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OBTAINING LIQUID FERTILIZERS WITH PHYSIOLOGICALLY ACTIVE SUBSTANCES

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Abstract
The paper substantiates the process of obtaining liquid fertilizers based on solutions of potassium sulfate, ammonium nitrate, urea, copper sulfates, and monoethanolammonium. The dependence of changes in the physicochemical properties of solutions on the composition of the components is studied. Based on the data obtained, diagrams of "composition-properties" are constructed.

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

Introduction

For normal growth, development and creation of high yields of plants, along with nitrogen-phosphorus, potassium fertilizers are necessary, which contribute to the normal course of vital processes in the plant organism. Deficiency of mobile forms of potassium in the soil reduces the yield, worsens the absorption of nitrogen and phosphorus fertilizers.

The range of produced potassium 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 affect the yield and quality of many industrial crops. Its use is especially unfavorable in the conditions of Central Asia, where most soils are of the gray earth type, prone to chloride salinization.

Among chlorine-free forms of potassium fertilizers, potassium sulfate, which supplies plants with potassium and sulfur, has the greatest production and use prospects. Potassium sulfate is a valuable chlorine-free fertilizer. Potassium sulfate has a much more effective effect on the size of the harvest and its quality if it is used in combination with nitrogen and phosphorus fertilizers. After using potassium sulfate in cultivated fruits, vegetables and berries, the content of sugars and vitamins increases significantly, the resistance of plants to various diseases increases, and the percentage of damage to finished products by heart and gray rot decreases. Potassium sulfate must be used as a fertilizer to ensure a successful wintering of perennial plants. By feeding fruit and berry trees and shrubs with potassium sulfate in the fall, you can expect that they will survive even the most severe frosts with minor losses [1].

One of the effective ways of producing mineral fertilizers is to obtain them in liquid form. The production of such fertilizers leads to a reduction in a number of processes and, compared to solid fertilizers, to a noticeable reduction in costs.

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

Results and their discussion

To substantiate the process of obtaining liquid fertilizer based on a solution of potassium sulfate and ammonium nitrate, the dependence of the change 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.

