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Solubility in the $NaClO_3$-$N(OHC_2H_4)_3 \cdot NH_4SCN$-$H_2O$ system

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ABSTRACT: The solubility of the system sodium chlorate - triethanolammonium thiocyanate from the temperature of complete freezing (–51,0^{0}C) to 60^{0}C was studied by visual-polythermal method using ten internal cuts. A polythermal solubility diagram of this system was constructed and the formation of a new compound of the composition –NaSCN was revealed.

KEYWORDS: defoliant, system, component, solution, crystallization temperature, polytherm, chlorate, sodium, diagram, consumption rate, triethanolammonium.

I. INTRODUCTION

In agriculture of Uzbekistan, as defoliants, chloric acid salts - sodium, calcium, magnesium chlorates [1,2] and derivatives of thiocyanic acid [3,4] are widely used as defoliants, which exhibits high physiological activity with a wide spectrum of action. The main disadvantages of chlorates are their high consumption rate and harshness of action on plants. The introduction of an ethylene-containing component into their composition eliminates the undesirable effect. It is known from the literature data that ethanolamines and their derivatives have physiological activity [5].

Therefore, it is necessary to study the solubility and interaction of components in the system sodium chlorate - triethanolammonium thiocyanate - water.

II. METHODS AND MATERIALS

For the study, we used sodium chlorate grade "pure", recrystallized from aqueous solutions. The synthesis of triethanolammonium thiocyanate was carried out by the interaction of ammonium thiocyanate with triethanolamine in molar ratios of 1:1, at a constant temperature of 50^{0}C, with vigorous stirring. After the end of the synthesis, a yellowish-brown thick mass is formed, the available pH is 9.63, the density is 1.159 g / cm^3, the viscosity is 1.188 mm^2/ s.

III. RESULTS AND DISCUSSION

For the physico-chemical substantiation of the process of obtaining new effective, complex-acting defoliants based on sodium chlorate and triethanolammonium thiocyanate, we studied the solubility visually - by the polythermal method [6] in the system sodium chlorate - triethanolammonium thiocyanate - water from a temperature of -51,0^{0}C to 60^{0}C using ten internal cuts. Sections I-VI are drawn from the side of triethanolammonium thiocyanate-water to the $NaClO_3$ pole, and sections VI-X from the side of sodium chlorate-water to the top of triethanolammonium thiocyanate.

The study of solubility in the binary system sodium chlorate - water of this system is devoted to a number of works that are in good agreement with the literature [7]. The eutectic point of the sodium chlorate - water system corresponds to the composition of 42.0% $NaClO_3$ and 58,0% H_2O at a temperature of – 18,5^{0}C.

The binary system of tritanol ammonium thiocyanate - water was studied by us for the first time and has a eutectic point at a temperature (–48,4^{0}C) and a content of 79.4% $N(OHC_2H_4)_3$ and 20,6% H_2O (Figure 1).

Solubility isotherms are plotted on polythermal solubility diagrams every 10^{0}C. The projections of polythermal solubility curves on the corresponding water sides of the system are constructed.

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Based on the obtained data of binary systems and internal sections, a polythermal solubility diagram of the $NaClO_3$-$N(OHC_2H_4)_3$·NH_4SCN-H_2O system was constructed from the temperature of complete freezing (-50.4) to 60^0C and areas of ice crystallization, $NaClO_3$, $N(OHC_2H_4)_3$·NH_4SCN and NaSCN as a new phase. These fields converge at two monovariant and three triple monovariant points of the system, for which the compositions of the equilibrium solution and the corresponding crystallization temperatures are determined (table)

