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Studying of the Process of Obtaining Liquid Fertilizer with Physiological Activity

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ABSTRACT: In the work to substantiate the process of obtaining liquid fertilizers based on solutions of potassium sulfate, ammonium nitrate, carbamide, copper sulfates and monoethanolammonium. The dependence of the change in the physicochemical properties of solutions on the composition of the components has been studied. On the basis of data obtained, the “composition-properties” diagrams were constructed.

KEYWORDS: solution, urea, diagram, system, ammonium nitrate, potassium sulfate, fertilizers, properties, composition, ratios.

I.INTRODUCTION

For normal growth, development and creation of high yields of plants, along with nitrogen-phosphorus fertilizers, potassium fertilizers are needed, which contribute to the normal course of vital processes in the plant organism. The lack of mobile forms of potassium in the soil will reduce productivity; impair the assimilation of nitrogen and phosphorus fertilizers.

II.MATERIALS AND METHODS

The range of manufactured potash fertilizers includes potassium chloride and potassium sulfate, as well as mixed potassium salts. However, the systematic introduction of chloride forms of potassium leads to the accumulation of chlorine ions in the soil, which adversely affects the yield and quality of many industrial crops. Its use is especially unfavorable in the conditions of Central Asia, where most of soils are of the serozem type, prone to chloride salinization.

Among the chlorine-free forms of potash fertilizers, potassium sulfate, which feeds plants with potassium and sulfur, has the greatest prospects for production and use. Potassium sulfate is a valuable chlorine-free fertilizer. Potassium sulfate has a much more effective effect on the size of the crop and its quality if it is used in combination with nitrogen and phosphorus fertilizers.

After the use of potassium sulfate in grown fruits, vegetables and berries, the content of sugars and vitamins increases noticeably, the resistance of plants to various diseases increases, and the percentage of damage to finished products by heart and gray rot decreases. Potassium sulfate as a fertilizer must be used to provide perennial plants with a successful winter. By feeding fruit and shrubs with potassium sulfate in autumn, one can expect that they will survive even the most severe frosts with insignificant losses [1]. One of the effective methods for the production of mineral fertilizers is to obtain them in liquid form. The production of such fertilizers leads to a reduction in to a number of processes and, in comparison with solid fertilizers, to a significant reduction in costs.

Today, one of the important tasks is the development and improvement of technologies for obtaining new fertilizers based on local raw materials. To solve this problem, it is relevant to use potassium sulfate produced at JSC «Maksam-Chirchik», followed by enrichment of the potassium sulfate solution with nitrogen fertilizer components, physiologically active substances and microelements.

III.RESULTS AND DISCUSSION

To substantiate the process of obtaining a liquid fertilizer based on a solution of potassium sulfate and ammonium nitrate, the dependence of the changes in the physicochemical properties of solutions on the composition of the components in the system [10%K_2SO_4+90%H_2O] +NH_4NO_3 was studied.

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In order to clarify the mutual influence of the components on the physicochemical properties of solutions of this system, the change in crystallization temperature, pH of the medium, density and viscosity of solutions from the composition of the components was determined [2-4]. On the basis of the data obtained, the diagram “composition-properties” of the system was constructed (Fig. 1, Table 1).