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

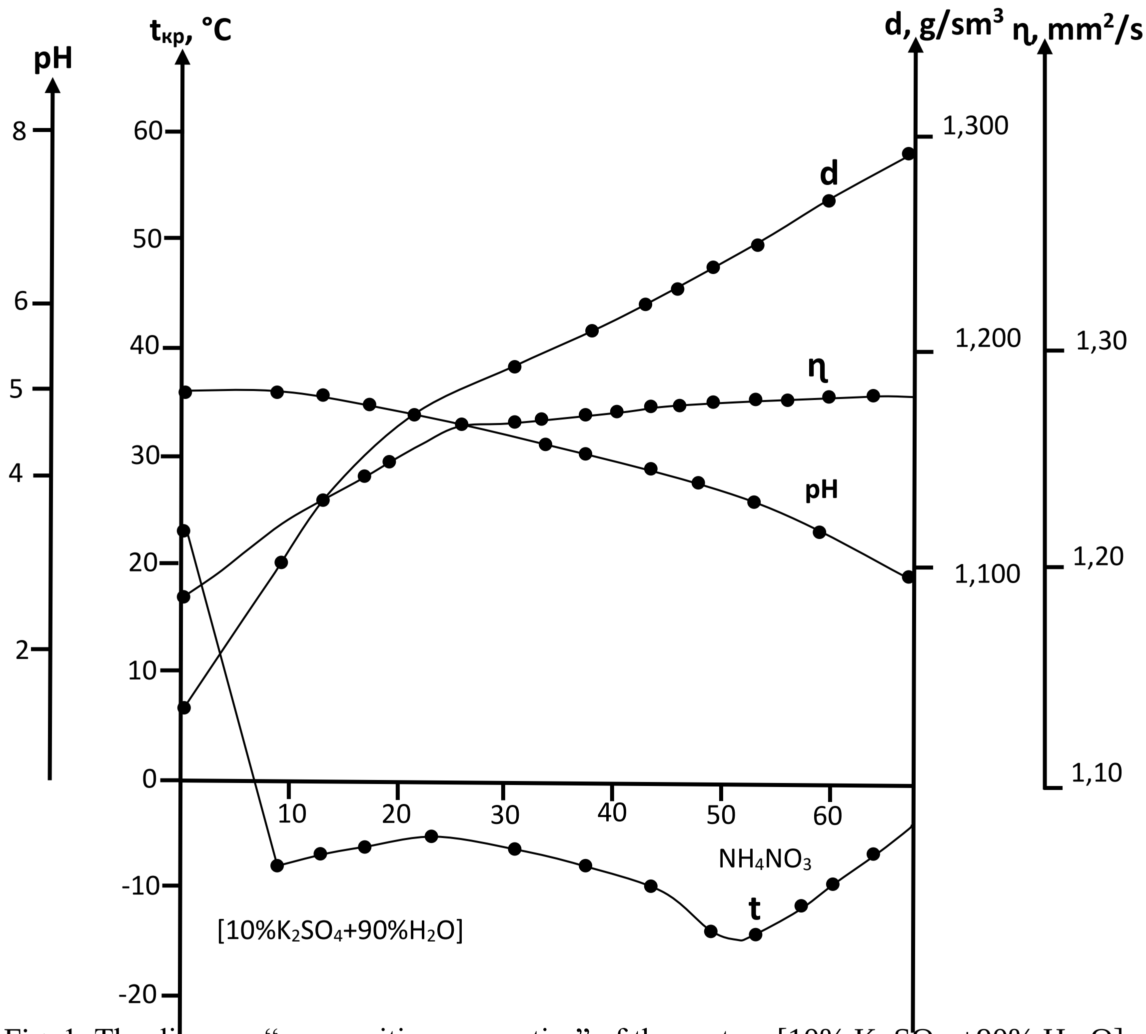

Fig. 1. The diagram “composition-properties” of the system [10% K_2SO_4 +90% H_2O] - NH_4NO_3

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webofjournals.com/index.php/5

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According to the obtained data, the composition-temperature crystallization diagram is characterized by the presence of three crystallization branches with obvious kinks in the solubility curve. The first branch corresponds to the crystallization of K2 SO 4 and continues up to 9.4% ammonium nitrate content. In the ammonium nitrate concentration range of 9.4÷50.0%, K2SO4 and NH4NO3 crystallize in the system. With increasing nitrate content,
more than 50% of ammonium in the system crystallizes 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 potassium sulfate solution, the pH values of the newly formed solutions gradually decrease. The density and viscosity values of the system's solutions gradually increase, respectively: 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 physical and chemical properties: crystallization temperature -9.0°C, density 1.22 g/cm3 , viscosity 1.268 mm2 / s and pH 4.24.
It is known that physiologically active substances are currently widely used to obtain high yields with good qualities.
(auxins, kinins, gibberellins and others), which have 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 also promote the synthesis of protein and nucleic acids.
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 essential nutrients by plants, increase crop yields, reduce the ripening period and improve the quality of products [7,8].
The most effective, economically and agrochemically feasible method of using physiologically active substances is their combined use with basic fertilizers. This eliminates the additional costs of applying each preparation separately, achieves their uniform distribution in the soil and increases the efficiency of fertilizers [9-12].
Thus, the combined use of physiologically active substances with fertilizers improves the use of all mineral nutrition elements and increases the efficiency of fertilizers. Therefore, research on obtaining more effective forms of fertilizers that contain physiologically active substances along with the main nutrition elements is relevant.
To obtain a liquid fertilizer containing such nutrients as K_2O , S , N , and also the FAS monoethanolammonium sulfate, the physicochemical properties of solutions in the system {60%[10% K_2SO_4 +90% H_2O] + 40% NH_4NO_3 }- $H_2SO_4 \cdot NH_2C_2H_4OH$ were studied .
Based on the obtained data, a "composition-properties" diagram of the system was constructed (Fig. 2).
The 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_{cr} from -9.0°C to -12.5°C. The values of density, viscosity and pH of the solutions gradually increase. Previously conducted agrochemical tests have established that the optimal rate of monoethanolammonium sulfate as a FAS 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 FAS by dissolving monoethanolammonium sulfate in the 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÷1.2252 g/cm3 ، a viscosity of 1.283÷1.287 mm2 / s and a pH of 5.0÷5.1.

