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Research of the Process of Obtaining Environmentally Safe, Water-Soluble Liquid NPK Fertilizers with Regulated Content of Nutrients

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ABSTRACT: In this work, the technology of obtaining environmentally friendly, water-soluble Nitrogenium Phosphorus Kalium-fertilizers with a controlled content of nutrient components has been studied. On the basis of the studies carried out, the optimal compositions of the Liquid Complex Fertilizers containing microelements and growth substances of the following brands were proposed: NPF + TE + GP; NKF + TE + GP; NPKF + TE + GP containing 28-30% of the amount of useful components.

KEYWORDS: System, component, solution, crystallization, density, viscosity, potassium nitrate, ammonium nitrate, carbamide, monoammonium phosphate, liquid, fertilizer.

I. INTRODUCTION

Liquid complex fertilizers are popular all over the world. The USA is considered the leader among the main consumers, Canada is in the second place. Europe and Central Asia use less liquid formulations due to poorly developed infrastructure for storing and applying this type of fertilizer, and this is also mainly due to climatic conditions and the nature of agricultural products grown.

Previously, chemical plants of the former USSR retained the technology and experience in the production of a once highly demanded product - liquid complex fertilizers, which were supplied abroad in almost 100% of their volume.

Liquid complex fertilizers are a necessary product in the innovative technology of intensive farming. The program for the development of agriculture, water saving and the development of drip irrigation provides for the development and involvement in agricultural circulation of lands that have lost their physical properties due to non-core or intensive exploitation. Liquid complex fertilizers, adapted to the assigned tasks, will help in solving this issue [1].

The purpose of this work is to create the theoretical foundations of the technology for the production of environmentally friendly, water-soluble Nitrogenium Phosphorus Kalium- fertilizers with a controlled content of nutrient components.

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Liquid complex fertilizers (LCF) are solutions that contain nutrients. In addition to them, pesticides and growth stimulants can be added to the mixture [2-4]. The advantage of liquid complex fertilizers over solid fertilizers is ease of production and lower costs in terms of capital investment, storage and transportation. The proportion of nutrients that make up the Liquid Complex Fertilizers can be adjusted depending on the properties of the soil.

In [5], we presented the optimal conditions for obtaining liquid fertilizer by nitric acid decomposition of dolomite to obtain, after separation of the insoluble residue, a solution of calcium and magnesium nitrates, followed by enrichment of the latter with ammonium and potassium nitrates

Despite some differences, solid and liquid compound fertilizers have the same effect on crops. Only on calcareous and base-rich soils do Liquid Complex Fertilizers show greater efficiency.

Liquid Complex Fertilizers are in absolute safety, not poisonous and not explosive.

Timely and regular feeding allows you to increase the yield and vitality of crops, accelerate the ripening of fruits and improve their vitamin and mineral composition. In agriculture, the use of liquid complex fertilizers is optimal: it guarantees an accurate dosage and rational use of nutrient formulations. Also, the nutrient components of liquid fertilizers are absorbed faster by the root system and leaves of fruit, cereal and vegetable crops [6].

As shown by the analysis of literature data, the content of the sum of nutrients in the solution at the ratio N: P2O5: H2O = 1: 1: 1 and 1: 2: 1 is 17.02, 10.5% at 15 ° C and 19.0; 18 , 9% at 25 ° C when using potassium chloride, monoammonium phosphate and ammonium nitrate [7,8]. And when using carbamide, phosphoric acid, ammonia, potassium chloride, the amount of nutrient components can be raised to 28%, when replacing carbamide with ammonium nitrate - 17%, and when used together - 22% with a crystallization temperature of 0 ° C [8,9].

II. SIGNIFICANCE OF THE SYSTEM

In this work, the technology of obtaining environmentally friendly, water-soluble NPK-fertilizers with a controlled content of nutrient components has been studied.The study of literature survey is presented in section III, methodology is explained in section IV, section V covers the experimental results of the study, and section VI discusses the future study and conclusion.

