INTERNATIONAL JOURNAL ON ORANGE TECHNOLOGY

https://journals.researchparks.org/index.php/IJOT e-ISSN: 2615-8140 | p-ISSN: 2615-7071
Volume: 5 Issue: 12 |Dec 2023

PHYSICO-CHEMICAL AND COMMERCIAL PROPERTIES OF MAGNESIUM-CONTAINING LIME AMMONIA NITRETTE

Nabiyev Abduraxim Abduxamidovich

Tashkent Institute of Chemical Technology., Uzbekistan

E-mail: nabievximik@mail.ru

ORCID ID: 0000-0002-7313-323x

Yunusova Go'zal

Tashkent Institute of Chemical Technology., Uzbekistan

E-mail: Rewarding777@gmail.com

Tukhtamushova Anisa Ubayevna

Tashkent Institute of Chemical Technology., Uzbekistan

E-mail: anisaubaevna@gmail.com

----------***----------

Abstract: In this work, we studied the physico-chemical and commercial properties of magnesium-containing lime ammonium nitrate (magnesium-containing IAS) (hygroscopic point, sorption kinetics of water vapor, sorption moisture capacity, dissolution rate, caking, porosity and bulk density of granules) were determined for fertilizer samples.

Keywords: Hygroscopic point, dissolution rate, caking, porosity, bulk density of granules.

Introduction

The tendency of fertilizer to absorb atmospheric moisture affects the production conditions, the quality of the product during storage, transportation and application to the soil. With significant hygroscopicity, fertilizers cake, their flowability and dispersion deteriorate, and the granules lose their strength.

Materials and Methods

To study the hygroscopice points, some samples of fertilizers were selected, which are shown in Table 1. The hygroscopic point of fertilizer samples with granule sizes of 2-4 mm was determined by the desiccator method at a temperature of 25 ºC. The pH value of 10% aqueous suspensions of finished fertilizerse was measurede in an I-125M laboratory ionometer with an accuracy of 0.05 pH units.[4]

INTERNATIONAL JOURNAL ON ORANGE TECHNOLOGY

https://journals.researchparks.org/index.php/IJOT e-ISSN: 2615-8140 | p-ISSN: 2615-7071

Volume: 5 Issue: 12 |Dec 2023

The rate of dissolutione of granulese of the obtained fertilizers with a size of 2÷3 mm was studied. To do this, the granule was lowered into a beaker with 100 ml of distilled water, visually observed, and the time of its complete dissolution was recorded. Room temperature, tests five times.

The caking capacity of magnesium-containing IAS fertilizer was determined according to the express method, the essence of which was as follows. A 100 g sample of magnesium-containing IAS was placed in a split cylindrical mold with an inner diameter of 50 mm. The mold was closed, a weight of 3.1 kg was set, after which it was placed in a thermostat with a temperature of 60 °C for 8 hours. After the specified pressing time, the weights were removed, the cassette was released and kept for 2 hours at room temperature. After cooling, the top panel was removed from the cassette and the resulting briquette was carefully removed from the mold. The briquettes were tested for destruction using the MIP-10-1 instrument.

The caking of samples X (in MPa) was calculated by the formula:

$$X=P/S$$

where P is the breaking force, N (kgf);

S is the cross-sectional area of the sample (cm^2).

Results

Ast the data in Table 1 showe, the introduction of dolomite raw materials into the AS melt leads to an increase in its pH from 5.17 in the original to 6.85-7.07 in the product. This suggests that when the NO3 anion is bound by alkaline cations (Ca+) and (Mg+) of dolomite, the pH value increases to a value approaching that of aqueous suspensions of dolomite. It can be assumed that dolomite raw materials neutralize the acidity of the AC. The discovered property of the samples can provide a decrease in the "acidification" of the soil after the application of AS.

Table 1

Chemical Composition and Humidity of Magnesium-Containing IAS

Number samples	Mass ratio AS : D	pH 10% - foot solution	Content of components, mass. %				Humidity, %
			N	CaO	MgO	CO_2	
1	NH_4NO_3 «ch.c»	5,17	35	-	-	-	0,20
2	100 : 9	6,85	32,0	2,28	1,61	3,32	0,36
3	100 : 16	6,88	30,11	4,45	2,73	5,29	0,39
4	100 : 29	7,01	27,06	6,22	4,46	9,0	0,41
5	100 : 45	7,07	24,04	8,64	6,17	9,15	0,44

INTERNATIONAL JOURNAL ON ORANGE TECHNOLOGY

https://journals.researchparks.org/index.php/IJOT e-ISSN: 2615-8140 | p-ISSN: 2615-7071

Volume: 5 Issue: 12 |Dec 2023

Source: [5].

