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Rheological Properties of Chelate Calcium at Various Concentrations

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ABSTRACT:The relative densities and viscosities of calcium chelate solutions of various concentrations were studied at temperatures of 10, 20, 30, 40, and 50 ° C. The refractive index, pH, and crystallization temperature were determined at standard temperature. The stability of calcium chelate solutions in a closed system for 60 days was studied.

KEY WORDS: density, viscosity, rheology, calcium chelate, stability of solutions, refractive index, crystallization temperature.

I.INTRODUCTION

To date, in our country there are no facilities for the production of complex salts of macro- and microelements based on local raw materials, and the research is not well understood. Therefore, our study is devoted to complex salts of macro- and microelements.
The increased digestibility of metal complexonates is due to the fact that the microelement is introduced in a biologically active form and has a high membrane permeability. Plants absorb metal complexonates much better and more efficiently, in comparison with salts of trace elements, which in the soil can cross-react and form compounds that are not absorbed by the plant. The most famous and used metal complexonate is ethylenediaminetetraacetic acid (EDTA), which firmly and reversibly binds divalent cations [1].
A balanced plant nutrition with macro- and microelements controls numerous metabolic processes and plays a key role in the formation of the crop and its quality. To date, considerable practical experience has been accumulated, testifying to the real possibility of targeted regulation of the conditions of mineral nutrition of plants to obtain products of a given qualitative composition [2].
For the correct choice of technological modes of production processes, knowledge of the rheological properties of microfertilizers is necessary. In this regard, an important stage of preliminary research in the implementation of a particular technological process is the conduct of special rheological tests of these systems.
The aim of the study is to determine the technological parameters of production by studying the rheological properties of calcium chelate solutions of various concentrations. To increase the duration of storage and transportation, their stability in certain periods of time was studied.

II. LITERATURE SURVEY

The conditions for the synthesis of calcium complex salt in 10, 20, 30, 40, 45% mother liquors at temperatures of 20, 40, and 60°C were studied. The optimal values of the synthesis technological process were obtained, such as the concentration of the starting reagents, time and pH[3].
In the synthesis of calcium chelate in different molar ratios it was found that the optimalmolar ratio of 99.72% calcium chelate and without additional substances is 1,0:1,0. To justify the synthesisof calcium disodium EDTA, its optimal mol amount and pH value were determined [4].

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III. METHODOLOGY

Density measurements. The density of the solutions is usually determined by a pycnometer. The method consists in determining the volume of liquid whose mass is known. In accordance with GOST 7465–55 [5], pycnometers are available in 1, 2, 3, 5, 10, 25, 50, 100 cm^3.
The results of all weighings determine the density of the liquid [6]:

$$\rho_{liq} = \frac{Q_3 - Q_1}{Q_2 - Q_1} Q_w$$

Where, ρ_w- is the density of water at the test temperature; Q_1 — mass of dry empty pycnometer; Q_2- is the mass of the pycnometer filled with water to the mark.
Density measurements for all solutions were made in triplicate, and mean values were reported for further analysis.
Kinematic viscosity measurements. This test method establishes a procedure for simultaneously measuring kinematic viscosity on a VPZh-2 viscometer. The kinematic viscosity ν, mm/s, is calculated by the formula [7]:

$$\nu = C \cdot \Delta t$$

where, C - is the constant of the viscometer, mm/s; Δt - is the arithmetic mean of the expiration time, s.
Refractive index measurements. Refraction indicators of calcium chelate solutions were measured using a digital refractometer (PAL-BX / RI) at a temperature of 293.15 K. This automatic digital refractometer had a point-to-point calibration of level I and was in accordance with the manufacturer's requirements with a stated error of ± 0.0001 refractive index [8]. Refractive index measurements were made in triplicate and average values were recorded.
Determination of crystallization temperature. The crystallization temperature is determined by the temperature stop or graphical method [9]. To determine the crystallization temperature in the range from room temperature to minus 35 ° C, the assembled device is lowered into a dewar vessel or a bath filled with a cooling mixture with a temperature 3-5 ° C lower than the expected crystallization temperature.
pH measurements of solutions. CIPAC MT 75.3 [10] and OPPTS 8307000 [11] describe methods for determining the pH of a chemical or a 1% (w / v) aqueous solution or dispersion of a chemical using a pH meter, electrodes and calibration solutions. The pH of the solutions was determined on a pH meter FE 20 METTLER TOLEDO.

IV.MATERIALS

To study the rheological properties of calcium chelate solutions, the “cl” grade calcium disodium salt of ethylene diamine tetraacetic acid was used and chemical identification CAS No. 23411-34-9. Conducted an appropriate chemical analysis. The content of Na_2EDTA^{2-} ions was determined by the method of [12] titration with a solution of magnesium salt, the amount of Na^+ and Ca^{2+} ions, respectively, by atomic absorption [13] and permanganometric [14] analysis methods. To study the rheological properties of calcium chelate solutions, 25, 30, 35, 40, 45, and 50% EDTA stock solutions were prepared.

