ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 7, Issue 5 , May 2020

The solubility of the $NaClO_3 \cdot CO(NH_2)_2$-$N(C_2H_4OH)_3 \cdot HNO_3$-$H_2O$ system

SidikovA.A., Toghasharov A.S., Shukurov J.S.,Tukhtaev S.

PhD doctoral student ofThe Institute of General and Inorganic Chemistry of the Academy of Sciences of the Republic of Uzbekistan, MirzoUlugbek 77A, 100071 Tashkent, Uzbekistan,
Chief researcher of The Institute of General and Inorganic Chemistry of the Academy of Sciences of the Republic of Uzbekistan,
Chief researcher of The Institute of General and Inorganic Chemistry of the Academy of Sciences of the Republic of Uzbekistan
Leading researcher, academician of The Institute of General and Inorganic Chemistry of the Academy of Sciences of the Republic of Uzbekistan

ABSTRACT: The solubility of the $NaClO_3 \cdot CO(NH_2)_2$-$N(C_2H_4OH)_3 \cdot HNO_3$-$H_2O$ system from the freezing point (-44.2) to 60.0°C was studied. A polythermal solubility diagram was constructed, on which the crystallization fields of ice, $NaClO_3 \cdot CO(NH_2)_2$, $CO(NH_2)_2$, and $N(C_2H_4OH)_3 \cdot HNO_3$, are demarcated. The system belongs to a simple eutonic type. The physicochemical properties of the system [60%$NaClO_3 \cdot CO(NH_2)_2$+40%H_2O]-$N(C_2H_4OH)_3 \cdot HNO_3$ were also studied and a “composition-properties” diagram was constructed based on the obtained data.

KEY WORDS: solubility, system, diagram, concentration, crystallization, temperature, viscosity, density, pH of the medium, refractive index

I.INTRODUCTION

The main factor in growing high and high-quality crops is the rational use of chemicals. Especially defoliation is one of the important conditions for successful and high-quality harvesting of raw cotton in the pre-breeding season [1]. In this regard, special attention is paid to the production of highly effective, low-toxic and physiologically active defoliants. Existing chlorate-containing defoliants based on chlorates do not meet modern requirements for defoliants. It is known that the defoliating effect of chlorates is always to one degree or another accompanied by a desiccation effect [2, 3].In the synthesis of new effective defoliants, the use of ethanol ammonium nitrate, which is a plant growth stimulator, is of considerable interest. Therefore, as a result of adding this substance to the composition of the defoliant, the drug acquires physiological activity [4].

The aim of this study was to obtain a new effective, physiological active cotton defoliant based on mono carbamidochlorate, produced in the domestic industry and ethanolammonium nitrate, which is an effective additive to chlorate-containing defoliants.

In the present work, we present new data obtained on heterogeneous phase equilibrium in a system with the participation of water, sodium chlorate, urea, and ethanol ammonium nitrate; its polythermal solubility diagrams are constructed. To justify the process of obtaining a complex acting defoliant containing physiologically active substances, the “composition-properties” of the system [60%$NaClO_3 \cdot CO(NH_2)_2$+40%H_2O]-$N(C_2H_4OH)_3 \cdot HNO_3$ were studied.

II.LITERATURE SURVEY

Kucharov X.et al [5] Clarified the interaction of components in the system of sodium chlorate, triethanolamine and water. The system has been studied over a wide temperature range. It is established that the sytem belongs to a simple eutonic type.

Authors HamdamovaSh.Sh. and Mirzaev N.A. [6] investigated the solubility of the magnesium chlorate-tetranolamine-water system using the visual-polythermal method at temperatures from -56.0 to 31.2 °C. The polythermic diagramme of solubility was built, on which bordered the fields of crystallization of an ice, sixteen, twelve and six-aqua

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 7, Issue 5 , May 2020

magnesium chlorate, treethanolamin and new substances with the structure $MgOHClO_3 \cdot N(C_2H_4OH)_3 \cdot 2H_2O$ and $(C_2H_4OH)_3 \cdot HClO_3$ are established. The compounds were identified by chemical and physical chemical methods of analysis.