Table 1 also shows that the initial moisture content of the first sample (ammonium nitrate) was 0.20%, the second - 0.36%, the third - 0.39%, the fourth - 0.41% and the fifth - 0.44%. The determination of the gain or loss of moisture in the substance at a constant temperature and certain relative air humidity was carried out for 3 hours. The required relative air humidity was created in a closed desiccator above a layer of sulfuric acid of known concentration poured into it. The relative humidity at which the substance is not moistened and does not dry out is called the hygroscopic point of the substance. If the hygroscopic point is less than the relative humidity of the air, then the substance absorbs moisture from the air. If it is greater than the relative humidity of the air, the substance dries up. The values of hygroscopic points for our fertilizers turned out to be equal: for sample 1 - 62.0%, for sample 2 - 53.7%, for sample 3 - 53.3%, for sample 4 - 52.8% and for sample 5 - 52,5 %.

The reason for the low value of the hygroscopic point of the products is due to the fact that the mixture of salts is more hygroscopic than its constituent components. Relative humidity for Uzbekistan is characterized by the following figures: average monthly minimum - 46%, average monthly maximum - 74%, average annual - 60%. According to the hygroscopicity scale of N.E. Pestov, all our magnesium-containing IAS (samples 2-5) are hygroscopic substances, they are more hygroscopic than the original ammonium nitrate.

On figures 1-5 show the kinetic curves of water vapor sorption by fertilizer granules under isothermal conditions at 25ºC and at relative air humidity of 52.5; 62.5; 70.5; 80; 90 and 100%. The numbering of the figures corresponds to the fertilizer numbers in Table 1.

As can be seen from Figures 1-5, at high relative air humidity of 80, 90 and 100% for all samples, equilibrium is not achieved during the entire test period. At a relative air humidity of 70.5% for samples 1, 4 and 5, equilibrium is also not established during the entire test period. Equilibrium occurs after 30 days for the second and third samples. At a relative humidity of 62.5%, the equilibrium occurs for the first sample after 5 days, and for 2-5 samples after 10-12 days. At a relative air humidity of 52.5% for samples 2-5, the equilibrium is established on days 4-6, and sample 1 is not moistened, but dries up.

The sorption capacity of fertilizers was also determined by the desiccator method at relative air humidity of 52.5; 62.5; 70.5; 80; 90 and 100%. Fertilizer samples were kept over acid for 30 days.

shows that the time of complete dissolution of pure ammonium nitrate granules is 46.8 seconds. With an increase in the proportion of dolomite in a mixture with saltpeter, the time for complete dissolution of the granules of magnesium-containing IAS steadily increases and reaches 73.6 seconds. for a sample in which AS : D = 100 : 45. This indicates that the resulting fertilizers will be washed out of the soil significantly (1.6 times) slower than pure ammonium nitrate.

Table 2

Dissolution rate of magnesium-containing IAS granules

Mass ratio AS:D	Time of complete dissolution of granules, sec					
	1	2	3	4	5	Average meaning
NH_4NO_3 brand «c»	51,00	51,00	42,00	47,00	43,00	46,80

https://journals.researchparks.org/index.php/IJOT e-ISSN: 2615-8140 | p-ISSN: 2615-7071
Volume: 5 Issue: 12 |Dec 2023

100 : 3	59,56	58,96	52,75	57,96	59,32	57,71
100 : 9	62,10	58,30	58,10	59,30	59,70	59,50
100 : 16	60,30	60,20	61,40	64,3	62,30	61,70
100 : 20	60,25	64,35	65,32	60,49	65,44	63,17
100 : 25	67,44	65,34	65,69	64,75	63,66	65,38
100 : 29	83,0	71,0	68,0	54,0	79,0	71,0
100 : 35	68,9	70,50	78,10	74,7	69,8	72,40
100 : 45	81,0	96,0	58,0	62,0	71,0	73,60

Source: [5].

The results of tests of magnesium-containing IAS using dolomite additives are presented in Table 3.

Table 3

Caking of magnesium-containing IAS

Mass ratio AS:D	The content of components, wt. %				Humidity, %	Caking, (kg/cm^2)
	N	CaO	MgO	CO_2		
NH_4NO_3 brand «c»	35	–	–	–	0,20	5,62
100 : 3	32,52	0,981	0,901	0,98	0,32	0,97
100 : 9	32,0	2,28	1,61	3,32	0,36	1,04
100 : 16	30,11	4,45	2,73	5,29	0,39	1,16
100 : 25	27,61	6,56	4,91	7,51	0,40	1,33
100 : 29	27,06	6,22	4,46	9,0	0,41	1,55
100 : 35	25,54	8,17	6,77	10,04	0,42	1,60
100 : 45	24,04	8,64	6,17	11,15	0,44	1,68

Source: [5].

