



# Department of chemistry

## Determination of critical solution temperature of phenol-water system

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**Objective :-** determination of critical solution temperature of phenol- water system.

- **Requirements:-**

- **a) glasswares :-**

- 1) weighing bottle and dropper

- 2) Two glass test tubes one with wide bore

- 3) Glass stirrer

- 4) Beaker

- b) chemicals:-**
  - 1) Phenol

- 2) distilled water

**theory :-** Two liquids when mixed may be (i) completely miscible, (ii) completely immiscible, (iii) partially miscible. In case (iii) one will have a definite solubility in other. Example of such cases are phenol-water system. If we add phenol to water it will be soluble up to a certain limit and this solubility value will increase with increase in temperature. Similarly, if we add water to phenol same phenomena will be observed. The number of homogeneous, mechanically separable and physically distinct parts of a heterogeneous system is known as the number of phases, **P**, of the system. Each phase is separated from other phases by a physical boundary. When an equilibrium exists between a number of phases under external controlling conditions such as temperature, pressure, and concentration, the following relationship holds good :

$$F = C - P + 2 \quad \text{.....(1)}$$

where **P** = number of Phases in equilibrium,

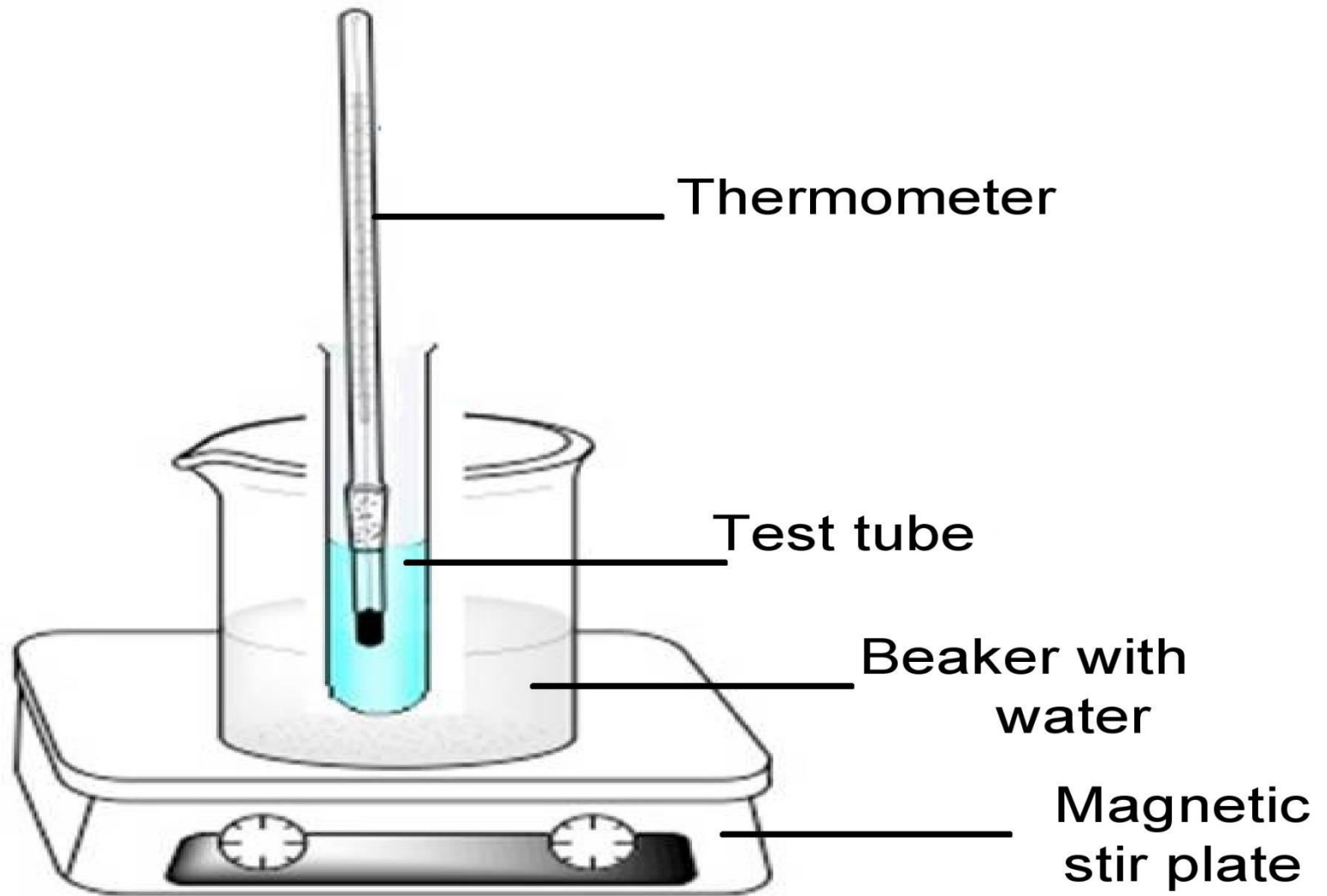
**C** = number of Components in the system, and