Khudoyberdiev F.I. [7] studied the solubility in the $NaClO_3 \cdot 3CO(NH_2)_2$-$N(C_2H_4OH)_3 \cdot C_4H_4N_2O_2$-$H_2O$ system by using a visual polythermal method. The solubility diagram of the system is constructed in the temperature range (-23.9) to 60ºC in order to justify the conditions for the synthesis of a new compound based on the starting components.

III.METHODOLOGY

The solubility polytherm of the $NaClO_3 \cdot CO(NH_2)_2$-$N(C_2H_4OH)_3 \cdot HNO_3$-$H_2O$ system was studied by the visual polythermal method [8]. To identify the components of the system, chemical and physicochemical methods of analysis were used. Quantitative chemical analysis of sodium solid phases was carried out by flame photometry [9], the chlorate-ion content was determined by the volume permanganometric method [10] and carbon, nitrogen, and hydrogen by elemental analysis [11].The relative density was determined by the pycnometric method [12] using a capillary pycnometer of 5 and 10 ml. The pH of the solutions was measured according to the procedure [13] with a FE20 METTLER TOLEDO pH meter. The kinematic viscosity of the solutions was determined on a VPZ capillary viscometer [14] with a capillary diameter of 1.16-1.84 mm. The refractive index was determined on an IRF 454 refractometer of the BM model in the range from 1.2 to 1.7 with one refractometric block [15].

IV.MATERIALS

In our studies, we used $NaClO_3 \cdot CO(NH_2)_2$, synthesized by alloying carbamide with sodium chlorate at a molar ratio of 1: 1. After the formation of a homogeneous melt of the starting components, crystals of the compound $NaClO_3 \cdot CO(NH_2)_2$ were isolated by cooling.
The binary $NaClO_3 \cdot CO(NH_2)_2$-H_2O system was studied by us in the temperature range from -33.0 to 100.0 °C. On the solubility curve of the system, the crystallization branches of ice, urea, sodium monocarbamidochlorate were established. The results obtained are consistent with the literature data presented in [16].
Triethanolammonium nitrate was synthesized based on nitric acid and triethanolamine, taken at a molar ratio of 1: 1. It is a brown colored fluid solution at 25 °C with a pH of 6.08.

V. RESULTS AND DISCUSSION

The solubility in the $N(C_2H_4OH)_3 \cdot HNO_3$-$H_2O$ system was studied by us in the temperature range from -19.0 to 1.0 °C (Fig. 1). The solubility diagram of the $N(C_2H_4OH)_3 \cdot HNO_3$-$H_2O$ system is characterized by the presence of two branches of ice crystallization and $N(C_2H_4OH)_3 \cdot HNO_3$. The eutectic point of the system corresponds to 81.75% $N(C_2H_4OH)_3 \cdot HNO_3$ and 18.25% H_2O, at a temperature of -19.0 °C.