They indicate that with an increase in the dolomite additive, the caking capacity of magnesium-containing IAS decreases from 0.97 to 1.68 kg/cm^2, that is, by 3.35 times.

INTERNATIONAL JOURNAL ON ORANGE TECHNOLOGY

https://journals.researchparks.org/index.php/IJOT e-ISSN: 2615-8140 | p-ISSN: 2615-7071

Volume: 5 Issue: 12 |Dec 2023

The data in Table 4 show that the addition of dolomite clay to the ND melt, as a rule, leads to a significant decrease in porosity and the internal specific surface of nitrate granules. For example, the porosity of granules of pure ammonium nitrate and AS with a magnesia additive is 22.0 and 9.10%, respectively. And the addition of dolomite clay of the Navoi deposit to the NA melt in an amount of to 45.0 g relative to 100 g of AS contributes to a decrease in the porosity of nitrate granules from 8.65 to 5.36%. This fact confirms the reasons for the increase in the strength of the product granules.

Table 4

Porosity and absorbency of granules of samples obtained

on the basis of ammonium nitrate melt and dolomite clay

"Navbakhor" of the Navoi field

Mass ratio AS:D	Nitrogen content, %	Granule porosity, %	Absorption of granules, gr.
NH_4NO_3 (brand «c»)	34,9	22,0	4,82
AC with magnesium additive	34,6	9,10	4,33
100 : 3	32,52	8,65	4,04
100 : 9	32,0	7,58	3,86
100 : 16	30,11	6,42	3,69
100 : 25	27,61	6,13	3,52
100 : 29	27,06	5,89	3,35
100 : 35	25,54	5,60	3,18
100 : 45	24,04	5,36	3,0

Source: [5].

INTERNATIONAL JOURNAL ON ORANGE TECHNOLOGY

https://journals.researchparks.org/index.php/IJOT e-ISSN: 2615-8140 | p-ISSN: 2615-7071

Volume: 5 Issue: 12 |Dec 2023

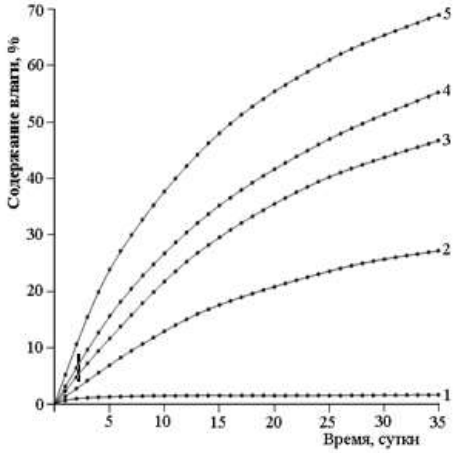

Fig. 1. Kinetics of water vapor sorption of the first sample at air humidity: 1 – 62.5%; 2 - 70.5%; 3 - 80%; 4 - 90%; 5 - 100%.

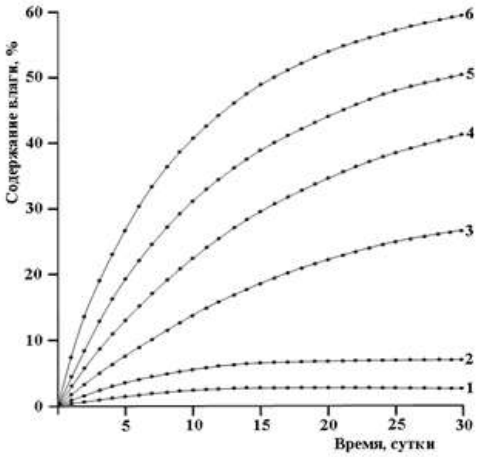

Fig. 2. Kinetics of water vapor sorption of the second sample at air humidity: 1 – 52.5%; 2 - 62.5%; 3 - 70.5%; 4 - 80%; 5 - 90%; 6 - 100%.

Source: [5].

