

Effect of Napthalene on Critical Solution Temperature of Partially Miscible Aniline-Cyclohexane System

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ABSTRACT: Partially miscible liquids become more soluble with the increase in temperature and at a certain temperature they are completely miscible. This temperature is known as the Critical Solution Temperature (CST) or Consolute Temperature. Above This temperature the phases of a system are completely miscible is known as Upper critical solution temperature(UCST) or Upper Consulate Temperature (UCT) and it gets affected by the addition of impurities. Aniline-Cyclohexane system exhibits upper critical solution temperature. Addition of impurities results in increase in the critical solution temperature. When Aniline and Cyclohexane are mixed, a certain amount of the two dissolves with the other due to hydrogen bonding and two conjugate layers of liquids are obtained. These two layers become more soluble with the increase in temperature and at a certain temperature they are completely miscible. This temperature is known as the CST of Aniline-Cyclohexane system. It was observed that the UCST of Aniline-Cyclohexane system increases with adding impurities irrespective of their nature. To study the miscibility temperature, the mixture was heated in a boiling tube until the turbidity disappeared and the final temperature was noted. Then, the mixture was cooled down and the temperature noted when the turbidity reappeared. Solutions of impurities of different concentrations were prepared and their effect on the phase was analyzed.

KEYWORDS: Critical Solution Temperature(CST), Aniline-Cyclohexane System, Napthalene.

I. INTRODUCTION

Liquid-liquid type solutions are of three types i.e. 1. completely miscible liquid pairs - E.g. Water-Acetic acid, Water-Ethylalcohol. 2. completely immiscible liquid pairs - E.g. Oil- Water, Nitrobenzene-water. 3. Partially miscible liquid pairs - E.g. Phenol-Water, Aniline-cyclohexane and Methanol-carbon disulphide[1]. Partially miscible liquids become more soluble with the increase in temperature and at a certain temperature they are completely miscible[2]. This temperature is known as the critical solution temperature (CST). The temperature above which the phases of a system are completely miscible is known as Upper Critical Solution Temperature (UCST). Similarly, the temperature below which the phases of a system are completely miscible is known as the Lower Critical Solution Temperature (LCST) and it gets affected by the addition of impurities and it gets affected by the addition of impurities[3, 4]. The addition of a external substance to a partially miscible system to increase its miscibility is known as 'blending' or 'salting-out'. This method is playing a significant role for the section of best solvent in the synthesis of drugs. In continuation to our previous research work regarding the effect of foreign compounds on the critical solution temperature phenol-water system[5], we have focused on the study of Aniline-cyclohexane system.

From the last few decades aniline and aniline derivatives became industrial commodity due to their immense use in the processing of rubber chemicals and products such as car tyres, balloons, gloves, as a dyeing agent in the manufacture of clothes such as jeans, in the production of drugs such as Tylenol, acetaminophen, used as a pesticide and fungicides in the agricultural industry and in the manufacture of polyurethane, which is in turn used in the making of plastics. [6,7]. When Aniline and Cyclohexane are mixed, due to hydrogen bonding a certain amount of the two dissolves with the other and results in formation of two conjugate layers of liquids. The composition of these

layers depends only on the temperature of the system. These two liquids become more soluble with the increase in temperature and at a constant temperature these are completely miscible is called miscibility temperature [8,9]. To find the miscibility temperature, the mixture was heated in a boiling tube until the turbidity disappeared and the final temperature was noted. Then, the mixture was cooled down and the temperature noted when the turbidity reappeared. Solution of Naphthalene of different concentrations were prepared and their effect on UCT of Aniline-cyclohexane system was analyzed. It was found that addition of impurities to Aniline-cyclohexane system show an increase in CST as they decrease the miscibility.

II. MATERIALS AND METHODS

All chemicals used in this experiments are of AR grade fine chemicals.

Procedure for Calculating the CST of a Aniline-Cyclohexane System (without adding Foreign compound)

Seven 20 ml of mixtures of Aniline and cyclohexane of different compositions were prepared (as shown in table-1) and transferred into seven different cleaned boiling test tubes designated by A,B,C,D,E,F and G respectively. A wire stirrer and a thermometer are allowed in the boiling tube through the cork and placed the boiling tube in the water bath, experimental setup was shown in the Figure-1. The Aniline-cyclohexane mixture in the tube formed into two layers. The mixture was thoroughly mixed with the wire stirrer, a turbidity(cloudiness) produced in the tube. The water bath was heated and the mixture was stirred at regular intervals of time. The temperature was noted when the turbidity disappeared completely and the burner was turned off. The set up was allowed to cool down and noted the temperature when the turbidity reappeared (shown in Figure-1). The average of the two temperatures will be the miscibility temperature of the mixture. In the same manner the miscibility temperature for each mixture was recorded in Table 2.

Finding the Effect of 0.5% (w/v) Napthalene solution on the CST of the Aniline-cyclohexane system

0.5 gram of Napthalene was weighed and dissolved in 100 ml cyclohexane in a beaker to get 0.5 % (w/v) Napthalene solution. By taking this solution and Aniline seven mixtures of different compositions were prepared as mentioned above. The miscibility temperature of the respective mixtures were determined and recorded in table 3.

Finding the Effect of 1% (w/v) Napthalene solution on the CST of the Aniline-cyclohexane system

One gram of Napthalene was weighed and dissolved in 100 ml cyclohexane in a beaker to get 1% (w/v) Napthalene solution. By taking this solution and Aniline seven mixtures of different compositions were prepared as mentioned above. The miscibility temperature of the respective mixtures were determined and recorded in table 4.