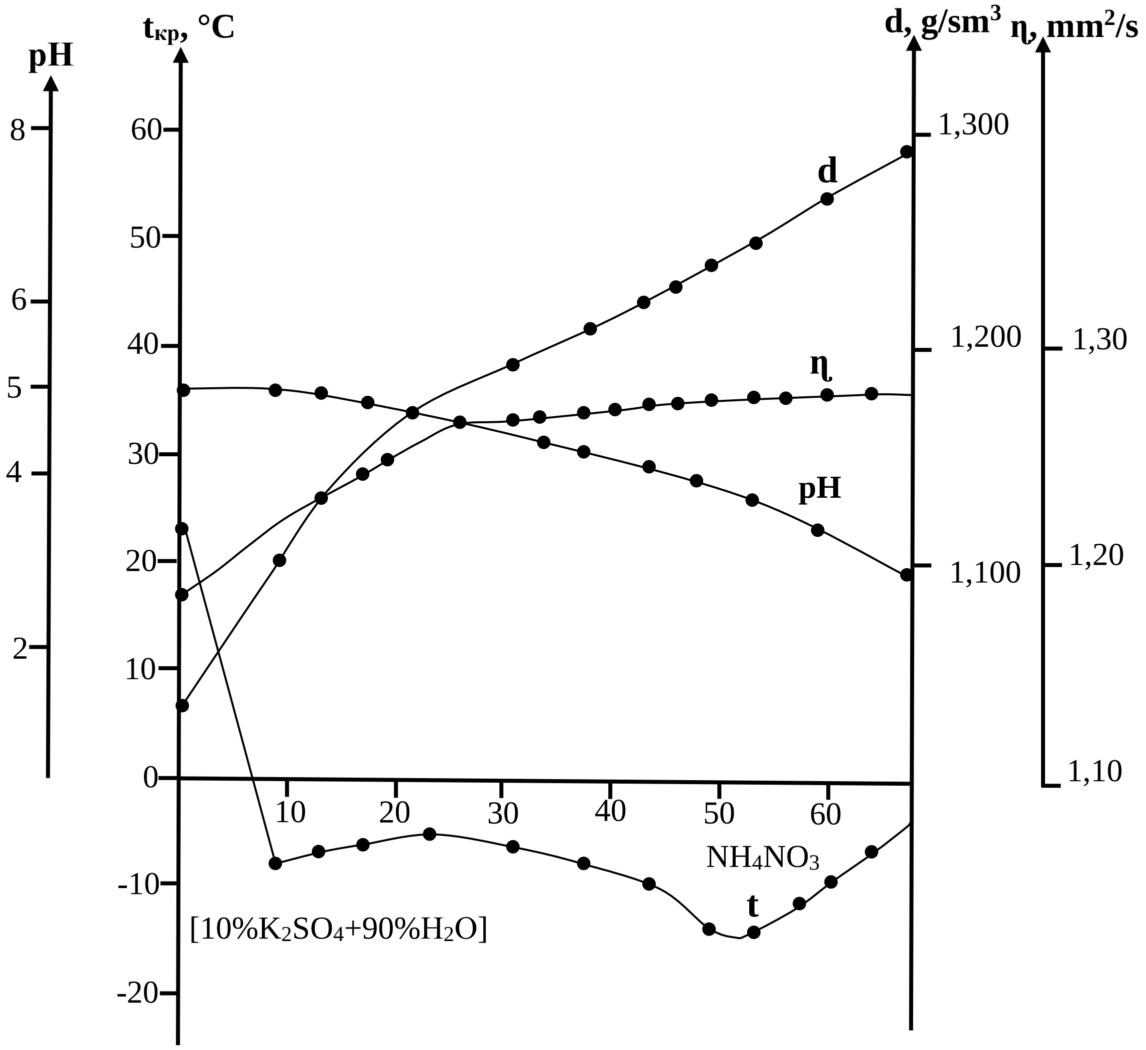

Fig. 1. Diagram «composition-properties» of the system [10%K_2SO_4+90%H_2O]-NH_4NO_3

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Table 2. Dependence of changes in the physicochemical properties of solutions from the composition in the system $[10\%K_2SO_4+90\%H_2O]+NH_4NO_3$

№	Component content, %		$t_{кр}$, °C	d, g/cm^3	η, mm^2/s	pH
	$[10\%K_2SO_4+90\%H_2O]$	NH_4NO_3				
1	100	-	23	1,086	1,134	5,0
2	90,24	-9,76	-8	1,12	1,20	5
3	87,05	12,95	-7	1,13	1,231	5
4	82,6	17,4	-6	1,14	1,245	4,98
5	80,82	19,18	-5,5	1,15	1,251	4,75
6	78,73	21,27	-5	1,16	1,254	4,69
7	76,5	23,5	-5	1,17	1,255	4,66
8	73,55	26,45	-4,5	1,18	1,265	4,54
9	69,12	30,88	-5	1,19	1,266	4,40
10	66,4	33,6	-5,5	1,19	1,266	4,36
11	62,45	37,55	-7	1,21	1,267	4,33
12	59,58	40,42	-9	1,22	1,268	4,24
13	56,66	43,34	-10	1,23	1,274	4,21
14	54,01	45,99	-10	1,23	1,275	4,21
15	50,78	49,22	-14	1,24	1,276	4,11
16	46,88	53,12	-14	1,25	1,277	3,87
17	42,69	57,31	-11	1,26	1,278	3,76
18	39,5	60,5	-9	1,27	1,280	3,73
19	35,2	64,8	-6	1,27	1,281	2,93
20	31,09	68,91	-3	1,29	1,282	2,90
21	28,44	71,56	0	-	-	-

