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RESEARCH ON THE STUDY OF PHYSICAL AND CHEMICAL PROPERTIES OF CALCIUM NITRATE BASED ON LIQUID FERTILIZERS.

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Abstract: the article has been carried out on physicochemical properties in binary, ternary and quaternary systems and over a wide temperature range in the presence of calcium nitrate and other fertilizers using the polythermal method and its physicochemical properties such as geometric position, density, concentration and viscosity, electrical conductivity changes were detected.
Keywords: calcium nitrate, liquid fertilizer, viscosity, electrical conductivity, density, polytherma, temperature.

One of the most effective ways to produce mineral fertilizers is to produce them in a liquid form. By enriching the composition of liquid fertilizers with physiologically active substances, it is possible to increase the efficiency. It is especially noteworthy that when liquid fertilizers are applied to the soil, first of all, it is necessary to avoid excessive costs, and secondly, it is relatively easy for plants to absorb the nutrients of the fertilizer. Much attention is paid to the provision of agriculture with new types of liquid fertilizers with a complex effect. Liquid complex fertilizers have a number of advantages over solid fertilizers: they do not dust, are not sticky, are characterized by free flow, production technology and assembly of equipment are simple. The simplicity of placement of devices and the implementation of additional stages in the technological process (drying, evaporation, granulation) reduces the cost by 2-3 times compared to the process of obtaining granulated fertilizers. Solubility polymers are used in the study of physical and chemical properties of liquid complex fertilizers.

Studies on the solubility polytherm of the calcium nitrate-urea-water triple system show that a complete diagram of this system can be constructed in the temperature range from -29,3 to 120^{0}C. This polytherma shows the boundaries of the crystallization area of the following 9 phases: ice, α - , β - , γ – modified urea, $CO(NH_2)_2 \cdot Ca(NO_3)_2$, $CO(NH_2)_2 \cdot Ca(NO_3)_2 \cdot 3H_2O$, hydrated and dehydrated forms of calcium nitrate.

Tables 1 and 2 below shows the electrical conductivity and viscosity values of $4CO(NH_2)_2 \cdot Ca(NO_3)_2$ solution depending on the solution temperature and salt concentration. We will be able to have a lot of information using these values.

$4CO\ (NH_2)\ 2 \cdot Ca(NO_3)_2$ The electrical conductivity of changes in straight lines at high temperatures. It can be observed that the electrical conductivity decreases as the concentration of the solution increases

Table 1 Electrical conductivity of $4CO(NH_2)_2{\cdot}Ca(NO_3)_2$ solution 10^{-4}, ohm^{-1}, sec^{-1}

Temperature, ^OC	Solution concentration, %			
	50	60	70	75
90	1615	1275	925	710
80	1450	1140	815	620
60	1120	875	600	440
40	800	600	380	260

The viscosity of this solution is directly proportional to the concentration of the solution and inversely proportional to the temperature.

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Table 2 Viscosity of solution $4CO(NH_2)_2 \cdot Ca(NO_3)_2$

Temperature, ^{O}C	Solution concentration, %			
	50	60	70	75
90	0,50	1,10	1,90	2,40
80	0,65	1,20	2,30	3,00
60	1,05	1,60	3,40	4,50
40	1,40	2,40	5,00	6,50

Ammonia, along with liquid ammonia and ammonia water, belongs to the class of unilateral liquid nitrogen fertilizers and represents ammonia or aqueous ammonia solutions of nitrogenous substances (salt, urea).
The nitrogen unit in liquid nitrogen fertilizers is much lower than in solid fertilizers. In order to prevent nitrogen loss, ammonia water, ammonia, and especially anhydrous ammonia should be placed in the soil at a depth of not less than 10 cm.
The disadvantage of liquid nitrogen fertilizers is the need for vehicles to build and store special tanks for their storage and transportation. $Ca(NO_3)_2$-NH_4NO_3-NH_3-H_2O system can be used in the production and storage of ammonia with the following composition for the specified solubility indices.

Table 3SYSTEMATIC SOLUTION: $Ca(NO_3)_2$-NH_4NO_3-NH_3-H_2O

Balanced solution composition, %				Mass dependence NH_3: NH_3+H_20
NH_4N0_3	$Ca(N0_3)_2$	NH_3	H_20	
At 11 °C				
29,67	39,33	11,8	19,2	0,3806
27,1	42,87	14,45	15,58	0,4769
At 20 °C				
37,13	32,12	11,78	18,97	0,3830
30,49	40,74	14,35	14,42	0,4988
At 30 °C				
34,75	40,75	8,1	16,4	0,3306
35,56	36,75	13,31	14,38	0,4807
At 40 °C				
42,94	32,42	8,83	15,81	0,3584
39,34	38,42	10,96	12,88	0,4597

It can be seen from this table that the total solubility of NH_4NO_3 + $Ca(NO_3)_2$ salts increases with increasing temperature. As the ratio of NH_3 : NH_3 + H_2O in the solution increases, the total solubility of the salts does not change, which may be explained by the formation of secondary salts of NH_4N0_3-$Ca(NO_3)_2$ in the primary phase.