III. METHODOLOGY

Fertilizer samples were prepared by dissolving solid components in a thermostated glass reactor at 20-30 ° C. First, we add the calculated amount of water, urea, ammonium nitrate and, after ammonization to the specified value, add Monoammonium phosphate. The obtained Liquid Complex Fertilizers was analyzed for the content of nitrogen, P2O5, and potassium oxide according to well-known methods [10-11]. The specific gravity of the samples of the studied compounds and solutions was determined by the pycnometric method [12] using a 5 cm3 capillary pycnometer. To determine the volume, the pycnometer was filled with bidistilled water, thermostated at 250C, and weighed. Knowing the weight of the dry pycnometer, the density of water at 25 ° C and the weight of the pycnometer filled with water, we calculated its volume. Weighing was carried out with an accuracy of ± 0.00005 mg. The results are presented with an accuracy of ± 0.1 kg / m3.

The pH of the solution medium was measured according to the method [13] on an EV-74 universal ion meter.

The kinematic viscosity of the solutions was determined using a VPZh capillary viscometer [14] with a capillary diameter of 1.16–2.75 mm. Accuracy of results is ± 0.0001 · 10-1 m2 / s

IV. EXPERIMENTAL RESULTS

The compositions of the base solutions in Table 1 were selected based on the analysis of the solubility diagrams (NH4) 2HPO4-NH4H2PO4-H2O [8] CO (NH2) 2-NH4NO3- (NH4) 2HPO4-H2O [8,15], as shown above, one component - MAP (monoammonium phosphate).

The P2O5 content in the liquid phase increases with an increase in the proportion of diammonium phosphate. Therefore, in this work, we first prepared a basic solution, 1.43 after ammonization of which the pH of the solutions is in the range of 4.99-5.08. Therefore, the ammonization process was preliminarily carried out to pH 6.22 and 7.34, respectively, by adding monoammonium phosphate.

The amount of additive was selected in such a way that the crystallization temperature of the obtained liquid complex fertilizers did not increase by more than 10 ° C (table 4).

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Table 1
Composition of liquid complex fertilizers

№ stock solutions	System composition	The content of salt components in the liquid phase, wt.%				Solid phase composition according to X-ray fluorescence analysis data	NutrientRatio N: P2O5	The sum of nutrient components, masses.%
		$CO(NH_2)_2$	NH_4NO_3	$NH_4H_2PO_4$	H_2O			
1	2	3	4	5	6	7	8	9
1	$CO(NH_2)_2$-$NH_4H_2PO_4$-H_2O	35,9	-	12,3	51,8	$CO(NH_2)_2$, $NH_4H_2PO_4$	2,21:1,0	24,4
2	NH_4NO_3-$CO(NH_2)_2$-$NH_4H_2PO_4$-H_2O	36,4	5,1	10,4	48,1	$CO(NH_2)_2$, $NH_4H_2PO_4$	2,94:1,0	25,2
3	NH_4NO_3-$CO(NH_2)_2$-$NH_4H_2PO_4$-H_2O	36,0	11,4	9,1	43,5	$CO(NH_2)_2$, $NH_4H_2PO_4$	3,71:1,0	26,4
4	NH_4NO_3-$CO(NH_2)_2$-$NH_4H_2PO_4$-H_2O	35,1	16,9	6,9	41,1	$CO(NH_2)_2$, $NH_4H_2PO_4$	5,19:1,0	26,6

From the data in Table 1, it can be seen that the N: P2O5 ratios of the stock solutions and the sum of nutrient components are in the range of 2.21: 5.19: 1 and 24.4-26.6%, respectively.

Table 2
Physical and chemical properties of base solutions

Sample numbers correspond. numbers in table 1	**Physical and chemical indicators of base solutions**			
	t_b °C	d g/cm^3	υ mm^2/s	pH
1.	-0.5	1.1700	350,64	5.01
2	-3.5	1.1631	1.3033	5.08
3	-3.3	1.1628	340,0	4.99
4	-3.3	1.1984	384,0	5.04

The crystallization temperature of the base solutions is within
-0.5 - (-3.3°C), and density and viscosity in the range of 1.528-1.1984 g/cm3 and 340-384 mm2/s, respectively.