Table 1. Composition of mixtures of Aniline and cyclohexane

Mixture(20 ml)	A	B	C	D	E	F	G
Aniline (in ml)	2	5	8	10	12	15	18
Cyclohexane (in ml)	18	15	12	10	8	5	2
% of Aniline	10	25	40	50	60	75	90

Table 2. Miscibility temperatures of Aniline-cyclohexane system(without adding impurity)

S.No.	Mixture	% composition of Aniline	Miscibility temperature (in °C)		
			Turbidity disappears	Turbidity re-appears	Average
1	A	10	51.0	46.5	48.7
2	B	25	58.0	54.5	56.2
3	C	40	64.5	59.0	61.7
4	D	50	66.5	61.5	64.0
5	E	60	65.5	59.5	62.5
6	F	75	59.5	54.0	56.7
7	G	90	49.5	44.0	46.7

Table 3. Miscibility temperature of Aniline-cyclohexane system with 0.5%(w/v) Napthalene

S.No.	Mixture	% composition of Aniline	Miscibility temperature (in °C)		
			Turbidity disappears	Turbidity re-appears	Average
1	A	10	57.0	52.5	54.7
2	B	25	64.0	60.5	62.2
3	C	40	69.5	64.0	66.7
4	D	50	72.5	67.5	70.0
5	E	60	71.5	65.5	68.5
6	F	75	65.5	60.0	62.7
7	G	90	56.5	51.0	53.7

Table 4. Miscibility temperature of Aniline-cyclohexane system with 1%(w/v) Napthalene

S.No.	Mixture	% composition of Aniline	Miscibility temperature (in °C)		
			Turbidity disappears	Turbidity re-appears	Average
1	A	10	63.5	59.0	61.2
2	B	25	70.5	67.0	68.7
3	C	40	76.5	70.5	73.5
4	D	50	79.0	74.0	76.5
5	E	60	77.5	71.5	74.5
6	F	75	72.0	66.5	69.2
7	G	90	63.0	57.5	60.2

III. CONCLUSION

When Aniline and cyclohexane are mixed, a certain amount of the two dissolves with the other due to hydrogen bonding and two conjugate layers of liquids are obtained. The composition of these layers depends only on the temperature of the system and is independent of the quantities of the liquids mixed. The presence of impurity dissolved in one or both of the phases changes the CST values as well as the liquid phase composition at CST. Substances soluble in only one of the liquids raise the upper CST. It was observed that the UCST of Aniline-cyclohexane system increases with increase in concentrations of impurities irrespective of their nature. CST of pure Aniline-cyclohexane was 64°C and with adding Napthalene it increased. The increase in CST with 0.5%(w/v)Napthalene was about 6°C. Similarly, with 1%(w/v)Napthalene the increase was about 12.5°C. Thus, it can be concluded that addition of impurities to Aniline-cyclohexane system show an increase in CST as they decrease the miscibility. Addition of impurity to a partially miscible system to increase its miscibility is known as 'blending' or 'salting-out' and This method is playing a significant role for the section of best solvent in the synthesis of drugs.

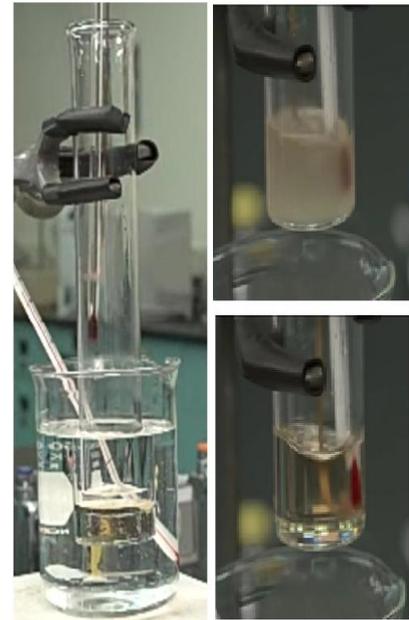
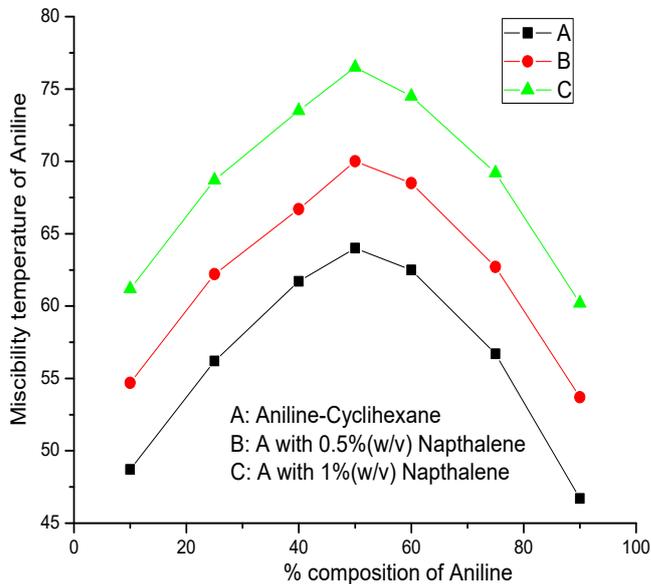


Figure-1: Experimental setup of CST

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