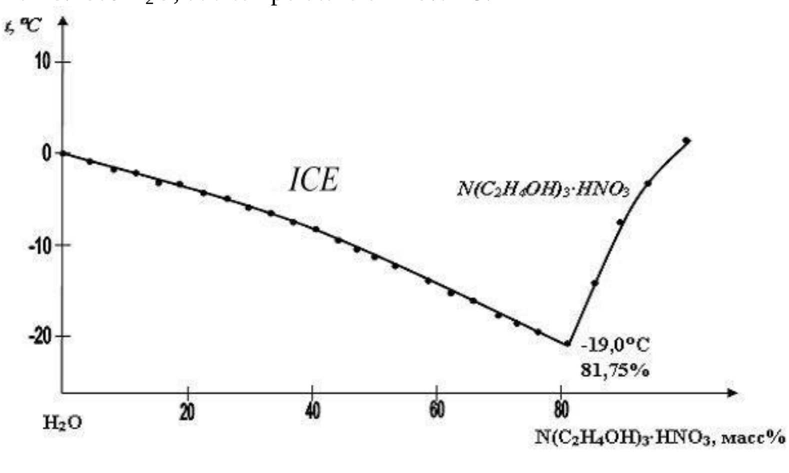

Fig. 1. The solubility diagram of the $N(C_2H_4OH)_3 \cdot HNO_3$-$H_2O$ system

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 7, Issue 5 , May 2020

The $NaClO_3 \cdot CO(NH_2)_2$-$N(C_2H_4OH)_3 \cdot HNO_3$-$H_2O$ system was studied using seven internal sections from -44.2 to 60 °C. On the polythermal solubility diagram, the fields of crystallization are distinguished: ice, $NaClO_3 \cdot CO(NH)_2$, $CO(NH_2)_2$ and $N(C_2H_4OH)_3 \cdot HNO_3$ (Fig. 2.).

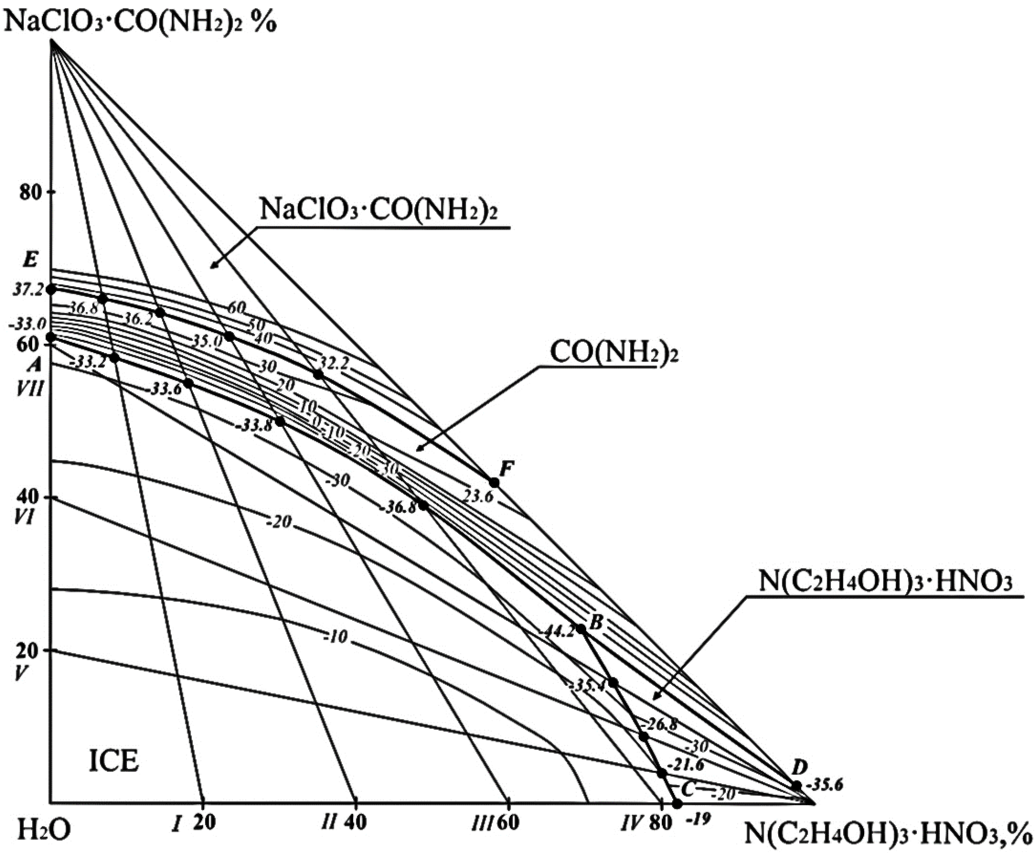

Fig. 2. Polythermal solubility diagram of the $NaClO_3 \cdot CO(NH_2)_2$-$N(C_2H_4OH)_3 \cdot HNO_3$-$H_2O$ system