According to the data obtained, the composition-crystallization temperature diagram is characterized by the presence of three crystallization branches with obvious breaks in the solubility curve. The first branch corresponds to the crystallization of K_2SO_4 and continues to 9.4% ammonium nitrate. In the ammonium nitrate concentration range of 9.4÷50.0%, K_2SO_4 and NH_4NO_3 crystallize in the system. Infatuated with nitrate content ammonium more than 50% in the system is crystalized by NH_4NO_3, which was confirmed by the results of chemical and X-ray phase analysis. Analysis of the "composition-properties" diagram of the studied system shows that as ammonium nitrate is added to the initial solution of potassium sulfate, the pH values of the newly formed solutions gradually decrease. The values of density and viscosity of the system solutions gradually increase accordingly: d from 1.086 to 1.29 g/cm^3 and η from 1.134 to 1.282 mm^2/s.

With this ratio of components, a solution is formed with satisfactory physicochemical properties: crystallization temperature-9.0°C, density 1.22 g/cm^3, viscosity 1.268 mm^2/s and pH 4.24. It is known that physiologically active substances are widely used to obtain high yields with good qualities (auxins, kinins, gibberelens and others), processes high activity and the ability to influence the intensity of all processes occurring in the plant organism [5,6]. They can enhance cell growth, stimulate cell division, and promote protein and nucleic acid synthesis.

Physiologically active substances have a beneficial effect on the growth, development and fruit accumulation of plants, significantly increase resistance to various diseases and improve the absorption of basic nutrients by plants, increase productivity, reduce the ripening period and improve product quality [7,8].

The most effective, economically and agrochemically expedient method of using physiologically active substances is their combined use with basic fertilizers. At the same time, additional costs for introduction of each drug are eliminated, their uniform distribution in the soil is achieved and the efficiency of fertilizers increases [9-12]. Thus, the combined use of physiologically active substances with fats improves the use of all elements of mineral nutrition and

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increases the efficiency of fertilizers. Therefore, research on obtaining more effective forms of fertilizers, which, along with the main elements of nutrition, contain physiologically active substances, are relevant. To obtain a liquid fertilizer containing such nutrients as K_2O, S, N, as well as FAS-monoethanolammonium sulfate, the physicochemical properties of solutions were studied in the system $\{60\%[10\%K_2SO_4+90\%H_2O]+40\%NH_4NO_3\}$-$H_2SO_4 \cdot NH_2C_2H_4OH$. On the basis of the data obtained, the diagram "composition-properties" of the system was constructed (Fig.2, Table 2).