In order to increase the content of the total nutrient components, Monoammonium phosphate, ammonia, potassium nitrate, a solution of trace elements (TE) and plant growth stimulants (GS) were added to the stock solutions.

To increase the amount of Monoammonium phosphate, the stock solutions were ammoniated to a pH of more than 6.0, and a certain amount of MAP was added. After completion of the addition of ammonia and Monoammonium phosphate, another component, nitrate, was introduced. The process indicator was the crystallization temperature of the compositions.

Table 3 shows that with an increase in the pH of solutions, the crystallization temperature rises from 0.5 to 7.5 ° and with the addition of monoammonium phosphate 0.2-0.3% of the total mass of the base solutions, the crystallization

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temperature also increases by 0.5- 1.0 ° C simultaneously with a decrease in the pH of the system by 0.13-0.3. With the addition of MAP, the density and viscosity of the samples increase by 10-20 kg / m3 and 15-16 mm2/s, respectively.

Table 3
Physicochemical indicators of liquid complex fertilizers obtained on the basis of basic solutions (Table 1)

Rheology after ammonization					Rheology after adding MAP				
№	t_b °C	d r/cm³	υ mm²/c	pH	Σ MAP adding, %	t_b °C	d g/cm³	υ mm²/c	pH
1	-0.5	1.1363	337	5.78	2	-0.5	1.1386	378,64	5.6
1^1	1	1.353	442,64	6.22	4	1.8	1.1463	338,64	6.09
1^2	3.2	1.491	386,64	6.63	6	3.8	1.1552	302,08	6.47
1^3	7.5	1.1556	433,32	7.54	8	8.5	1.1649	149,66	7.24
1^4	32	1.1587	461,32	7.74	10	30	1.1721	163,0	7.46
2	0.5	1.1457	337,32	6.16	2	1	1.1401	340,0	6.02
2^1	2	1.1514	336,0	6.58	4	3	1.1665	381,32	6.38
2^3	4	1.1703	412,0	6.73	6	3.5	1.1587	426,64	6.55
2^4	6	1.1642	421,32	7.07	8	5	1.1663	449,32	6.88
2^5	54	1.1587	411,0	7.34	10	80	1.1801	504,0	7.16
3	-1	1.1630	392,0	6.32	0,4	17	1.1670	396,0	6.03
3^1	1.5	1.1682	460,0	6.69	0,8	7	1.1914	440,0	6.41
3^2	55	1.1547	470,64	7.09	1,2	-	1.1815	449,6	6.82
4	-1	1.1756	386	6.42	0,5	38	1.1943	396	5.99
4^1	-	1.1891	394,4	6.8	1,1	-	1.1864	438,6	6.62

Table data. 4 show that the content of the sum of nutritional components rises to 28-30%.

In order to obtain Nitrogenium Phosphorus Kalium- fertilizers containing microelements and plant growth stimulants, we add potassium nitrate, microelements of nitrate salts and physiological substances to the obtained Liquid Complex Fertilizers.

The composition and physicochemical index of the obtained microelements and physiologically active substances containing liquid fertilizers are given in Table 4.

Table 4
Physicochemical indicators of liquid chlorine-free complex fertilizers containing nitrogen-phosphorus, nitrogen-potassium, nitrogen-phosphorus-potassium, trace elements and growth substances

№	The name of indicators	1	2	3
1	Appearance	colorless liquid	colorless liquid	colorless liquid
2	Mass fraction of total nitrogen at the border , %	21,66	22,63	21,04
3	Mass fraction of P2O5 at the border , %	5,62	-	5,22
4	Mass fraction of K2O at the border , %	-	5,68	3,25
5	Mass fraction of growth weights , %	1,0	1,0	1,0
6	Mass fraction of microelements CuO and ZnO at the border , %	0,03	0,03	0,03
7	The sum of nutritional components wt , %	27,28+0,2+1,0 Σ 28,48	28,31+0,2+1,0 Σ 29,51	26,26+0,2+1,0 Σ 27,46
8	Hydrogen pH not lower than	6,68	6,35	6,99
9	Density at 20 ° C, not less , g/cm³	1,2234	1,2534	1,2672
10	Crystallization temperature , °C	1,0	+10	8,0

