Saturation of Refractive Index of Nacl Solution Beyond its Saturation Limit

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***Abstract*: Refractive index of NaCl solution of 1,2,3,4,5,10 and 15.5 molal concentration were obtained at room temperature (26°C). It was found that saturation limit of NaCl solution at room temperature is 6.2 molal concentration. Graph of refractive index against concentration revealed that refractive index of medium increases with increase in NaCl concentration up to saturation limit of solution. Beyond saturation limit Refractive index of NaCl solution was found to be almost constant.**

***Keywords*: Concentration, NaCl, Refractive index, Saturation limit.**

1. Introduction

Refractive index of NaCl solution at different concentration level was obtained using hollow glass prism and spectrometer at room temperature. Sodium source was used as a monochromatic light source. While preparing different molal concentration solution it was found that beyond 6.2 molal concentration if we try to dissolve more amount of NaCl in the solution the NaCl crystals don't dissolve anymore and settle down in that solution as shown in fig. 1. Refractive index of the solution beyond saturation limit was founded to have almost same value at 10 and 15.5 molal concentration solution.

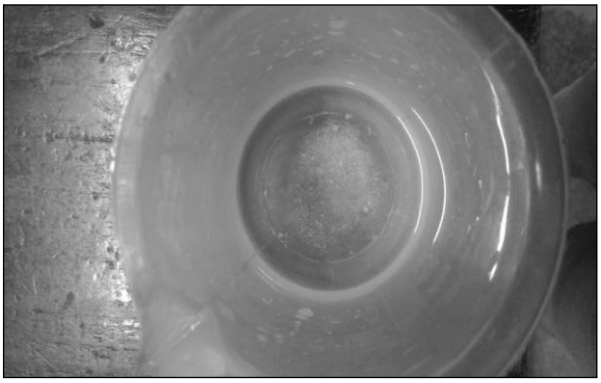

Fig. 1. Unmixed NaCl crystal in the solution beyond saturation limit

2. Experiment

At the room temperature NaCl solution of 1,2,3,4,5,10 and 15.5 molal concentration solution were prepared separately. With help of spirit level, the telescope, prism table and collimator were aligned horizontally. Cross wire of telescope was adjusted on fine slit. One molal NaCl was poured in hollow glass prism. Prism was placed on prism table with its base parallel to collimator and telescope. Angle of minimum deviation was obtained using Shuster's method [2]. To reduce error this procedure was repeated five times for one molal NaCl solution. Angle of prism A=60° when substituted in prism formula,

$$\mu = \frac{\sin\{[A+\text{∫m}]/2\}}{\sin[A/2]} \quad [3]$$

Reduces to equation $\mu = 2*\sin[(60+\text{∫m})/2]$ (1)

Where ∫m is mean of angle of minimum deviation and μ is the refractive index. Equation (1) was used to calculate refractive index of medium. Similarly, refractive index of 2, 3, 4, 5, 10 and 15.5 molal concentration solution was calculated. Graph of refractive index against molal concentration was plotted. Refractive index at zero molal concentration was 1.3290 which was verified with standard value of refractive index of water [4]. Due to lack of availability of NaCl only two solutions having molal concentration of 10 and 15.5 were considered beyond saturation limit. Observation table are given below.

Thus ∫m= 24°11'

$\mu = 2*\sin[(60+\text{∫m})/2]$

$\mu = 1.3406$

Hence refractive index of 1 molal NaCl solution at room temperature was 1.3406.

Table 1
One molal NaCl solution

S. No.	∫m position		Direct reading		difference		mean
	A'	B'	A	B	A'-A	B'-B	∫m
1	162°33'	342°16'	138°17'	317°59'	24°16'	24°17'	24°16'
2	148°59'	328°36'	125°	304°42'	23°59'	23°54'	23°56'
3	135°27'	315°05'	111°28'	291°09'	23°59'	33°56'	23°57'
4	122°48'	302°34'	98°45'	278°30'	24°03'	24°04'	24°03'
5	110°04'	289°57'	85°21'	265°06'	24°43'	24°51'	24°47'

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Table 2
Two molal NaCl solution

S. No.	∫m position		Direct reading		difference		mean
	A’	B’	A	B	A’-A	B’-B	∫m
1	94°57’	274°44’	69°55’	249°45’	25°02’	24°49’	24°55’
2	81°30’	261°22’	56°40’	236°05’	24°50’	25°17’	25°03’
3	66°50’	246°40’	41°47’	221°44’	25°03’	24°56’	24°59’
4	51°08’	231°13’	26°35’	206°37’	24°33’	24°36’	24°34’30’’
5	38°39’	218°43’	14°02’	194°12’	24°37’	24°31’	24°34’

Table 3
Three molal NaCl solution

S. No.	∫m position		Direct reading		difference		mean
	A’	B’	A	B	A’-A	B’-B	∫m
1	25°341’	205°46’	0°5’	180°18’	25°36’	25°28’	25°32’
2	11°30’	191°39’	345°53’	166°09’	25°37’	25°30’	25°33’
3	357°30’	177°42’	331°59’	152°11’	25°31’	25°31’	25°31’
4	344°05’	164°27’	318°30’	139°	25°35’	25°27’	25°31’
5	326°12’	146°33’	300°36’	121°	25°36’	25°33’	25°34’

