}$

$= 1.18\ g/cm^3$

② Calculate viscosity – We can calculate the viscosity of different concentration of acetic acid by using the relation,

$$\eta_i = d_i \times t_i \times \eta_w$$

(horizontal line) 3cm = 1 unit
(vertical line) 1cm = 1 unit



vivo Y20 2025.02.18 11:29

Therefore, viscosity of 20% acetic acid,

$\eta_1 = d_1 t_1 \eta_w = 1.14 \times 1.12 \times 0.801$
$= 1.02$ cP

Viscosity of 40% acetic acid, $\eta_2 = d_2 t_2 \eta_w$
$= 1.15 \times 1.52 \times 0.801$
$= 1.41$ cP

Viscosity of 60% acetic acid, $\eta_3 = d_3 t_3 \eta_w$
$= 1.16 \times 2.01 \times 0.801$
$= 1.86$ cP

Viscosity of 80% acetic acid, $\eta_4 = d_4 t_4 \eta_w$
$= 1.17 \times 2.14 \times 0.801$
$= 2.005$ cP

Viscosity of 100% acetic acid, $\eta_5 = d_5 t_5 \eta_w$
$= 1.18 \times 2.56 \times 0.801$
$= 2.40$ cP

Plotting the graph:— To visualize the relationship between concentration and viscosity, plot a graph with the concentration of acetic acid solutions on the x-axis and the corresponding viscosity values on the y-axis. Use the following data points for the plot:

(i) (20%, 1.02); (ii) (40%, 1.41); (iii) (60%, 1.86); (iv) (80%, 2.005); (v) (100%, 2.40)

Mark each point clearly and connect them with a line to observe the trend.

Teacher's Signature ____________

Precautions:-

(1) Ensure that the viscometer is free from any impurities and air bubbles.

(2) Handle acetic acid solution very carefully to avoid any spills.

(3) Ensure consistent temperature conditions during the experiment as viscosity is temperature-dependent.

(4) Take multiple readings to ensure accuracy and minimize experimental errors.

Conclusion:-
From the experiment, it is observed that the viscosity of acetic acid solution increases with the increasing concentrations.