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V. CONCLUSION AND FUTURE WORK

Thus, on the basis of the studies carried out, the optimal compositions of Liquid Complex Fertilizers containing microelements and growth stimulators of the following brands have been proposed: NPF + TE + GP; NKF + TE + GP; NPKF + TE + GP containing 28-30% of the amount of useful components.

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REFERENCES

[1].S. Kramerev, L. Bondura. Comparative evaluation of the effectiveness of solid and liquid complex fertilizers. Proposition - The main magazine on agribusiness issues. # 7., 2019. -pp. 25-33. https://propozitsiya.com/sravnitelnaya-ocenka-effektivnosti-tverdyh-i-zhidkih-kompleksnyh-udobreniy.
[2]. Murovtsev GS, Chkanikov DI, Kulaeva ON. Fundamentals of chemical regulation of plant growth and productivity. M .: Agropromizdat, 1987.-pp. 387.
[3]. Nickell LJ Plant growth regulators. Application in agriculture, in English, 1984.
[4]. Saibova M.T. A complex of nitrogen and nitrogen-phosphorus fertilizers with physiologically active substances // Doctoral Dissertation in Chemistry. Tashkent, 1989.-pp. 351.
[5]. Askarova MK, Isabaev DZ, Eshpulatova MB, Makhamatova GA, Ergashev DA, Isabaev DZ Research of systems substantiating the process of obtaining a liquid fertilizer of complex action // International scientific research journal "Eurasian Union of Scientists" (ESU) №5 (62). 2019.1 Part. – pp.25-30.
[6]. Abdullaeva MT Obtaining liquid nitrogen fertilizers based on carbamide and ammonium nitrate with physiologically active substances. // Aftorefe ... diss. (PhD) Doctor of Philosophy in tech. sciences. -Tashkent. -2018. -pp.53.
[7]. M.E. Pozin, B.A. Kopylev, N.K. Shilling. ZhPH, 37, No. 11, 2341.1964. 38, No. 1, 22.1965.
[8].G.L. Tudorovskaya, F.G. Margolina. Physicochemical research and methods for obtaining complex fertilizers using urea. Proceedings of NIUIF.Vol. No. 34. Issue 12. 1965 - pp. 2124-2143.
[9]. Franz. Pat 1469089. 1967. Production of stable solutions of binary or ternary fertilizers from phosphoric acid. Paul Souviron, Pierre Zonides 1965-12-24. Application filed 1967-02-10. Application approved 1967-02-10 Publication FR1469089A
[10]. Vinnik MM, Erbanova LN, Zaitsev PM et al. Methods of analysis of phosphate raw materials, phosphoric and complex fertilizers, fodder phosphates. -Moscow .: Chemistry.-1975.-pp 218.
[11]. Poluektov NS Analysis methods for flame photometry.-Moscow .: Chemistry. -1967.-pp 307.
[12]. Zdanovskiy A.B. Hallurgy. -L .: Chemistry, 1972 .-pp. 572.
[13]. Gorabachev S.V. Physical chemistry workshop. - M .: Higher school, 1974 .-pp. 310.
[14]. FlorovYu.G. Colloidal chemistry course. Surface phenomenon and dispersed systems. - M .: Chemistry, 1982. -pp. 117-124.
[15]. Dashko NS Perspective compositions of sulfur-containing liquid nitrogen fertilizers /NS Dashko, AF Minakovsky // International interdisciplinary scientific conference of students, graduate students and young scientists “Science and Scientists”. - Dnepropetrovsk, 2015. –pp. 197-200.