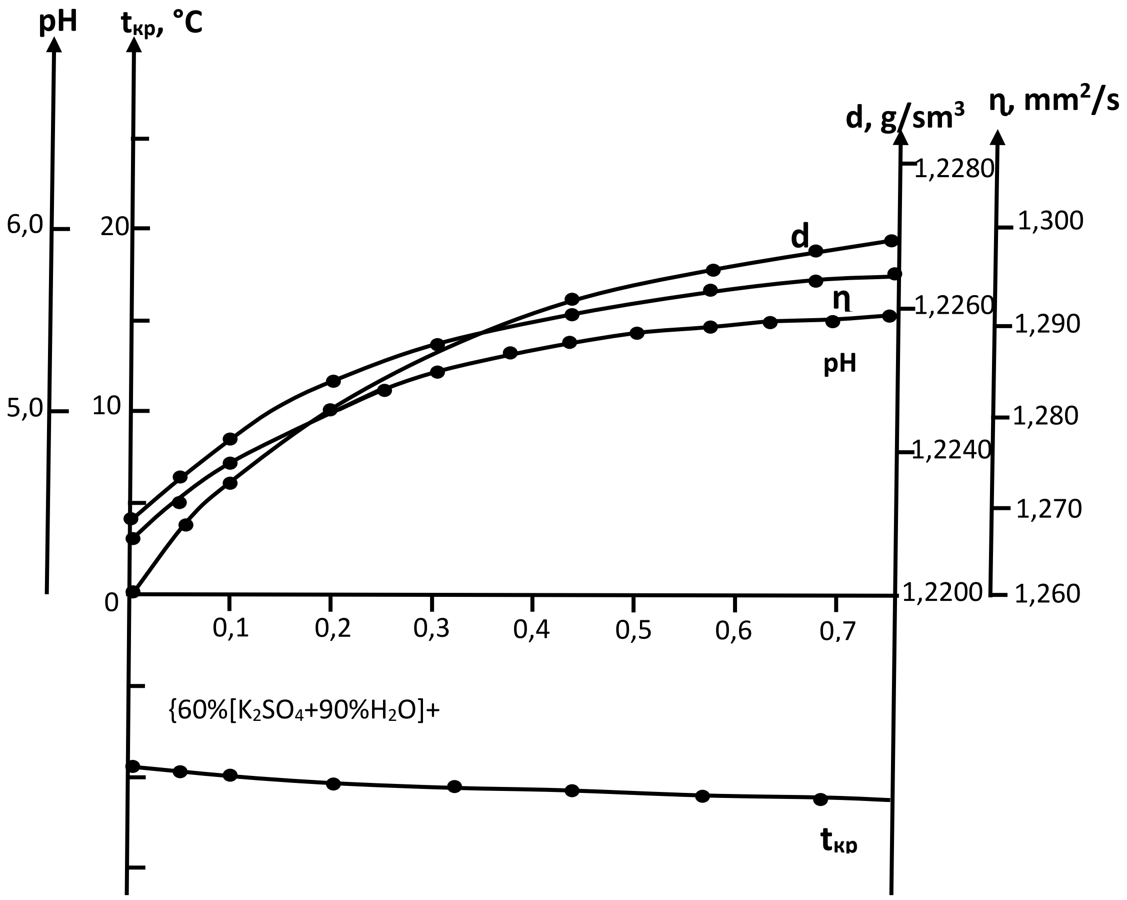

Fig.2. Composition-properties diagram of the system {60%[10% K_2SO_4+90%H_2O]+40% NH_4NO_3}- H_2SO_4 · $NH_2C_2H_4OH$

An integral part of measures to increase the yield of agricultural crops is the use of microelements, since for the normal development of plants the use of only mineral and organomineral fertilizers is insufficient. The role of microelements in plant nutrition is multifaceted.

Microelements increase the activity of many enzymes and enzyme systems in the plant organism and improve the use of macronutrients and other nutrients from the soil by plants [13].

In order to introduce a microelement into the composition of the obtained fertilizer, the dependence of the change in the rheological properties of solutions 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 by measuring the crystallization temperature, density, viscosity and pH of the solution medium. Based on the data obtained, a “composition-properties” diagram of the system was constructed (Fig. 3).