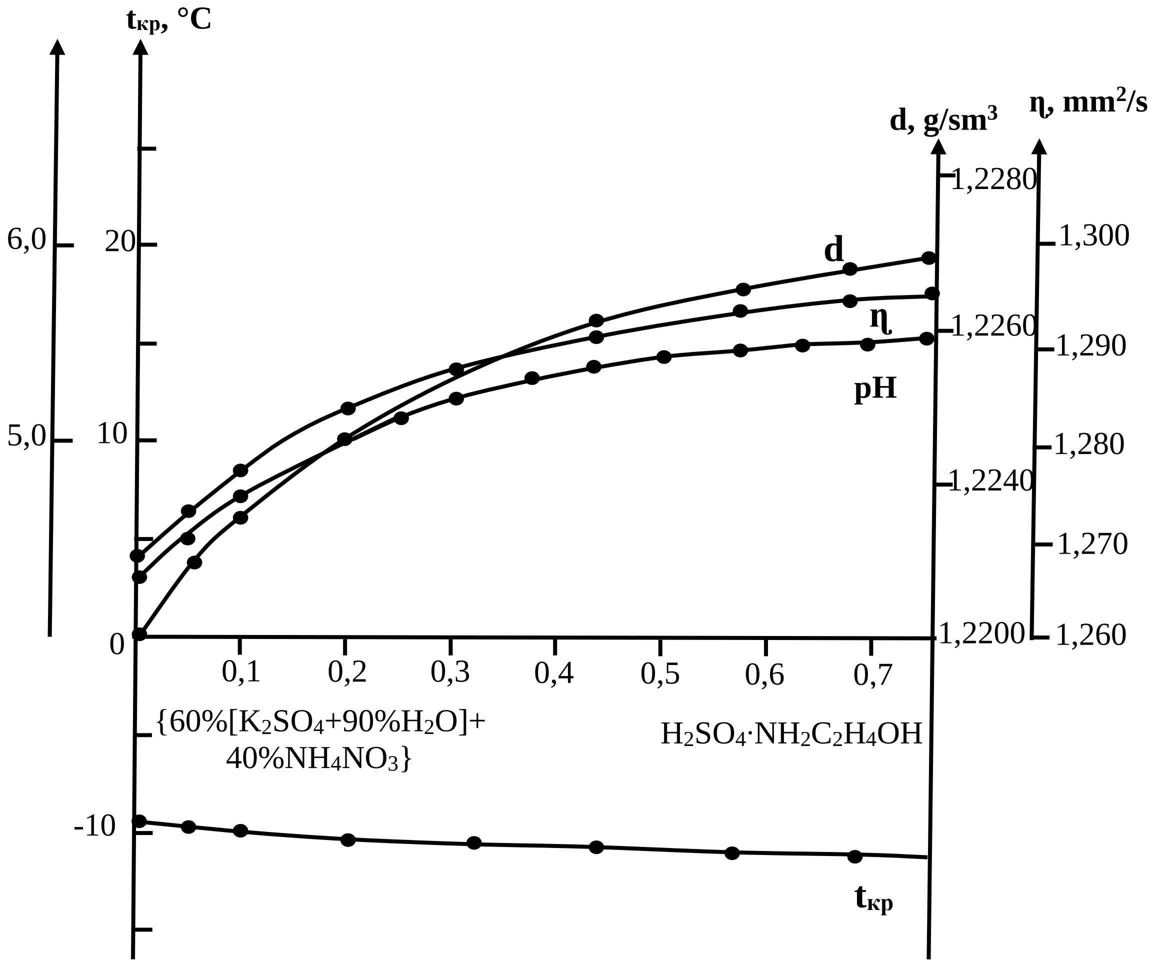

Fig. 2. Composition-property diagram of the $\{60\%[10\%K_2SO_4+90\%H_2O]+40\%NH_4NO_3\}$-$H_2SO_4 \cdot NH_2C_2H_4OH$ system

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Table 2 Dependence of changes in the physicochemical properties of solutions from the composition in the system $\{60\%[10\%K_2SO_4+90\%H_2O]+40\%NH_4NO_3\}-H_2SO_4\cdot NH_2C_2H_4OH$

№	Component content, %		$t_{кр}$, °C	d, g/cm^3	η, mm^2/s	pH
	$\{60\%[10\%K_2SO_4+90\%H_2O]+40\%NH_4NO_3\}$	$H_2SO_4\cdot NH_2C_2H_4OH$				
1	100	-	-9,0	1,2200	1,268	4,24
2	99,95	0,05	- 10,0	1,2220	1,273	4,52
3	99,9	0,1	-10,5	1,2233	1,277	4,70
4	99,8	0,2	-11,0	1,2244	1,283	5,00
5	99,68	0,32	-11,5	1,2252	1,287	5,10
6	99,56	0,44	-11,8	1,2258	1,290	5,20
7	99,43	0,57	-12,0	1,2265	1,292	5,30
8	99,31	0,69	-12,5	1,2268	1,294	5,49