V. EXPERIMENTAL RESULTS

This study examined rheological properties at constant and different temperatures.
To determine the viscosity and density of calcium chelate, 25%, 30, 35, 40, 45, and 50% solutions were prepared. In laboratory conditions, the densities and viscosities of the above percentages of calcium chelates at various temperatures were checked using appropriate methods. The results of the study of density and viscosity at different temperatures are shown in table 1. The measurements were carried out in the temperature range from 10 to 50 ° C. A diagram of the dependence of viscosity and density on various concentrations of calcium chelate with different temperatures was constructed (Fig. 1).

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Table 1. The results of the study of density and viscosity at different temperatures

Index			The concentration of calcium chelate, (%)				
			25	30	35	40	45
Temperature, °C	Viscosity, cP	10	1,4277	1,5224	1,9602	2,7806	3,8606
		20	1,3064	1,4822	1,8614	2,5738	3,4699
		30	1,2041	1,3960	1,7373	2,3670	2,1250
		40	1,0789	1,2799	1,6201	2,0350	2,5508
		50	0,9491	1,2466	1,5052	1,8270	2,2912
	Density, g /cm^3	10	1,191	1,228	1,257	1,290	1,323
		20	1,188	1,223	1,252	1,286	1,316
		30	1,186	1,218	1,248	1,282	1,308
		40	1,184	1,212	1,244	1,277	1,301
		50	1,182	1,207	1,239	1,273	1,295

The results of the study show that with an increase in the concentration of calcium chelate, the viscosity of solutions increases. For example, at a temperature of 10 ° C, with an increase in the concentration of calcium chelate solution from 25 to 45%, the viscosity of the solutions increased from 1.4277 to 3.8606, respectively. In addition, at constant concentrations of calcium chelate, the viscosity of solutions decreases with increasing temperature of the calcium chelate. For example, for a 25% calcium chelate solution, with an increase in temperature from 10 to 50 ° C, the viscosity decreased from 1.4277 to 0.9491, respectively.
These results are graphically depicted in Figure 1 (a).

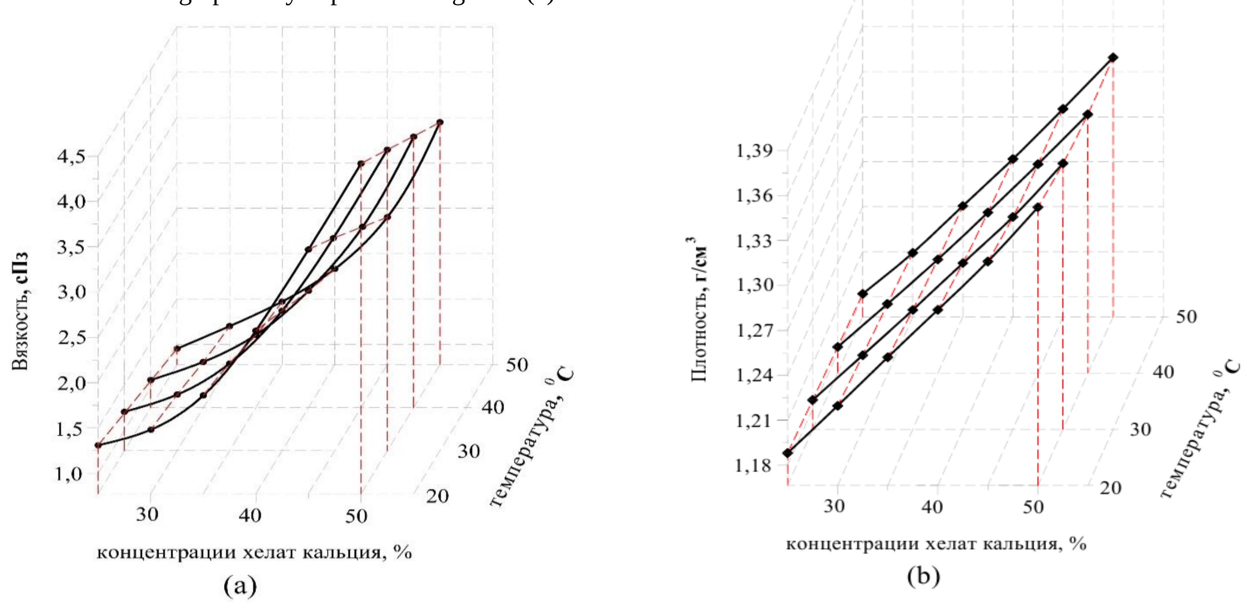

Fig. 1. Dependence of viscosity (a) and density (b) on different concentrations of calcium chelate with different temperatures.

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The results of the study show that with an increase in the concentration of calcium chelate, the density of solutions increases. For example, at a temperature of 10 ° C with an increase in the concentration of the calcium chelate solution from 25 to 45%, the density of the solutions increased from 1.191 to 1.323, respectively. In addition, at constant concentrations of calcium chelate, the flatness of the solutions decreases with increasing temperature of the calcium chelate. For example, for a 25% calcium chelate solution, with an increase in temperature from 10 to 50 ° C, the viscosity decreased from 1.191 to 1.182, respectively. These results are graphically depicted in Figure 1 (b).
In the subsequent stages of the study, we studied the rheological properties of calcium chelate solutions with different concentrations at standard temperatures. Table 2 was compiled and a "composition-properties" diagram of these solutions was constructed based on the measurement of pH and refractive index of light (Fig. 2 and Fig. 3).