**F** = number of degrees of Freedom.

Equation (1) is called the ***Phase Rule***, which relates the *phases, components and degrees of freedom* of the system.

When 2 partially miscible liquids are mixed and shaken together, we get 2 solutions of different compositions. e.g. on shaking phenol and water, we get 2 layers : the upper layer is a solution of water in phenol, and the lower layer is a solution of phenol in water. At a fixed temp, the composition of each solution is fixed, and both the solutions are in equilibrium.

‘Above a particular temperature, such solutions are completely miscible in all proportions. Such a temperature is known as the **Critical Solution Temperature (CST) or Consolute Temperature.**’



Diag. experimental arrangement for cst determination of phenol water system

- **Procedure:-** CST for Phenol - Water system
  - 1) Weigh out about 5.0 g of phenol in a dry boiling tube.
  - 2) Add **2.0 ml of distilled water**. The solution is stirred.
  - 3) Heat the solution in a water bath, with continuous stirring.
- 4) At a certain temperature, the mixture becomes **clear**. Note this temperature ( **$t_1^{\circ}\text{C}$** ).
- 5) Remove the tube from the water bath, and allow the solution to cool down slowly. Note the temperature at which the **turbidity** re-appears ( **$t_2^{\circ}\text{C}$** ).
- 6) Repeat Steps 2 to 6, *after each addition of 2 ml of solution, followed by heating and subsequent cooling, note the temperature of disappearance of turbidity, and the temperature of the re-appearance of turbidity.*
- *The observation is that the temperature ( $^{\circ}\text{C}$ ) of complete miscibility rises, reaches a maximum value, and then decreases.*

# Observation and calculation:-

Lab. Temp= ....°c

$$\% \text{ of phenol} = \frac{((\text{density} \times \text{volume}) \text{ of phenol}) \times 100}{((\text{density} \times \text{volume}) \text{ of phenol} + \text{volume of water})}$$

Weight of phenol=.....g

Density of phenol =.....g/ml

Density of water =.....g/ml

S.N	Volume of water (ml)	wt % of phenol in water	miscibility	Temp.(°)	Average miscibility temp
			Turbidity Disappear	Turbidity appear	
1.					
2.					
3.					