The ice and urea crystallization fields in the diagram are delimited by a curved line connecting points A and B. At the eutectic point of the system, the concentration of components is 22.2% $NaClO_3 \cdot CO(NH_2)_2$, 69.6% $N(C_2H_4OH)_3 \cdot HNO_3$ and 8.2% H_2O. The crystallization temperature of point C (-19.0) °C, the concentration of triethanolammonium nitrate is 81.75%, and water is 18.25%. The fields of urea and triethanolammonium nitrate are delimited by a curved line between points B and D.The crystallization temperature of point D is (-35.6) °C, the concentration of $NaClO_3 \cdot CO(NH_2)_2$ and $N(C_2H_4OH)_3 \cdot HNO_3$ is 2.4% and 97.6%, respectively. The crystallization fields of sodium and urea monocarbamidochlorate are delimited by a curve connecting the points of the diagrams E and F. The double and triple points of the $NaClO_3 \cdot CO(NH_2)_2$-$N(C_2H_4OH)_3 \cdot HNO_3$-$H_2O$ system are shown in Table 1.

Table 1. Double and triple points of the $NaClO_3 \cdot CO(NH_2)_2$-$N(C_2H_4OH)_3 \cdot HNO_3$-$H_2O$ system

Composition of the liquid phase (%)			T_c (°C)	Solid phase
$NaClO_3 \cdot CO(NH_2)_2$	$HNO_3 \cdot N(C_2H_4OH)_3$	H_2O		
61.2	-	38.8	-33.0	Ice + $CO(NH_2)_2$
58.4	8.2	33.4	-33.2	The same

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 7, Issue 5 , May 2020

55.2	17.8	27	-33.6	-//-
50.0	29.8	20.2	-33.8	-//-
38.2	49.0	12.8	-36.8	-//-
22.2	69.6	8.2	-44.2	Ice + $CO(NH_2)_2$ + $HNO_3 \cdot N(C_2H_4OH)_3$
16.0	73.4	10.6	-35.4	Ice + $HNO_3 \cdot N(C_2H_4OH)_3$
8.8	77.8	13.4	-26.8	The same
4.0	80.0	16	-21.6	-//-
-	81.6	18.4	-19.0	-//-
2.4	97.6	-	-35.6	$CO(NH_2)_2$ + $HNO_3 \cdot N(C_2H_4OH)_3$
67.4	-	32	37.2	$NaClO_3 \cdot CO(NH_2)_2$ + $CO(NH_2)_2$
66.2	6.8	27	36.8	The same
64.2	14.2	21.6	36.2	-//-
56.4	34.6	9	32.2	-//-
42.6	57.4	-	23.6	-//-

Projections of the system were constructed on the sides of sodium monocarbamidochlorate - water A and on the sides of triethanolammonium nitrate - water B (Fig. 3.).

