

# NITROGEN-SULPHUR CONTAINING FERTILIZERS BASED ON AMMONIUM NITRATE, AMMONIUM SULPHATE AND PHOSPHOGYPSUM AND THEIR COMMODITY

Mamataliyev A.A.<sup>1</sup>, Namazov Sh.S.<sup>2</sup> (Republic of Uzbekistan) Email: Mamataliyev331@scientifictext.ru

<sup>1</sup>Mamataliyev Abdurasul Abdumalikovich – Senior Scientific Researcher;

<sup>2</sup>Namazov Shafolat Sattarovich – Doctor of Technical Science, Professor, Chief of Laboratory,  
LABORATORY OF PHOSPHATE FERTILIZER,  
INSTITUTE OF GENERAL AND INORGANIC CHEMISTRY  
OF THE ACADEMY OF SCIENCES OF THE REPUBLIC OF UZBEKISTAN,  
TASHKENT, REPUBLIC OF UZBEKISTAN

**Abstract:** in this article the samples of nitrogen-sulphur containing fertilizers in which the molar ratio of ammonium sulphate to ammonium nitrate varied from 1:1 to 1:8, have been prepared. The phosphogypsum, waste production of JSC “Ammophos-Maxam”, as additive was used in amount of 5; 10 and 15% of the total weight of ammonium nitrate-sulphate. The composition, density, viscosity, strength and dissolution rate of granules, hygroscopic point of water vapor sorption kinetics and sorption moisture capacity to them was determined. The introduction of 62.3% of ammonium sulfate and 15% of phosphogypsum into the melt of ammonium nitrate increases the strength of the product granules from 1.32 to 7.86 MPa.

**Keywords:** ammonium nitrate, ammonium sulfate, phosphogypsum, nitrogen-sulphur containing fertilizer composition, and properties.

## АЗОТСЕРОСОДЕРЖАЩИЕ УДОБРЕНИЯ НА ОСНОВЕ АММИАЧНОЙ СЕЛИТРЫ, СУЛЬФАТА АММОНИЯ И ФОСФОГИПСА И ИХ ТОВАРНЫЕ СВОЙСТВА

Маматалиев А.А.<sup>1</sup>, Намазов Ш.С.<sup>2</sup> (Республика Узбекистан)

<sup>1</sup>Маматалиев Абдурашул Абдумаликович – старший научный сотрудник;

<sup>2</sup>Намазов Шафолот Саттарович – доктор технических наук, профессор, заведующий лабораторией, лаборатория фосфорных удобрений,  
Институт общей и неорганической химии  
Академии наук Республики Узбекистан,  
г. Ташкент, Республика Узбекистан

**Аннотация:** в работе получены образцы азотсеровосодержащих удобрений, в которых молярные соотношения сульфата к нитрату менялись от 1 : 1 до 1 : 8. В качестве добавки к ним применен фосфогипс – отход производства АО «Аммофос-Максам» в количестве 5; 10 и 15% от общей массы сульфат-нитрата аммония. Для них определены состав, плотность, вязкость, прочности и скорости растворения гранул, гигроскопические точки, кинетики сорбции паров воды и сорбционной влагоёмкости. Введение в расплав аммиачной селитры 62.3% сульфата аммония и 15% фосфогипса повышает прочность гранул продукта с 1.32 до 7.86 МПа.

**Ключевые слова:** аммиачная селитра, сульфат аммония, фосфогипс, азотсеровосодержащее удобрение, состав и свойства.

Ammonium nitrate is a concentrated, efficient and the most common in the world as a nitrogen fertilizer [1]. However, ammonium nitrate has some drawbacks. Firstly, it is caking during the storage. Secondly, it is its explosion hazard. Nitrate nitrogen in the soil is not fixed and washed out of ammonium nitrate in terms of the normal moisture and irrigation. Therefore, ammonium nitrate is not used for fertilizing of winter crops during sowing spring and autumn is as the main fertilizer. These drawbacks can be eliminated with addition of ammonium nitrate sulfate. Ammonium form of nitrogen is being in the ammonium nitrate and ammonium sulfate is in a well available to plants that is relatively a little mobile and is washed out of the soil [2]. The advantage of ammonium sulfate - nitrate to ammonium nitrate is also the presence of sulfur in it, which is a part of proteins and amino acids in the formation of the crop. In connection there have been conducted the studies on preparation of nitrogen-sulphur fertilizers with the additive into melt of ammonium nitrate two perspective additives, ammonium sulfate and phosphogypsum.

The crystalline ammonium sulfate previously milled in a porcelain mortar until the particle size of 0.063 mm. Phosphogypsum is from JSC “Ammophos-Maxam” that is in the form of calcium sulfate as dihydrate ( $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ ) with a moisture content of 18-20%. Therefore, before adding it to ammonium nitrate, the latter is

dried in an oven at 90 °C, and then it is milled in a porcelain mortar. Composition of the dried phosphogypsum (wt.%):  $P_2O_{5\text{total}}$  1.59;  $CaO_{\text{total}}$  37.47;  $SO_{3\text{total}}$  54.49.

For experiment AN sample is melted in a metal cup by electric heating. Ammonium sulfate was added to the nitrate in an amount such that the ratio of the starting components  $(NH_4)_2SO_4$ :  $NH_4NO_3$  mixture is ranged from 14.5: 78.8 to 59.2%: 32.0%. Phosphogypsum additive is taken in amount of 5; 10 and 15% of the total weight of the mixture. The mixture was thoroughly stirred. The melts were kept at 190°C for 15 minutes.

As it is seen from data obtained that with increasing amounts of ammonium sulfate injected into melt of ammonium nitrate, from 14.5 to 59.2% decreased the total nitrogen content in the product from 27.58% to 24.89%, while the sulfur content is increased in the product from 6.63% to 15.27%. With increasing amount of additive phosphogypsum from 5 to 15%, the sulfur content is also increased from 4.89 to 6.63% at a ratio of  $(NH_4)_2SO_4$ :  $NH_4NO_3$  = 1: 8, and from 15.27 to 15.96% when  $(NH_4)_2SO_4$ :  $NH_4NO_3$  = 1: 1. With increasing fraction as ammonium sulfate and phosphogypsum in ammonium nitrate melt increased strength of the resulting fertilizer granules to 7.86 MPa. Whereas the strength of the granules of ammonium nitrate (mark "pure") is 1.32 MPa (0.67 kg / granule). The time of complete dissolution of granules of pure ammonium nitrate is 44.6 seconds. However, the increase of the share as ammonium sulfate and phosphogypsum in the mixture with ammonium nitrate, time completely dissolution of nitrogen-sulphur fertilizers granules has reached its maximum 124.34 seconds with  $(NH_4)_2SO_4$ :  $NH_4NO_3$  = 53%: 32% to 15% addition of phosphogypsum. This suggests that the resulting fertilizer will slowly washing out of the soil than pure ammonium nitrate.

Values of the hygroscopic points of nitrogen-sulphur fertilizers varied in a range 47.5 - 52.7% depending upon addition.

At the same time, all samples are liquefied. It was found that the granules of pure AN when the moisture 3.5% strongly become compressed and lose their friability, and nitrogen-sulphur fertilizer samples retain the appearance and friability even when the moisture content of 5-6%. When the moisture equal to 7%, granules lose their ability to sowing only.

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