Table 4
A number of physicochemical properties of calcium nitrate-based ammonia

The composition of the mixture, %				Viscosity	Density, g/sm^3
NH_4N0_3	$Ca(N0_3)_2$	NH_3	H_20		
27,33	24,65	18,05	29,97	3,67	1,204
29,89	27,47	20,18	22,46	5,62	1,22

To increase the assimilation of nutrients, liquid fertilizers are most often used, as they are often indispensable for feeding and are especially effective during foliar feeding. Liquid fertilizers based on calcium nitrate make up for the lack of a vital element, helps to restore the balance of physiological saline, which affects the root system of plants. Calcium nitrate is widespread in nature, in all cultivated soils and the best form for fertilizing nitrogen in soils.

Calcium nitrate in terms of physical properties is highly hygroscopic and is even superior to ammonium nitrate. Hygroscopic points of $Ca(NO_3)_2 \cdot 4H_2O$ at different temperatures are equal: 15ºC - 55.9%, 20ºC - 55.4%, 25ºC - 50.5%, 30ºC - 46.7%, 40 ° C - 35.5% .[1] As you can see, with decreasing temperature, hygroscopicity increases, and this is one of the main disadvantages of this fertilizer. In order to increase resistance to hygroscopicity, the fertilizer surface is treated with calcium carbonate (up to 6%), or with paraffin oil (up to 2%), and stored in closed dry warehouses in tarred paper bags [2]. But at the same time, the nitrogen concentration decreases more, that is, when one of the deficiencies is eliminated, another is formed. In liquid fertilizers, such a drawback is not observed, since all components are dissolved.

To increase the mass fraction of nitrogen, the $Ca(NO_3)_2 \cdot NH_4NO_3 \cdot H_2O$ system is used. In fig. 1. A diagram of the solubility of the system is shown as a function of the mass fraction of nitrogen.

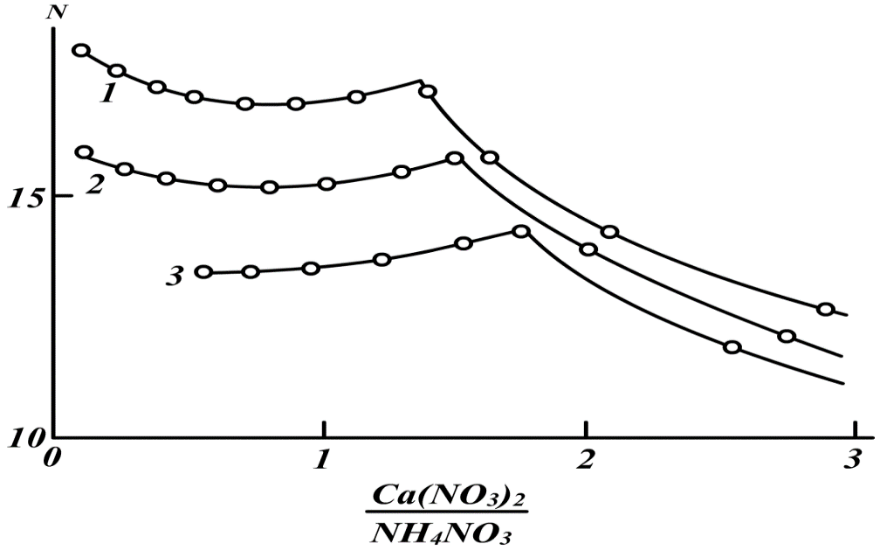

Fig. 1. Nitrogen isotherms in the $Ca(NO_3)_2 \cdot NH_4NO_3 \cdot H_2O$ system.
N- nitrogen content (%). Temperature (^{0}C): 1 - 0; 2 - (-10); 3 – (-20)

It follows from them that the maximum nitrogen content in solutions with negative crystallization temperatures occurs in the absence of calcium nitrate. However, in the crystallization region of ammonium nitrate (the left branch of the curves), the presence of calcium nitrate has very little effect on the change in nitrogen content. So, at a temperature of -10° C, a pure solution of ammonium nitrate contains 16.8% nitrogen, with the addition of calcium nitrate to a ratio of 1.5 to ammonium nitrate, the nitrogen content becomes 15.8%. Thus, in the system under consideration, low-temperature compositions have an insufficient nitrogen content so that they can be used as liquid nitrogen fertilizers.

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