Analysis of the diagram shows that as monoethanolammonium sulfate is added to the initial solution of the composition $\{60\%[10\%K_2SO_4+90\%H_2O]+ 40\%NH_4NO_3\}$, the crystallization temperatures of the newly formed solutions gradually decrease $t_{кр}$, from -9.0˚C to -12,5˚C. The values of density, viscosity and pH of the solutions gradually increase. Rani carried out agrochemical tests it was found that the optimal rate of monoethanolammoniumsulfate as PAS is 0.2-0.3%. The obtained results of the study of this system and the results of agrochemical tests indicate the possibility of obtaining a liquid fertilizer containing PAS by dissolving monoethanolammonium sulfate in an initial solution based on potassium sulfate and ammonium nitrate at a mass ratio of 1.0:0,002-0.003. The resulting solution has a crystallization temperature of -11,0-11,5˚C, a density of 1.2244-1225 g/cm^3, a viscosity of 1.283-1.287 mm^2/s and a pH of 5.0-5.1.

An inseparable component of measures to increase the productivity of agricultural crop is the use of microelements, since the use of only mineral and organomineral fertilizers is not enough for the normal development of plants. The role of trace elements in plant nutrition is multifaceted. Trace elements increase the activity of many enzymes and enzyme systems in the plant body and improve the use of macrofertilizers and other nutrients from the soil by plants [13]. With the aim of introducing a microelement into the composition of the resulting fertilizer, the dependence of the change in the rheological properties of solutions in the system $\{59.6\%[10\%K_2SO_4+90\%H_2O]+40\%NH_4NO_3+0.3\%H_2SO_4\bullet NH_2C_2H_4OH\}-CuSO_4\bullet 5H_2O$ by measuring the crystallization temperature, density, viscosity and pH of the solution medium. On the basis of the data obtained, the diagram «composition-property» of the system was constructed (Fig.3, Table 3).

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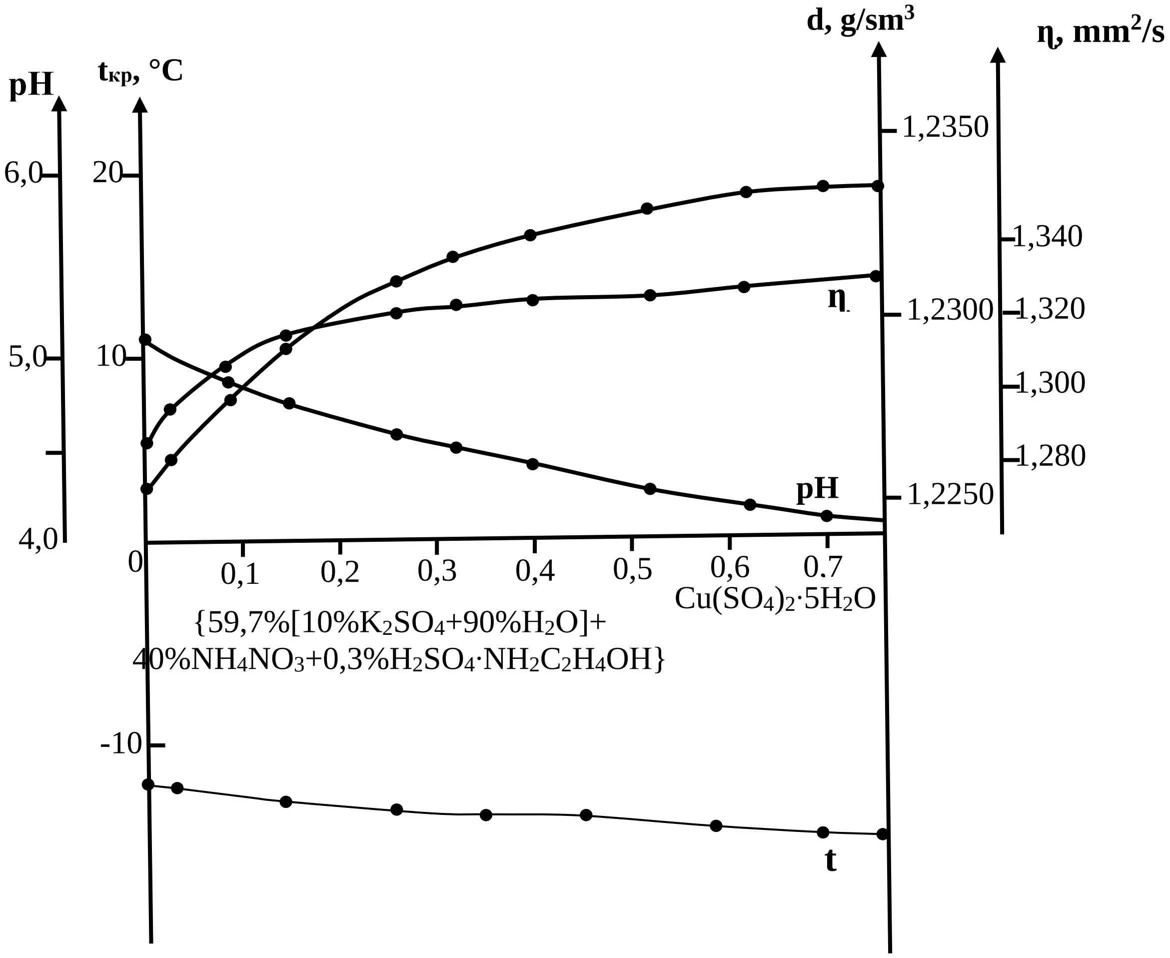