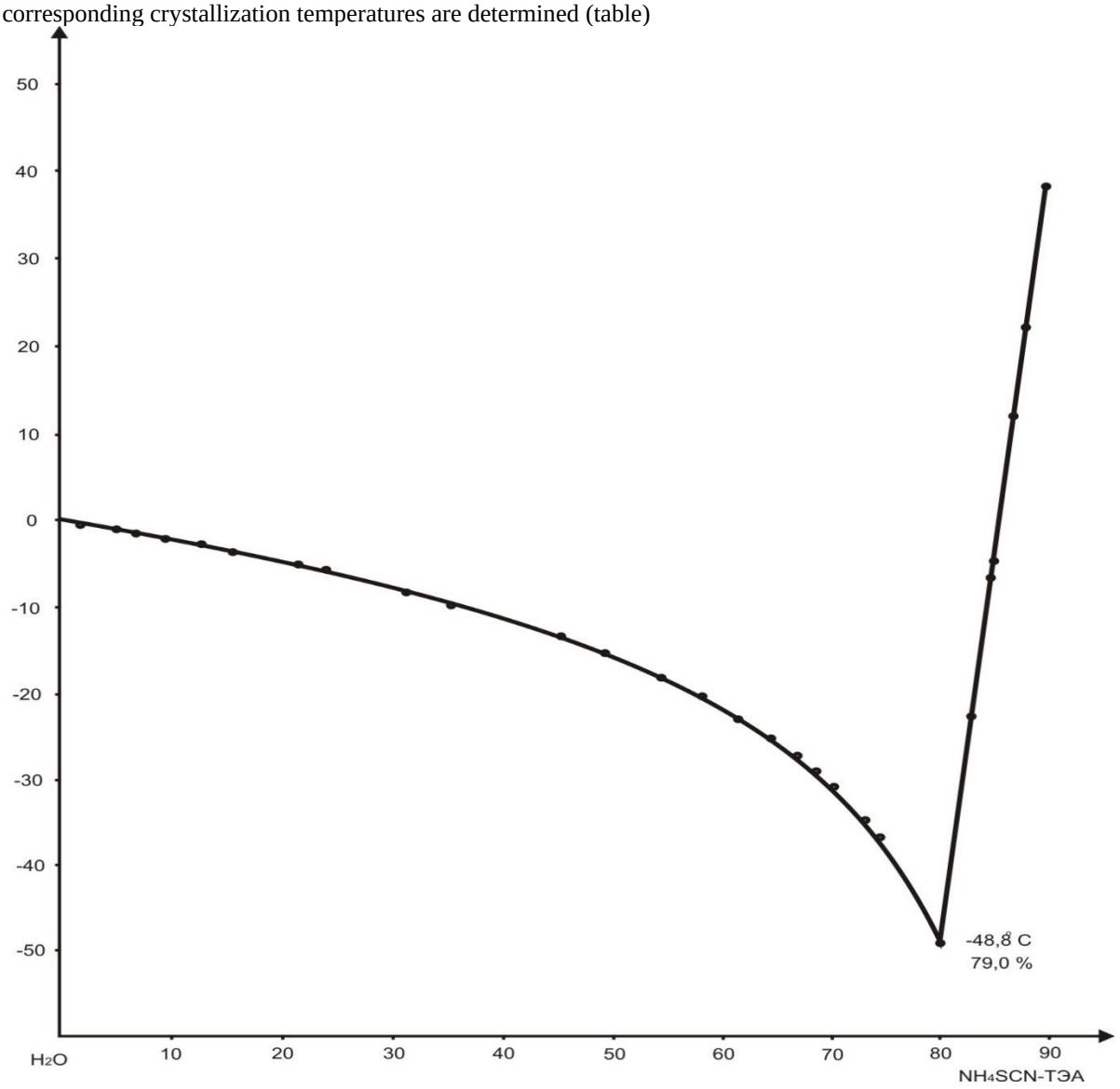

Fig.1 Solubility of the binary system triethanolamonium thiocyanate - water.

On the polythermal diagram, the smallest part is occupied by the crystallization field of sodium thiocyanate, due to its good solubility in comparison with the initial components in this system. The formation of NaSCN is observed at concentrations of monoethanolammonium thiocyanate 14.8÷79.2% and sodium chlorate 1.6÷37.8%, in the temperature ranges -22.6÷-51.0^{0}C.

In the joint presence of sodium chlorate with triethanolammonium thiocyanate, the following reaction probably takes place:

$[(HOC_2H_4)_3N]^+OH{\cdot}HSCN + NaClO_3$,=$NaSCN+[(HOC_2H_4)_3N]^+{\cdot}ClO_3+H_2O$

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Vol. 9, Issue 3 , March 2022

Table

Double and triple points of the sodium chlorate-triethanolammonium thiocyanate-water system

Liquid phase composition, %			Crystallization temperature, °C	solid phase
$NaClO_3$	$N(OHC_2H_4)_3 \cdot NH_4SCN$	H_2O		
41,9	-	58,1	-18,5	Ice + $Na(ClO_3)_2$
37,8	10,2	52,0	-22,6	Same
34,6	16,8	48,6	-27,6	Ice + $Na(ClO_3)_2$+NaSCN
33,2	17,2	49,6	-26,5	Ice + NaSCN
20,2	23,5	56,3	-17,1	Same
18,7	24,6	56,7	-16,4	« »
9,6	34,7	55,7	-15,8	« »
5,5	45,7	48,8	-19,6	« »
2,1	65,8	32,1	-32,0	« »
1,7	75,2	23,1	-50,4	Ice +NaSCN + $N(HOC_2H_4)_3SCN$
1,6	79,2	19,2	-51,0	Same
-	79,6	20,4	-48,4	Ice + $(HO\ C_2H_4)_3SCN$
4,2	79,4	16,4	-38,2	NaSCN + $N(HOC_2H_4)_3SCN$
5,8	79,6	14,6	-18,4	Same
8,1	80,4	11,5	-8,0	« »
9,8	80,8	9,4	26,6	$Na(ClO_3)_2$+NaSCN + $N(HOC_2H_4)_3SCN$
35,4	19,0	45,6	-6,4	$Na(ClO_3)_2$+NaSCN
34,5	25,2	40,3	10,5	Same
29,4	34,3	36,3	22,0	« »
23,0	42,8	34,2	37,0	« »
15,4	66,3	18,3	34,2	« »

