Section 4. Chemistry

https://doi.org/10.29013/AJT-22-7.8-31-35

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STUDYING THE PHYSICAL AND CHEMICAL PROPERTIES WHEN ADDING THE SOL OF STABILIZED FERTILIZERS

Abstract. The article defines the chemical composition of nitrogen-potassium fertilizers obtained by introducing ash into the melt of ammonium nitrate at mass ratios of ammonium nitrate: ash = 100: (3–25) and a temperature of 180 °C. The density and viscosity of the ammonium nitrate melt with the addition of ash in the temperature range 160–185 °C were also determined, and the strength of the granules was determined at the above ratios of ammonium nitrate: ash.

Keywords: ammonium nitrate, ash, melt, nitrogen-potassium fertilizer, density, viscosity, strength of granules

Introduction

From practical and scientific experience in the production of granulated ammonium nitrate (AN), it has been established that in order to ensure good physical properties of granulated AN, the moisture content in it should not exceed 0.2%. This concentration of water can be achieved in pre-evaporators purged with hot air. However, such a result is difficult. In this regard, various additives are used that bind free moisture, which can be divided into: 1) substances or reaction transformation products that dissolve well in water and simultaneously carry nutritional properties, capable of producing crystalline hydrates, 2) substances that adsorb moisture, but do not carry nutritional load. The latter is usually introduced directly into the AS melt before its granulation.

The first class of the category includes magnesium and calcium-containing additives: magnesite, brucite, dolomite, calcite, etc. [1–3]. At present, magnesia additive is used in many enterprises of the CIS countries [2]. The magnesia additive is recognized as the best additive that eliminates AC caking. To obtain this additive, caustic magnesite obtained by roasting natural magnesite is used. Under production conditions, caustic magnesite is decomposed by 35% HNO_3, while obtaining a 40% solution of $Mg(NO_3)_2$. Anhydrous magnesium nitrate binds free water remaining in the AS melt and binds to $Mg(NO_3)_2 \cdot 6H_2O$, which ensures the production of product granules with good physical and chemical properties.

At present, $Mg(OH)_2$ and MgO and methods for their preparation are covered in applied research work done in the field of powder technologies [1].

It was shown in [4] that magnesium nitrate increases the transition temperature IV → III from 32 to 55 °C and III→II from 84 to 90 °C. When the AS melt is cooled, the following transformations proceed sequentially: melt → I, I → II, and II → IV, respectively, at 167, 128, and 50 °C, bypassing phase III.

Water-binding additives can include hemihydrate and anhydrite of gypsum or phosphogypsum, capable of attaching 1.5 or 2 molecules of water to form a solid crystalline hydrate $CaSO_4 \cdot 2H_2O$ [5; 6]. The condition for the reliability of the action of solid additives requires a high degree of their dispersion, ensuring uniform distribution of saltpeter granules over the mass, maximum use of additives and a high rate of moisture absorption from the mother liquor. It is noted in [6] that a finely divided addition of gypsum or phosphogypsum should be introduced into the melt at about 5% before prilling on a granulation tower. Fertilizer with the addition of phosphogypsum with an N content of 24% (wt.) Has a hygroscopic point of 67%, while for pure AS (under the same conditions) this figure is 59.5%.

An important task at present is to reduce the level of potential hazard of ammonium nitrate. For this, research is underway to select highly effective additives that improve the strength of granules and increase the thermal stability of the fertilizer [6].

Objects and methods of research

In our work, we used sunflower sol of the Republic of Uzbekistan composition. Ammonium nitrate with the addition of sol, the strength of the granules of the products was determined on the device MIP-10–1 according to GOST 21560.2–82. The density of the melts was determined by the pycnometric method [7–9], and the viscosity was determined on a VPZh-2 viscometer with a diameter of 1.77 mm.

The experiments were carried out as follows. Granulated ammonium nitrate produced by JSC Fargonaazot (34.5% N) was melted in a metal reactor in a thermostat filled with glycerin. Phosphate raw materials were added to the AS melt at 180 °C with stirring in such an amount that the weight ratio of AS melt: Sol was equal to 100: (3–25). The temperature was maintained using a contact thermometer. The melt was kept for 20 min, after which it was poured into a granulator, which is a metal cup with a perforated bottom, the hole diameter in which was 1.2 mm. Pressure was created in the upper part of the glass using a pump, then the melt was sprayed from the sixth floor of the building onto a plastic film lying on the ground. Drops of the melt, falling from a height, solidified and turned into granules [10; 11].

In conditions of a large shortage of nitrogen-potassium fertilizers in our country, ash for the production of nitrogen-potassium fertilizers attracting the ash of Uzbekistan and the development of a technology for producing nitrogen-potassium fertilizers based on these ash are relevant. Until now, these ash is not used in the production of nitrogen-potassium fertilizers. The paper provides a general description of the evils of Uzbekistan and the possibility of their use as a potash raw material in the production of nitrogen-potassium fertilizers.