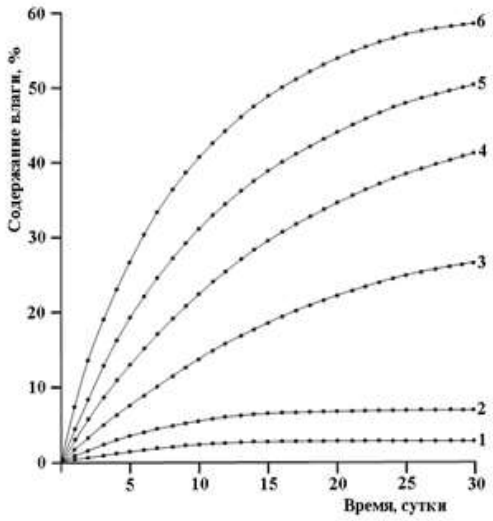

Fig. 3. Kinetics of water vapor sorption of the third sample at air humidity: 1 – 52.5%; 2 - 62.5%; 3 - 70.5%; 4 - 80%; 5 - 90%; 6 - 100%.

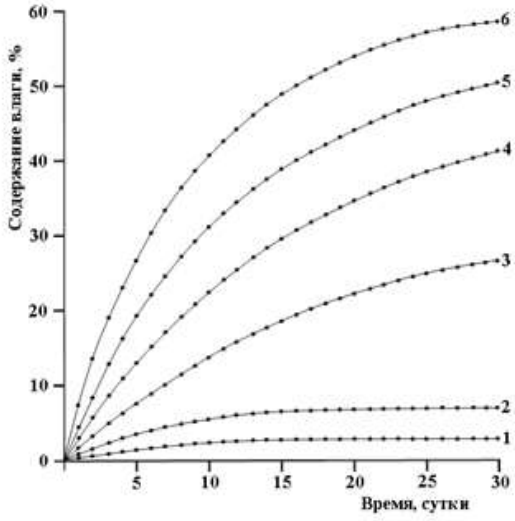

Fig. 4. Kinetics of water vapor sorption of the fourth sample at air humidity: 1 – 52.5%; 2 - 62.5%; 3 - 70.5%; 4 - 80%; 5 - 90%; 6 - 100%

Source: [5].

INTERNATIONAL JOURNAL ON ORANGE TECHNOLOGY

https://journals.researchparks.org/index.php/IJOT e-ISSN: 2615-8140 | p-ISSN: 2615-7071

Volume: 5 Issue: 12 |Dec 2023

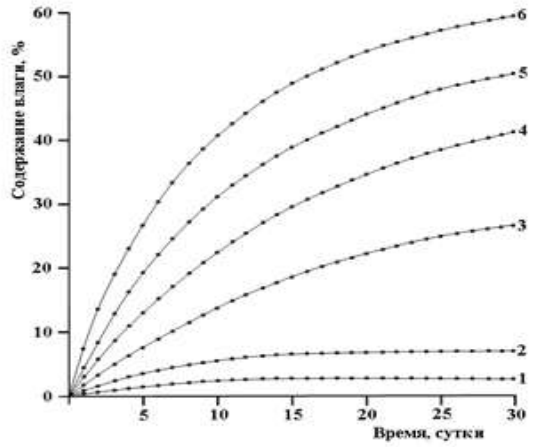

Fig. 5. Kinetics of water vapor sorption of the fifth sample at air humidity: 1 – 52.5%; 2 - 62.5%; 3 - 70.5%; 4 - 80%; 5 - 90%; 6 - 100%.

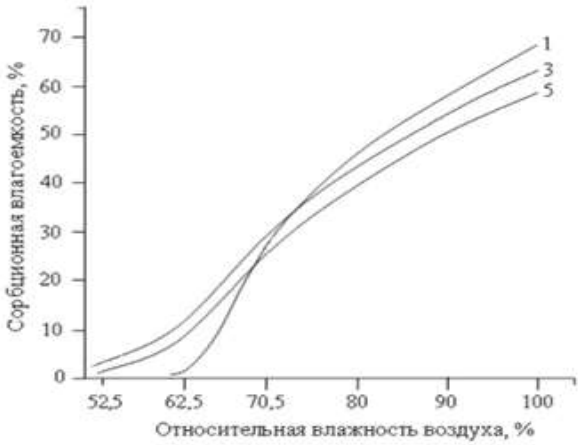

Fig. 6. Dependence of the sorption capacity of fertilizers on the relative humidity of the air.

Source: [5].

Sorption capacitye moisture is a very important indicator of the qualitye of fertilizers, as it indicates the maximum amount of absorbed moisture at which fertilizers retain their appearance and friability. Figure 6 shows the sorption capacity curves for fertilizer samples 1, 3 and 5. The curves for samples 2 and 4 are not shown in the figure, since they are very close to the curves for samples 3 and 5. It can be seen from the figure that ammonium nitrate at 52, 5% relative air humidity does not absorb moisture, and the third and fifth samples absorb 2.83 and 2.42 % moisture, respectively. But at the same time, the granules retain their appearance and friability. At a relative humidity of 62.5 % in ammonium nitrate, the moisture content reaches 1.78%, in the third sample 7.11% and in the fifth 6.82%. The granules at the same time retain their appearance, but slightly clumped. At a relative air humidity of 70.5%, the increase in moisture in saltpeter is 27.8%, in the third sample 24.3% and in the fifth - 22.06%. All samples become liquid. The following was noted: ammonium nitrate, upon reaching a moisture content of 3.5%, strongly cakes and loses its friability, while samples of magnesium-containing IAS retain their appearance and friability at a moisture content of 6%. At a moisture content of 7%, they lose their ability to sieving.