Table 4
Four Molal NaCl solution

S. No.	∫m position		Direct reading		difference		mean
	A’	B’	A	B	A’-A	B’-B	∫m
1	310°28’	130°46’	284°36’	104°59’	25°52’	25°47’	25°49’
2	297°20’	117°36’	271°38’	91°49’	25°42’	25°47’	25°44’
3	282°23’	102°38’	256°15’	76°24’	26°08’	26°14’	26°11’
4	268°26’	88°33’	62°28’	242°18’	26°08’	26°05’	26°06’
5	254°53’	75°	228°43’	48°48’	26°10’	26°12’	26°11’

Table 5
Five molal NaCl solution

S. No.	∫m position		Direct reading		difference		mean
	A’	B’	A	B	A’-A	B’-B	∫m
1	154°44’	334°28’	128°30’	308°06’	26°14’	26°22’	26°17’
2	140°48’	320°30’	113°48’	293°35’	27°	26°55’	26°57’30’’
3	124°52’	304°37’	98°41’	277°58’	26°11’	26°39’	26°25’
4	110°52’	290°05’	83°39’	263°23’	27°13’	26°42’	26°57’30’’
5	96°06’	275°56’	69°50’	249°41’	26°16’	26°15’	26°15’30’’

Table 6
Ten molal NaCl solution

S. No.	∫m position		Direct reading		difference		mean
	A’	B’	A	B	A’-A	B’-B	∫m
1	80°23’	260°12’	53°06’	233°05’	27°17’	27°07’	27°12’
2	64°58’	244°51’	37°11’	217°43’	27°47’	27°08’	27°28’30’’
3	48°40’	228°44’	21°36’	201°44’	27°04’	27°0’	27°02’
4	33°11’	213°17’	185°43’	5°30’	27°41’	27°34’	27°37’30’’
5	16°47’	196°55’	349°30’	169°45’	27°17’	27°10’	27°13’30’’

Table 7
15.5 molal NaCl solution

S. No.	∫m position		Direct reading		difference		mean
	A’	B’	A	B	A’-A	B’-B	∫m
1	87°08’	267°06’	60°14’	240°11’	26°54’	26°55’	26°55’
2	72°30’	252°28’	45°38’	225°37’	26°52’	26°51’	26°52’
3	58°06’	238°04’	31°06’	211°10’	27°	26°54’	26°57’
4	44°02’	224°0’	16°46’	196°52’	27°16’	27°08’	27°12’
5	29°33’	209°40’	2°15’	182°25’	27°18’	27°15’	27°17’

Thus ∫m= 24°49’06”

$\mu = 2*\sin[(60+\int m)/2] = 1.3488$

Hence refractive index of 2 molal NaCl solution at room temperature was 1.3488.

Thus ∫m= 25°32’

$\mu = 2*\sin[(60+\int m)/2]$

$\mu = 1.3580$

Hence refractive index of 3 molal NaCl solution at room temperature was 1.3580.

∫m = 26°0’

$\mu = 2*\sin[(A+\int m)/2]$

$\mu = 1.3640$

Hence refractive index of 4 molal NaCl solution at room temperature was 1.3640.

∫m = 26°34’

$\mu = 2*\sin[(A+\int m)/2] = 1.3712$

Hence refractive index of 5 molal NaCl solution at room temperature was 1.3712.

∫m = 27°18’
μ = 2*sin{[A+∫m]/2}
μ = 1.3800

∫m = 27°03’
μ = 2*sin{[A+∫m]/2}
μ = 1.3780

3. Result and Discussion

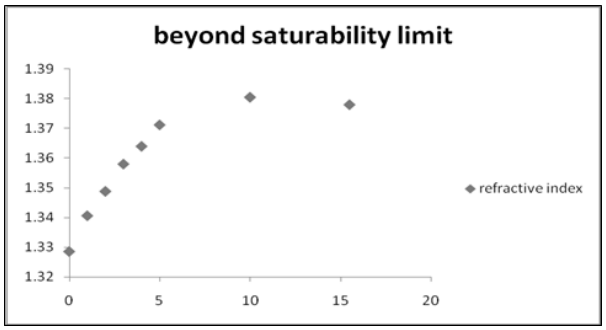

Fig. 2. Graph of refractive index (y-axis) against molal concentration (x-axis) of NaCl solution

Fig. 2, denotes the graph of refractive index against molal concentration of NaCl solution which reveals that Refractive index of NaCl solution increases with increase in molal concentration up to saturation limit [5]. Beyond saturation limit at 10 and 15.5 molal concentration Refractive index was found almost similar. We might obtain same Refractive index for other concentration of NaCl solution which is beyond saturation limit.

4. Conclusion

There might be saturation of refractive index of NaCl solution beyond its saturation limit.

5. Future Scope

Any researcher across the globe can verify the conclusion for other molal concentration of NaCl solution beyond saturation limit. The conclusion may also be verified for other crystal compounds too. Researcher by help of graph can derive a mathematical formula to find saturation point of refractive index satisfying for all compound.

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