Based on the foregoing, in this paper we investigated the processes of obtaining nitrogen-potassium fertilizer based on ammonium nitrate melt with the addition of ash, the chemical composition of which is shown in Table 1.

Table 1. – Chemical properties of ash

The chemical composition of ash	K	Na	P	Ca	Si	Fe	Al	Mg	O	CI	S	C	W
A	12.4	2.8	3.4	15.7	10.0	1.1	1.4	4.6	36.4	2.5	1.6	–	8.1
Б	13.6	2.2	2.4	19.2	2.4	0.6	0.9	6.7	39.4	2.2	1.5	8.9	–
C	8.8	2.4	2.3	12.4	10.0	1.0	1.4	3.3	34.1	4.7	0.9	16.0	2.7

Results and its discussion

In this report, we present the results of determining the strength of ammonium nitrate granules obtained by adding ash at the above weight ratios AS: Sol. The strength of the granules is one of the

most important indicators characterizing the stabilized ammonium nitrate.

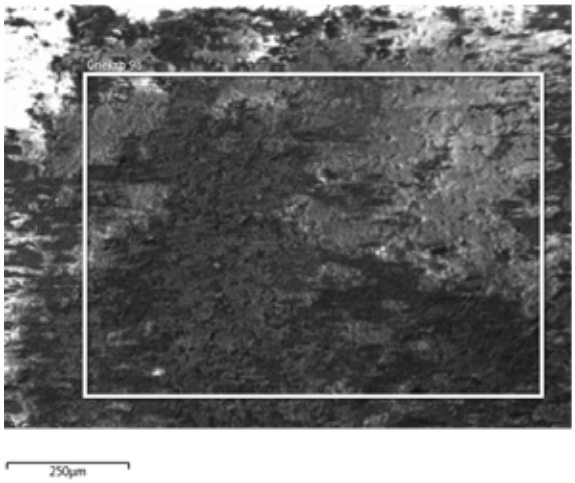
After that, the strength of the granules was measured. In this case, granules of nitrogen-phosphorus fertilizers were obtained, similar in appearance to granules of pure AS. The strength of the granules is 2–3 mm in size. Experimental data are given in (Table 2).

As can be seen from the tables, the more ash additives are added to the AS composition, the higher the strength of the granules. Thus, the addition of ash in the AS melt in the amount of 100 : 20 increases the strength of the granules from 5.52 MPa to a nitrogen content of 27.54%. And the strength of standard AS granules is only 2.91 MPa. This suggests that the introduction of a sol into the AS melt leads to a compaction of the granule structure and an increase in its crushing strength and abrasion, which ultimately has an effect on reducing the caking of the product during storage.

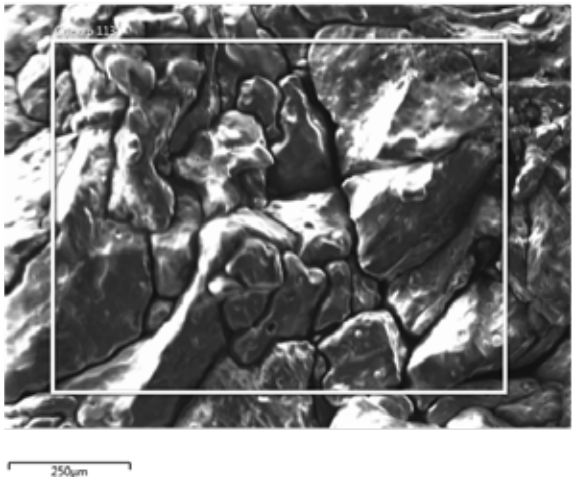
Table 2. – Strength of fertilizer granules obtained by introducing ammonium nitrate and sol into the melt

Mass ratio AS: Sol	N,%	K_2O,%	Granule strength		
			kg/granule	kgs/sm^2	MPa
Granule diameter 2–3 mm					
100: 3	33.44	0.17	1.51	28.81	2.91
100: 5	32.76	0.29	2.01	30.62	3.16
100: 8	31.62	0.38	2.51	38.61	3.86
100: 10	30.31	0.47	2.80	43.26	4.31
100: 12	29.83	0.68	3.11	49.90	4.91
100: 15	29.19	0.89	3.37	53.75	5.34
100: 18	28.40	0.98	3.61	53.98	5.41
100: 20	27.54	1.11	4.02	55.85	5.52
100: 22	26.38	1.23	4.41	56.71	5.72
100: 25	25.42	1.38	4.60	59.35	5.91

Based on laboratory experiments, it was shown that the introduction of ash ammonium nitrate into the melt makes it possible to obtain new nitrogen-potassium fertilizers with a high relative content of the assimilable form of K_2O.