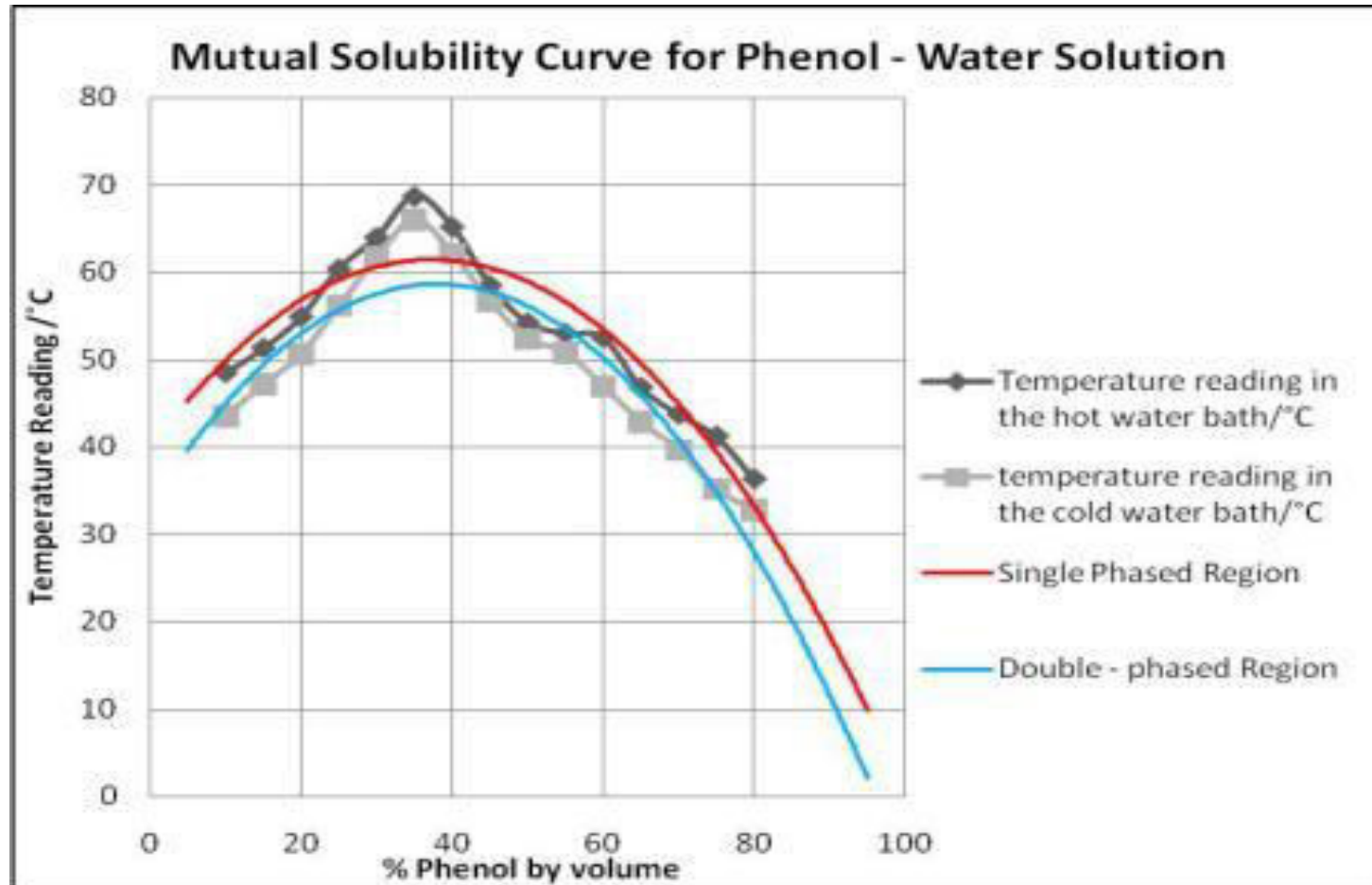


Fig. solubility curve of phenol water-system



Calculation:- 1) A curve is plotted between miscibility temp. and conc. Of phenol.

2) The maximum of the solubility curve gives the value of critical solution temp.

Result :- the critical solution temperature of phenol water system = .....°c

And % of phenol at CST is = .....%

**Precautions :-** 1) temp. of solution should be increased very slowly.

2) Mixture should be continuously and uniformly stirred.

3) Care should be taken while handling phenol.

*The end*

*Thank you*