Discussion

The data obtained indicate that the studied magnesium-containing IAS in the climatic conditions of the autumn, winter and spring seasons, when the average relative humidity of the air exceeds 50%, will be constantly moistened.

The high dissolution rate of ammonium nitrate granules is one of the reasons for the unfavorable commercial and physico-chemical properties of this fertilizer, which causes its caking during storage and large losses of nutrients as a result of leaching from the soil after being applied under crops. Reducing the dissolution rate of granules is an important task in the development of highly effective fertilizers based on ammonium nitrate. Therefore, we carried out work to determine the dissolution rates of magnesium-containing IAS granules.

https://journals.researchparks.org/index.php/IJOT e-ISSN: 2615-8140 | p-ISSN: 2615-7071
Volume: 5 Issue: 12 |Dec 2023

Caking is one of the most important indicators of the commercial properties of magnesium-containing IAS.

An indicator of the quality of magnesium-containing IAS is also the porosity of the granules. For porous AS used as a component of explosive mixtures, this figure is 20% or more, while for conventional AS with dense granules it does not exceed 8-10

One of the indicators characterizing the quality of granulated AS is the adsorption capacity of granules for liquid fuel. This indicator is expressed as the number of grams that 100g can absorb granules (g/100g). The smaller the porosity of the granules, the lower their absorbency should be.

Conclusion

As the data in Table 4 show, this provision is indeed linked. Depending on the type of dolomite clay used and the mass ratio of SA : D, the absorbency of AS granules varies within the limits for dolomite clay Navbakhor of the Navoi deposit 4.04-3.0 g of fuel relative to 100 g of the product. It is 4.82 % for granulated ammonium nitrate, and 4.33% for AC with magnesia additive.

Thus, mixing ammonium nitrate melt with powdered dolomite, followed by pulp granulation in a granulation tower, makes it possible to obtain high-quality magnesium-containing IAS with improved physical and chemical properties. Ammonium nitrate modified with dolomite clay significantly exceeds industrial nitrate (GOST 2-85) in terms of performance.

References

1. A. A. Nabiev, A. M. Reimov, Sh. S. Namazov, and M. Zh. Obtaining calcium and magnesium-containing ammonium nitrate // V International Polyakov N.N., Zhmai L.A., Afanasiev A.N. Production of lime-ammonium nitrate // Chemicalization of agriculture. - 1988, No. 4, p. 21-24.
2. Postnikov A.V. Production and application of lime-ammonium nitrate // Chemicalization of agriculture. - 1990, No. 9, p. 68-73.
3. Zhmay L., Khristianova E. Ammonium nitrate in Russia and in the world. Modern situation and prospects // World of sulfur, N, P and K. - 2004, No. 2, p. 8-12.
4. Conference-school on chemical technology. Volgograd. - May 16-20, 2017 - Section 1. - P. 279-281.
5. Reimov A.M., Nabiev A.A., Namazov Sh.S., Madenov B.D. Durability of granules of magnesium-lime ammonium nitrate // Scientific Bulletin (Samarkand). - 2016. - No. 5 (99). - S. 153-156.
6. 6.Nabiev A.A.,Yuldashev B.A . Investigation of thermal stability,Modification of the transition, and splitting of ammonium nitrate with dolomite additives// EPRAInternational Journal of Published By :EPRA Publishing CC License Multidisciplinary Research SJIF Impact Factor :5.614 ISI I.F. Value : 1.188 DOI : 10.36713/epra2013. ISSN (Online) : 2455 – 3662 Monthly Reviewed & Indexed International Online Journal Volume: 6 Issue: 1 January 2020
7. 7.Nabiev A.A, Mamajonov M.M ,Reymov A.M Influence of dolomites of the Dekhkanabad fileld on the physical and chemical properties of ammonium nitrate.// The international journal of analytical and experimental modal analysis. Volume XII, Issue VII, Jule/ 2020 Page № 2274-2281, ISSN NO : 0886-9367 http // ijaema/com/, Impact factor- 6,3 DOI: 18.0002. IJAEMA.2020.VI217.200001.01568590070