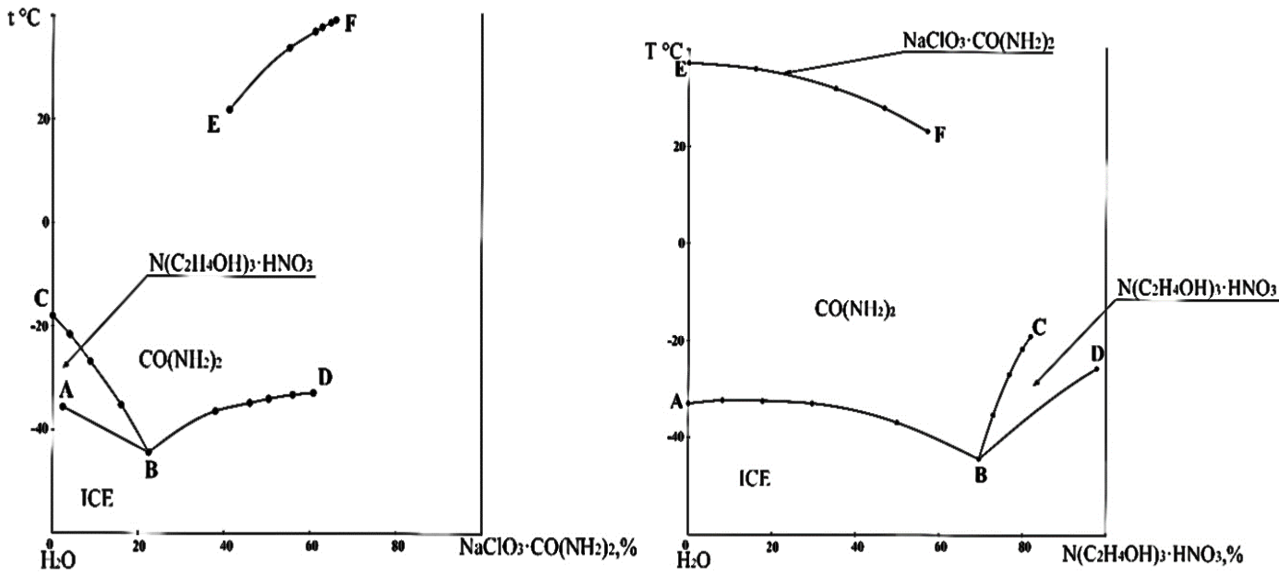

Fig. 3. Projections of the $NaClO_3 \cdot CO(NH_2)_2$-$N(C_2H_4OH)_3 \cdot HNO_3$-$H_2O$ system: A-$NaClO_3 \cdot CO(NH_2)_2$-H_2O; B-$N(C_2H_4OH)_3 \cdot HNO_3$-$H_2O$

In order to justify the process of obtaining a defoliant based on sodium monocarbamidochlorate and triethanolammonium nitrate, we studied the solubility and rheological properties of the components in the system [60%$NaClO_3 \cdot CO(NH_2)_2$+40%H_2O]-$N(C_2H_4OH)_3 \cdot HNO_3$.

The system [60%$NaClO_3 \cdot CO(NH_2)_2$+40%H_2O]-$N(C_2H_4OH)_3 \cdot HNO_3$ was studied by the solubility method, measuring

ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 7, Issue 5 , May 2020

density, viscosity, pH and refractive index, the results are shown in Table 2. The composition – properties diagram is constructed »Of this system (Fig. 4.).

Physico-chemical and rheological properties of the system
[60%$NaClO_3$·$CO(NH_2)_2$+40%H_2O]-$N(C_2H_4OH)_3$·HNO_3

Components content, %		Cryst. temperature., t. °C	Density, d, g/cm^3	Viscosity, η.mm^2/s	pH	Refractive index, n	Solid phase
60%$NaClO_3$· $CO(NH_2)_2$+ 40%H_2O	$NH(C_2H_2OH)_3$·HNO_3						
100	-	13.0	1.425	1.82	6.01	1.4153	Ice + $CO(NH_2)_2$
93.3	6.7	9.2	1.422	1.94	6.02	1.4172	The same
85.2	14.8	4.5	1.412	2.06	6.02	1.4206	-//-
79.0	21.0	0	1.402	2.25	6.03	1.4232	-//-
73.5	26.5	-3.0	1.392	2.44	6.03	1.4252	-//-
68.1	31.9	-6.5	1.383	2.56	6.04	1.4274	-//-
61.6	38.4	-11.0	1.372	2.84	6.04	1.4308	-//-
56.6	43.4	-14.0	1.363	3.11	6.05	1.4357	-//-
50.7	49.3	-18.5	1.354	3.48	6.05	1.4353	-//-
45.0	55.0	-22.0	1.345	3.77	6.06	1.4370	-//-
40.0	60.0	-25.5	1.348	4.03	6.07	1.4397	-//-
26.6	73.4	-35.4	1.332	4.38	6.07	1.4415	-//-
18.3	81.7	-21.2	1.307	5.55	6.07	1.4472	$CO(NH_2)_2$+ $N(C_2H_4OH)_3$·HNO_3
8.2	91.8	-7.5	1.297	6.18	6.08	1.4498	Ice + HNO_3·$N(C_2H_4OH)_3$
-	100	1.0	1.292	6.59	6.08	1.4525	The same