A



AC: K = 100: 3 ratio

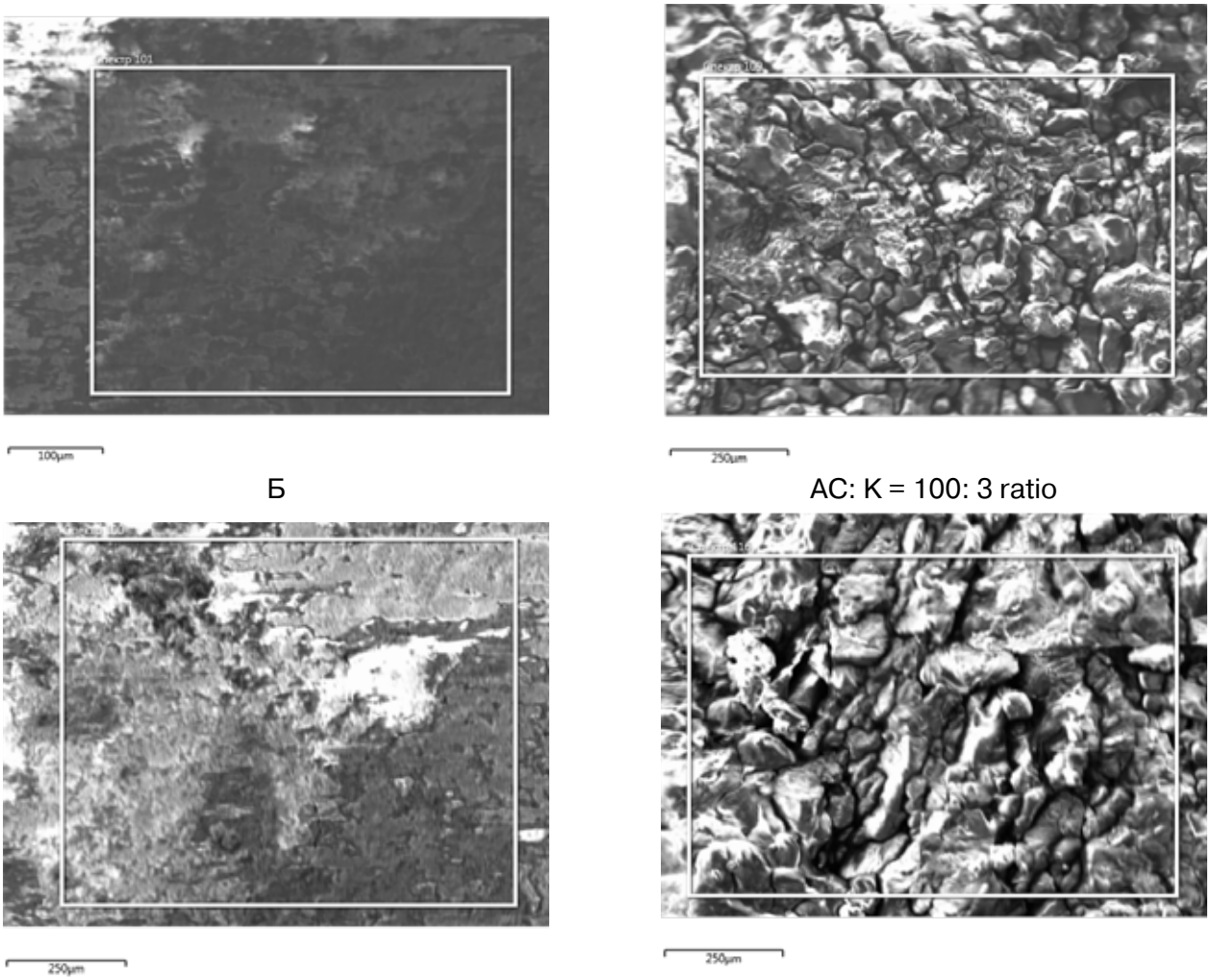


Figure 1. Electron microscopic photographs of the surface granules AC: sunflower (A); AU: Animal Dung (B) and AC: cotton stalk ash (C)

The rheological properties of saltpeter melts with sol were studied in the temperature range 160–185 °C. At the same time, it was shown that in all ratios of AS: Sol, potassium nitrate melts have a fairly good fluidity, which allows them to be granulated in a granulation tower by prilling without any special technological difficulties. Micrographs of granules of expanded ammonium nitrate of the obtained contact layer based on them. a) sunflower ash, (b) animal manure ash, (c) cotton stalk ash, on thermally expanded ammonium nitrate.

Conclusion

Thus, sunflower sol can be considered a very promising additive for the production of ammonium nitrate, which has a lower detonation stability.

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