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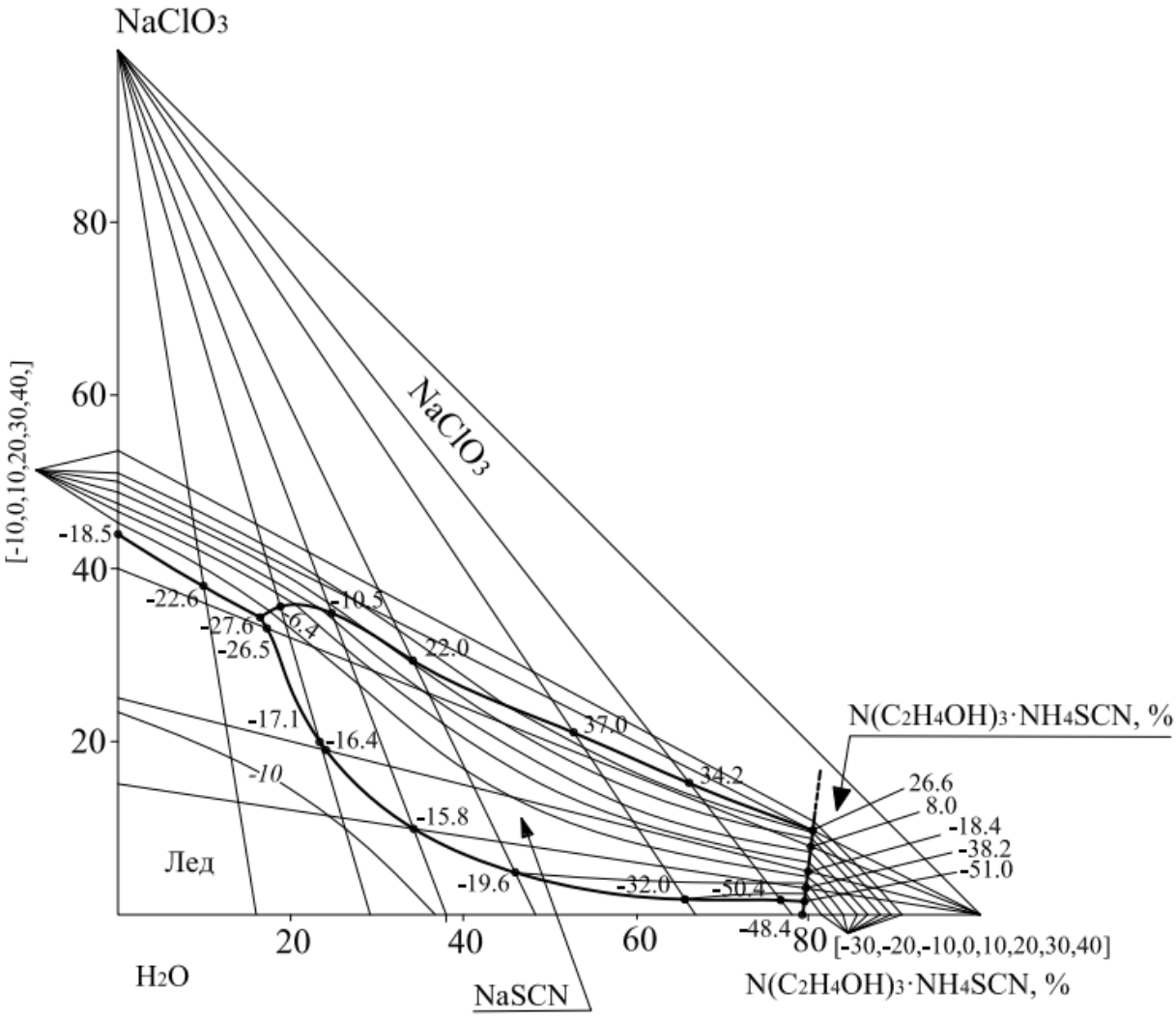

Fig. 2. Solubility diagram of the system sodium chlorate - triethanolammonium thiocyanate – water.

Another feature of this system is that it has a mutual salting out action of the components on each other. Analysis of the solubility diagram of the system shows that triethanolammonium thiocyanate has a greater salting out effect on sodium chlorate, so the area of crystallization of sodium chlorate occupies the largest part of the solubility diagram.

IV. CONCLUSION

Based on the results of the study of the sodium chlorate-triethanolammonium thiocyanate-water system, it was noted that it is advisable to obtain defoliants in those ratios of components at which there is a minimal salting-out effect of triethanolammonium thiocyanate on sodium chlorate.

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International Journal of Advanced Research in Science, Engineering and Technology

Vol. 9, Issue 3 , March 2022

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