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Product Properties of Lime-Ammonium Nitrate Based on Dolomite Mineral, Ammonium Sulfate and Nitrate

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ABSTRACT: In the article, the introduction of ammonium sulfate $(NH_4)_2SO_4$) in the amount of 3-10% of its total mass into the dolomite-nitrate liquid formed based on the addition of dolomite mineral (DM) AS:DM=100:3 to 100:45 by weight to the ammonium nitrate (AS) liquid The composition and rheological properties of magnesium lime-alloy saltpeter samples obtained through According to it, it was found that in the temperature range of 165-185^oC and at the studied weight ratios, lime-ammonium nitrate liquids with $(NH_4)_2SO_4$) additives can be easily granulated by spraying in a granulation tower.

KEYWORDS: Ammonium nitrate, ammonium sulfate, dolomite mineral, lime-ammonium nitrate with $(NH_4)_2SO_4$) addition, composition, density and viscosity.

I.INTRODUCTION

The governments of literally all countries of the world are faced with the problem of providing food to the population of their countries. The fact is that the population of the Earth is growing at a very fast pace. If in 1830 1 billion people lived on Earth, then in 1986 it was 4.9 billion, in 2000 – 6,1 billion, in 2015 – 8,0 billion, and by 2050 already 9,0 is expected. billion [1]. At the same time, the area of land occupied by grain crops (per capita) by the end of the 20th century decreased from 0,24 to 0,1 ha. According to calculations, by 2050 it will decrease to 0,08 ha per person. The decrease in the area of arable land occurs not only as a result of rapid population growth.

A similar picture is observed in Uzbekistan. It has 25 million 736 thousand hectares of agricultural land, including 3.73 million hectares of irrigated land [2]. It is on irrigated lands that over 97% of all agricultural products of the republic are obtained. In this case, as well as advanced skills, it is possible to provide the population with quality food only through the chemicalization of agriculture. Because the increase in crop yields by an average of 40-50% occurs due to the rational use of mineral fertilizers [3]. Therefore, the production of mineral fertilizers is increasing all over the world [4, 5].

N, P_2O_5, K_2O, S, CaO and MgO are among the most important and basic nutrients for crops. Plants obtain the main part of nutrient nitrogen from nitrogen (urea, ammonium nitrate, ammonium sulfate, AFU, etc.) fertilizers [6]. Of these, the most effective and versatile fertilizer is ammonium nitrate (AN) [7]. But it has two very serious drawbacks: high caking and explosiveness [8]. Explosions with ammonium nitrate led to the fact that in a number of countries calcium carbonate, chalk, and dolomite were added to it, as a result of which any danger of it was eliminated. This product is marketed under the name Calcium Ammonium Nitrate (CAN). The share of CAN production capacities in the world is estimated at about 7% [9]. In the world, CAN with a nitrogen content of 20–33,5% is produced and supplied by 42 companies, of which 31 companies are in Europe [10, 11].

There are also several large deposits of dolomite (D) mineral in Uzbekistan: Shursu (Fergana region), Navbakhor (Navoi region), Dehkonobod (Kashkadarya region) and others. Therefore, it became possible to organize the production of magnesium and calcium-containing IAS in Uzbekistan.

The objective of this work is to study the compositions and commercial properties of the products obtained by the interaction of the melt of ammonium nitrate grade "khch" with powdered dolomite and ammonium sulfate.

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II. SIGNIFICANCE OF THE SYSTEM

In the article, the introduction of ammonium sulfate $(NH_4)_2SO_4$) in the amount of 3-10% of its total mass into the dolomite-nitrate liquid formed based on the addition of dolomite mineral (DM) AS:DM=100:3 to 100:45 by weight to the ammonium nitrate (AS) liquid. The study of methodology is explained in section III, section IV covers the experimental results of the study, and section V discusses the future study and conclusion.

III. METHODOLOGY

As initial components, we used pure AS (34.96% N), ammonium sulfate $(NH_4)_2SO_4$) and crystalline DM, whose complete chemical composition of the sample is given in Table 1.

Table 1. Chemical composition of dolomite from the Shorsu deposit, Fergana region.