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 7, Issue 5 , May 2020

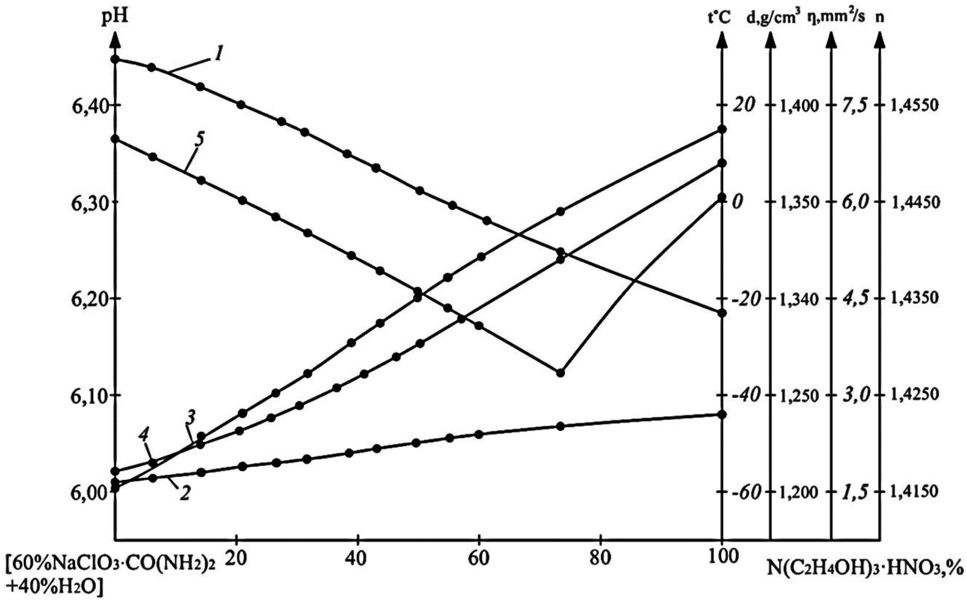

Fig. 4. The composition-property diagram of the system [60%$NaClO_3 \cdot CO(NH_2)_2$+40%H_2O]-$N(C_2H_4OH)_3 \cdot HNO_3$ at 25 °C depending on the density change (1); pH of the medium (2); viscosity (3); refractive index (4); crystallization temperature (5).

Studies have shown that when (74.67%) triethanolammonium nitrate is added to the studied saturated sodium monocarbamidochlorate solution, a decrease in the crystallization temperature of the solution is observed from 13.0 to (-35.4) °C, density from 1.425 to 1.292 g/cm^3 and viscosity increase from 1.82 up to 6.59 mm^2/s, medium pH from 6.01 to 6.08, refractive index from 1.4153 to 1.4525.At the eutectic point, two solid phases crystallize - urea and triethanolammonium nitrate. As the solubility study showed, a further increase in the concentration of triethanolammonium nitrate in a saturated solution of systems from 73.6 to 100% leads to an increase in the crystallization temperature from (-35.4) to -1.0 °C.

VI. CONCLUSION

The $NaClO_3 \cdot CO(NH_2)_2$-$N(C_2H_4OH)_3 \cdot HNO_3$-$H_2O$ system under study belongs to the simple eutonic type, and no new compounds were found.

Since this system has not been previously studied, the data we have obtained are a scientific reference for masters and doctoral students working in this field.

Based on the results of the study, a physicochemical substantiations of the processes for obtaining a new defoliant was established.

With the aim to develop technologies for the production of new effective defoliants and determine their composition, studied the solubility of the [60%$NaClO_3 \cdot CO(NH_2)_2$ + 40% H_2O] - $N(C_2H_4OH)_3 \cdot HNO_3$ system, «composition-property».On the basis of the data obtained, a polythermal solubility diagram and a «composition-property» diagram of the system was constructed. The data obtained are used for fundamental investigation into the analysis of salt systems as reference data.