Table 2 The results of the study of rheological properties at standard temperature

Index	The concentration of calcium chelate, (%)					
	25	30	35	40	45	50
pH	7,20	7,15	7,10	7,00	6,95	6,88
Light refractive index	1,3690	1,3790	1,3880	1,3955	1,4015	1,4125

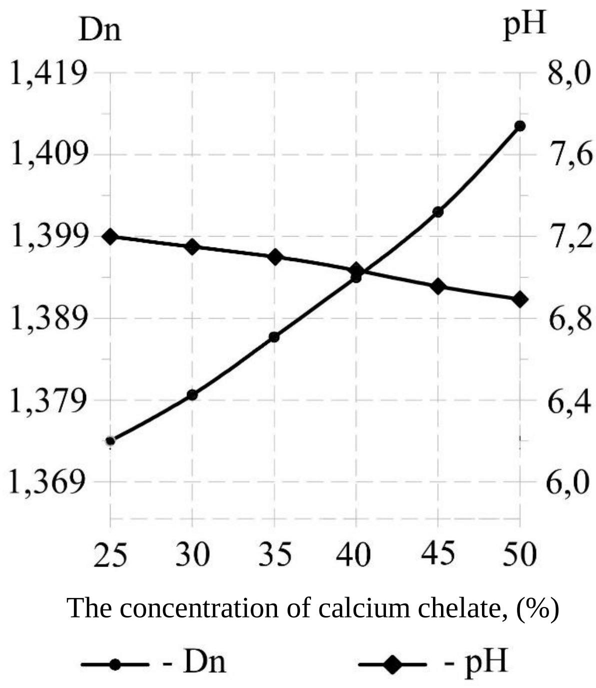

Fig. 2. The diagram "composition-properties" of a calcium chelate at 25 °C depending on various concentrations of calcium chelate. pH -1, refractive index -2, and crystallization temperature -3.

The results of the study showed that with an increase in the concentration of calcium chelate, the pH of solutions decreases, and the refractive index of light increases. Figure 2 shows that with a decrease in the concentration of the solution, the pH increases. When the concentration of calcium chelate solutions decreases from 50% to 25%, their pH increases from 6.88 to 7.2, respectively. This is due to the fact that the more the solution is diluted, the more the amount of free calcium ions in it increases.
We studied the binary system $C_{10}H_{12}CaN_2Na_2O_8$-H_2O in the temperature range from -7.2 to 60.0 °C (Fig. 3).

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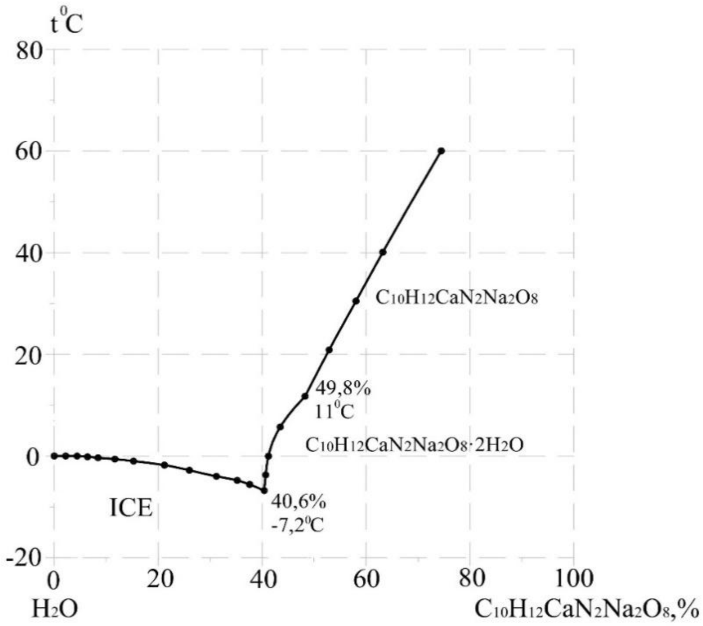

The solubility curve of the system shows branches of ice crystallization in the range from 0 to -7.2 °C, $C_{10}H_{12}CaN_2Na_2O_8$ $2H_2O$ from -7.2 to 11 ° C, and $C_{10}H_{12}CaN_2Na_2O_8$ from 11 to 60 ° C.

VI.CONCLUSION

The results of the study were determined by studying the rheological properties of calcium chelate solutions of various concentrations as the optimal concentration of 35-40% calcium chelate for the production, storage and transportation of liquid and transparent micronutrient fertilizers.

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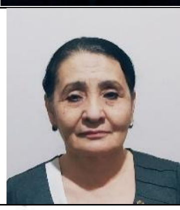
4.	**Akhmadzhonova Manzura Kholdarovna** Senior Researcher, Institute of General and Inorganic Chemistry, Academy of Sciences of the Republic of Uzbekistan, Ph.D., Tashkent, Uzbekistan.	
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