Oxide content per air-dry matter , %											
SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MgO	MnO	CaO	Na_2O	K_2O	P_2O_5	SO_3	CO_2
2.87	0.02	0.32	0.29	19.17	0.01	31.48	0.05	0.15	0.03	0.30	45.00

DM and $(NH_4)_2SO_4$ were preliminarily ground in a porcelain mortar to a size of 0,25 mm. The experiments were carried out as follows: melted at 175°C in a metal cup by electric heating. DM was added to AS in such an amount that the mass ratio of AS:DM in the mixture varied from 100:3 to 100:45. A $(NH_4)_2SO_4$ was taken in amounts of 3, 5, 7, and 10% of the total mass of the mixture. The mixture was thoroughly mixed. The melts were kept at a temperature of 170-175°C. The total interaction time of the components was 10 min. The nitrate-carbonate-sulfate melt after the completion of the interaction of the components was poured into a porcelain cup and, as it cooled, was intensively stirred with a glass rod, resulting in granulation. The mass was cooled and then dispersed according to particle size. Particles with sizes of 2–3 mm were tested for strength according to GOST 21560.2–82 [12]. After that, the products were crushed and analyzed. The nitrogen content in the products was determined according to by distillation of ammonia in an alkaline medium with Devard's alloy followed by titration [13]. The content of SO_3^{2-} ion was determined by weight - precipitation in the form of barium sulfate [14]. The content of CaO and MgO was determined by the complexometric method [15].

IV. EXPERIMENTAL RESULTS

The results are shown in table 2. It can be seen that in the studied weight ratios, the total amount of nitrogen in the products decreased from 33,58 to 23,82%, while the amount of SO3, CaO and MgO decreased from 1,80 to 6,07%, 0,82 to 9,48%, respectively. % increased from 0,48 to 5,75%. In addition, in the samples, the forms of CaO and MgO absorbed in citric acid are in the range of 43,52-14,25% and 36,56-11,41%, respectively. Also, the presence of water-soluble forms of CaO and MgO in the samples (CaO_{water}:CaO_{total}= 4,37-19,02% and MgO_{water}:MgO_{total}= 3,23-14,54%) at a temperature of 170-175°C mainly explained by the course of this reaction:

$$4NH_4NO_3+CaMg(CO_3)_2 \rightarrow Ca(NO_3)_2+Mg(NO_3)_2+4NH_3\uparrow+2SO_2\uparrow+2H_2O.$$

Table 2.

Composition of magnesium lime-ammonium nitrate obtained on the basis of AS liquid, "Shursu" mine DM and $(NH_4)_2SO_4$.

AS:DM weight ratio	The amount of $(NH_4)_2SO_4$ in the mixture,%	Amount of components, heavy. %				$\frac{CaO_{ass.}}{CaO_{total.}}$ 2 percent acid. %	$\frac{MgO_{ass.}}{Mg_{total.}}$ 2 percent acid. %	$\frac{CaO_{water.}}{CaO_{total.}}$ %	$\frac{MgO_{water.}}{MgO_{total.}}$ %
		N	SO_3	CaO	MgO				
100 : 3	3	33,58	1,80	0,87	0,53	43,52	36,56	17,56	13,78
100 : 3	5	33,32	3,05	0,84	0,51	41,87	34,79	16,28	13,09
100 : 3	7	33,06	4,25	0,83	0,50	40,41	33,08	15,01	12,36
100 : 3	10	32,68	6,0	0,82	0,48	38,05	31,37	13,4	11,78
100 : 10	3	31,52	2,82	2,75	1,67	35,58	28,76	11,89	10,47
100 : 10	5	31,28	3,03	2,71	1,62	34,57	27,87	11,45	9,92

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100 : 10	7	31,04	4,22	2,63	1,60	33,09	27,03	11,09	9,38
100 : 10	10	30,73	6,05	2,57	1,54	31,76	26,12	10,68	8,79
100 : 20	3	28,88	1,80	5,04	3,09	29,09	24,2	9,92	8,09
100 : 20	5	28,75	3,02	4,96	3,04	27,58	23,28	9,56	7,82
100 : 20	7	28,57	4,24	4,87	2,95	26,17	22,27	9,18	7,63
100 : 20	10	28,35	6,05	4,70	2,85	24,72	21,36	8,90	7,42
100 : 30	3	26,73	1,81	7,04	4,26	22,26	19,38	8,06	6,79
100 : 30	5	26,61	3,01	6,87	4,18	21,31	18,44	7,58	6,32
100 : 30	7	26,49	4,23	6,74	4,09	20,28	17,36	7,15	5,92
100 : 30	10	26,33	6,06	6,53	3,95	19,29	16,42	6,71	5,48
100 : 45	3	24,03	1,86	9,48	5,75	17,28	14,37	5,82	4,64
100 : 45	5	23,95	3,05	9,27	5,63	16,31	13,23	5,27	4,18
100 : 45	7	23,91	4,25	9,05	5,51	15,22	12,26	4,88	3,75
100 : 45	10	23,82	6,07	8,78	5,33	14,25	11,41	4,37	3,23