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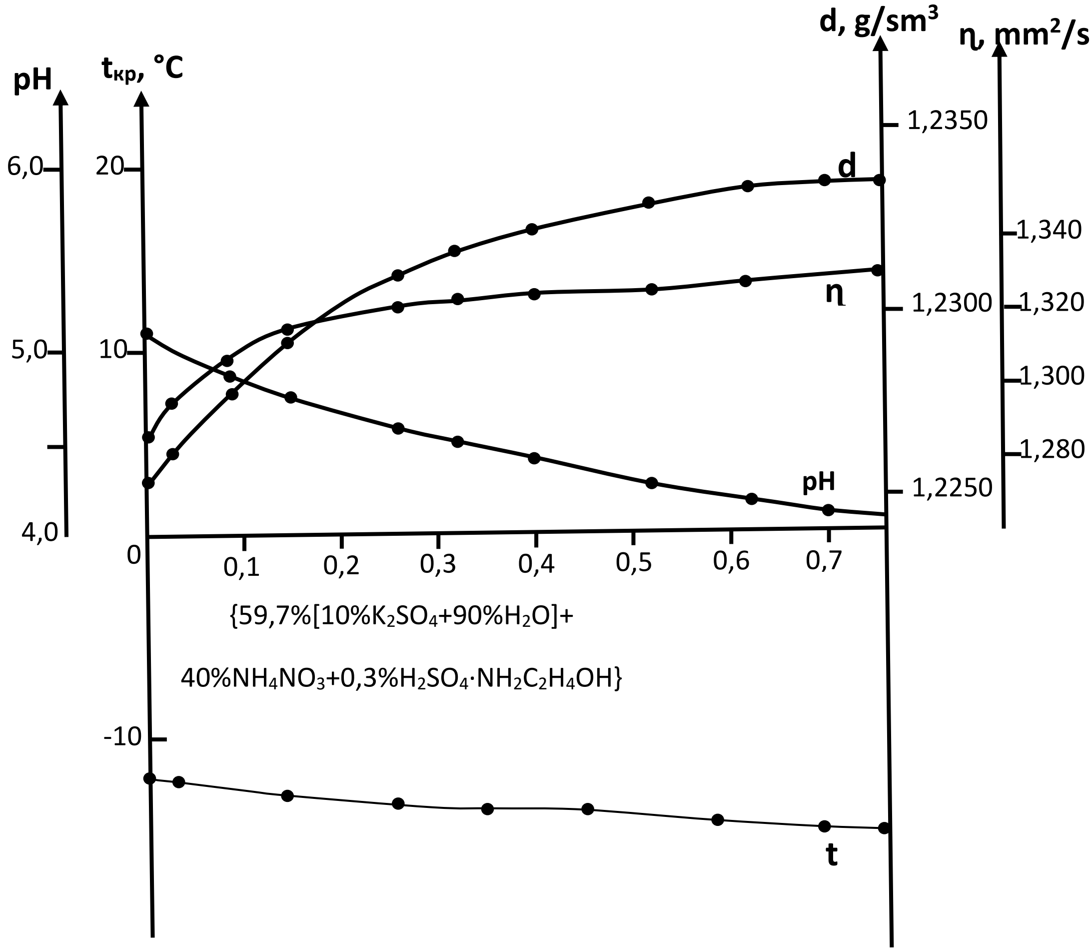

Fig .3. Composition-property diagram of the system {59.7 % [10% K_2SO_4 +90% H_2O] + 40% NH_4NO_3 + 0.3% $H_2SO_4 \cdot NH_2C_2H_4OH$ }- $CuSO_4 \cdot 5H_2O$

Analysis of the diagram shows that there are no breaks in the composition-crystallization temperature, density, viscosity and pH curves of this system, that is, within the studied concentration ranges in the system, no changes occur in the crystallizing solid phases and the components retain their individuality, and therefore their physiological activity.

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 microelement (Cu), it is necessary to dissolve copper sulfate in the initial solution based on potassium sulfate, ammonium nitrate, monoethanolammonium sulfate in a mass ratio of 1.0:0.001÷0.002.

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

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