REFERENCES

[1] Teshaev F., Khaitov B. Effect of defoliants and fertilizers on yield and quality of upland cotton (Gossypiumhirsutum L.) // Journal of Cotton Research and Development (CRDA). –India, 2015. -№1. pp. 57-60.

[2] Umarov A.A., Kutyanin L.I. New defoliants: search, properties, applications. M.: Chemistry. 2000. -87s.

[3] Shukurov J.S., Askarova M.K., Tukhtaev S. Solubility in systems comprising sodium dicarbamidochlorate, monoethanolamine acetate, ethanol and acetamiprid // Russian Journal of Inorganic Chemistry. - Moscow, 2018 Vol. 63.-№ 2. pp. 260-264.

[4] Turaev K.A., Togasharov A.S., ShukurovZh.S., Tukhtaev S. Study of the solubility and rheological properties of solutions of the system sodium tricarbamidochlorate - monoethanolammonium nitrate - water // Universum: Engineering: electron. scientific journal 2019.No.10 (67) S. 66-72. http://7universum.com/en/tech/archive/category/1067.

[5] KhamdamovaSh.Sh., Kucharov X., Tukhtaev S. Solubility polytherm of sodium chlorate-triethanolamine-water system // Uzbek Chemical Chem. - 2003.-№5. S.29-32.

[6] KhamdamovaSh.Sh., Mirzaev N.A. The interaction of components in the Mg (ClO3) 2 - N (C2H4OH) 3 - H2O system // Universum: Chemistry and Biology: Electron. scientific journal 2020. No. 1 (67). http://7universum.com/en/nature/archive/item/8606

[7] Khudoyberdiev F.I. Solubility study in the NaClO3 · 3CO (NH2) 2 - N (C2H4OH) 3 · C4H4O2N2 - H2O system // Universum: Chemistry and Biology: Electron. scientific journal 2018.No 9 (51). http://7universum.com/en/nature/archive/item/6288

[8] Trunin A.S. Petrova D.G. Visual polythermal method / Kuibyshev Polytechnic. Inst. - Kuibyshev: 1977, 94 p. Dep. at VINITI No. 584-78.

[9] Poluektov N.S. Methods of analysis by flame photometry. - M.: Chemistry, 1967.- 307 p.

[10] GOST 12257 - 77 Sodium chlorate. Technical conditions - M.: Publishing house of standards. -1987. No. 548 - 78.

[11] Klimova V.A. The main micromethods for the analysis of organic compounds. - M.: Chemistry, 1975.- 224 p.

[12] Zdanovsky A.B. Gallurgy. - L.: Chemistry, 1972.- 572 p.

[13] Gorbachev S.V. Workshop on physical chemistry. - M.: Higher School, 1974. - 310 p.

[14] FrolovYu.G. The course of colloid chemistry // Surface phenomenon and dispersed systems. - M. 1982.P. 117 - 124.

[15] TO 34. 15.051 Technical description and instruction manual.

AUTHOR'SBIOGRAPHY

№	Full name place of work, position, academic degree and rank	Photo
1	**Sidikov Abdulaziz Abdumanopogli,** PhD doctoral student of The Institute of General and Inorganic Chemistry of the Academy of Sciences of the Republic of Uzbekistan, Tashkent, Uzbekistan.	
2	**Togasharov AhadSalimovich,** Chief researcher of The Institute of General and Inorganic Chemistry of the Academy of Sciences of the Republic of Uzbekistan,DSc.,Tashkent, Uzbekistan.	
3	**Shukurov Jamshid Sultonovich,** Chief researcher of The Institute of General and Inorganic Chemistry of the Academy of Sciences of the Republic of Uzbekistan,DSc., Tashkent, Uzbekistan.	
4	**Tukhtaev Saidakhral,** Leading researcher, Professor, Academician of The Institute of General and Inorganic Chemistry of the Academy of Sciences of the Republic of Uzbekistan, Tashkent, Uzbekistan.