At the next stage of the work, the rheological properties of dolomite-gypsum-nitrate liquids obtained on the basis of ammonium nitrate liquid, "Shursu" dolomite mineral and ammonium sulfate, that is, the density was determined using a pycnometer, and the viscosity was determined using a VPJ-2 viscometer with a diameter of 1,47 mm. The experiments were carried out as follows. Samples were prepared by adding crushed dolomite mineral and ammonium sulfate additives to ammonium nitrate liquid. The products were cooled and ground. Weighed powdered samples were placed in a prepared pycnometer and viscometer and placed in a thermostat filled with glycerin. When the temperature in the thermostat rises to the set values (165-180°C), the powder mixture in the pycnometer and viscometer begins to liquefy. Liquids are kept at the specified temperatures for 3-5 minutes, and measurements are taken and accurate readings are recorded. The results are presented in Table 3. It can be seen from it that the density and viscosity of dolomite-sulfate-nitrate liquids also increase significantly as the amount of dolomite mineral and ammonium sulfate increases in the liquid of ammonium nitrate. At a temperature of 165°C, "pure" brand NH_4NO_3 does not liquefy and does not flow naturally.

Table 3.

Density and viscosities of magnesium lime-ammonium nitrate liquids with ammonium sulfate addition

AS:DM weight ratio	$(NH_4)_2SO_4$ in the mixture amount, %	Liquid density at temperatures of 165-180°C (g/cm^3)				Viscosity of liquids at temperatures of 165-180°C (sPz)			
		165	170	175	180	165	170	175	180
"Toza" brand NH_4NO_3		-	1,450	1,448	1,446	-	5,71	5,34	5,02
100 : 3	3	1,597	1,584	1,572	1,561	6,25	6,04	5,87	5,65
100 : 3	5	1,615	1,598	1,587	1,576	6,63	6,41	6,23	5,99
100 : 3	7	1,632	1,613	1,601	1,590	7,02	6,79	6,59	6,33
100 : 3	10	1,650	1,628	1,616	1,605	7,402	7,16	6,96	6,67
100 : 10	3	1,739	1,702	1,689	1,678	9,32	9,04	8,78	8,38
100 : 10	5	1,757	1,716	1,703	1,693	9,71	9,41	9,15	8,73
100 : 10	7	1,774	1,731	1,718	1,708	10,09	9,79	9,51	9,07
100 : 10	10	1,792	1,746	1,733	1,723	10,47	10,16	9,87	9,41
100 : 20	3	1,809	1,760	1,747	1,737	10,86	10,54	10,24	9,75
100 : 20	5	1,827	1,775	1,762	1,752	11,24	10,91	10,60	10,09
100 : 20	7	1,845	1,789	1,776	1,767	11,63	11,29	10,97	10,44
100 : 20	10	1,863	1,804	1,791	1,781	12,01	11,66	11,33	10,78
100 : 30	3	1,881	1,819	1,805	1,796	12,39	12,04	11,69	11,12
100 : 30	5	1,898	1,834	1,820	1,811	12,43	12,41	12,06	11,46
100 : 30	7	1,916	1,848	1,835	1,826	12,82	12,79	12,42	11,81
100 : 30	10	1,934	1,863	1,849	1,840	13,30	13,16	12,79	12,15
100 : 45	3	2,023	1,937	1,922	1,914	15,12	15,04	14,61	13,86
100 : 45	5	2,040	1,951	1,937	1,928	15,50	15,41	14,97	14,2

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100 : 45	7	2,058	1,966	1,952	1,943	15,89	15,79	15,33	14,54
100 : 45	10	2,076	1,981	1,966	1,957	16,62	16,18	15,71	14,90

Addition of dolomite mineral and ammonium sulfate to ammonium nitrate liquid reduces its liquefaction temperature, and the resulting magnesium-lime-ammonium nitrate liquids liquefy at a temperature of 165℃. At a temperature of 170℃ AS:DM=100:3 to 100:45 ratios and general dolomite-nitrate liquefaction.

density and viscosities of dolomite-sulfate-nitrate liquids added in the amount of 3-10% by mass of $(NH_4)_2SO_4$ increase from 1,584 to 1,981 g/cm^3 and from 6,04 to 16,18 sPz, respectively. It was found that these values decrease with increasing temperature.

V. CONCLUSION AND FUTURE WORK

In conclusion, it can be said that the four-component fertilizer liquids obtained as a result of the interaction of ammonium nitrate liquid with dolomite mineral and ammonium sulfate in all studied proportions can be easily granulated using sprinkling (prilling) or rapid mixing (okatka) methods at temperatures between 165-185℃.

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