Fig. 3. Composition-property diagram of the system {59,7%[10%K_2SO_4+ 90%H_2O]+40%NH_4NO_3+0,3%H_2SO_4·$NH_2C_2H_4OH$}- $CuSO_4$•5H_2O

Table 3. Dependence of changes in the physicochemical properties of solutions on the composition of components in the system {59,7%[10%K_2SO_4+90%H_2O] + 40%NH_4NO_3+0,3%H_2SO_4·$NH_2C_2H_4OH$}-$CuSO_4$•5H_2O

№	Component content, %		$t_{кр}$, °C	d, g/cm^3	η, mm^2/s	pH
	{59,7%[10%K_2SO_4+90%H_2O]+ 40%NH_4NO_3+0,3%H_2SO_4·$NH_2C_2H_4OH$}	$CuSO_4$• 5H_2O				
1	100	-	-11,5	1,2252	1,287	5,10
2	99,97	0,03	-11,7	1,2262	1,297	5,00
3	99,91	0,09	-12,0	1,2277	1,315	4,87
4	99,85	0,15	-12,2	1,2292	1,316	4,75
5	99,74	0,26	-12,4	1,2310	1,317	4,58
6	99,68	0,32	-12,5	1,2317	1,322	4,50
7	99,60	0,40	-12,8	1,2323	1,325	4,40

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8	99,48	0,52	-13,0	1,2330	1,326	4,26
9	99,39	0,61	-13,5	1,2335	1,327	4,18

Analysis of the diagram shows that no breaks are observed on the curves of composition-crystallization temperature, density, viscosity, and pH of this system, that is, within the studied concentration limits, changes in crystallizing solid phases do not occur in the system and the components retain their individuality, and therefore physiological activity. The physico-chemical properties of the obtained liquid fertilizer have the following parameters: crystallization temperature t_{cr}=-12,0°C, density d=1.2300 g/cm^3, viscosity η=1.317 mm^2/s, pH=4.58 and content mass. %: N= 14.07; K_2O=3.21; S=1.84; FAM=0.3; Cu=0.02.

IV.CONCLUSION

Thus, based on the results of the studied systems and preliminary agrochemical tests of various compositions, it follows that in order to obtain a liquid fertilizer of complex action containing a trace element (Cu), it is necessary to dissolve copper sulfate at a mass ratio in the initial solution, based on potassium sulfate, ammonium nitrate, monoethanolammonium sulfate 1,0:0.001÷0.002.

The resulting fertilizer solution has the following physical and chemical properties: blue solution, t_{cr}=-12°C, d=1.2300 g/cm^3 , η=1.317 mm^2/s, pH=4.58 and contains mass.%: N= 14.07; K_2O=3.21; S=1.84; FAV=0.3; Cu=0.02.

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