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Production Of Complex Fertilizers Based On Nitric Acid Decomposition Of Unenforced Phosphorites Of Central Kyzylkums

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Annotation. New types of complex fertilizers containing nitrogen in the form of calcium and potassium nitrates, phosphorus – mono- and dicalcium phosphate, as well as undecomposed raw materials inactivated form, potassium and calcium, have been obtained on the basis of decomposition products of high-carbonate phosphate with an incomplete norm of nitric acid and potassium chloride. The optimal rate of nitric acid for the decomposition of high-carbonate phosphorous is 40-50% of stoichiometry since this results in pulp with satisfactory technological parameters for further processing into complex fertilizers.

Keywords: phosphorite, nitric acid, concentration, temperature, ratio, decomposition, phosphorus, nitrogen, potassium, technology, calcium nitrate, ammonium nitrate, calcium phosphates.

Introduction. The process of obtaining phosphorus fertilizers consists in the conversion of indigestible forms of phosphorus in phosphate raw materials into forms assimilable for plants. This is usually done by acidic methods, that is, by decomposition of raw materials with sulfuric, nitric, phosphoric, or hydrochloric acids. The nitric acid method of processing phosphate raw materials allows the complex use of raw materials components. The main advantage of nitric acid processing is that the chemical energy of nitric acid is not only used for the decomposition of phosphorites, but also NO_3 anions- in the form of a nutrient component remain in the composition of complex fertilizers.

The essence of the technology being developed is the use of an incomplete stoichiometric norm of nitric acid for the decomposition of Kyzylkum phosphorites containing 16-22% P_2O_5. At the same time, there is no complete decomposition of the phosphate mineral of the raw material with the formation of digestible forms of phosphates (mono- and dicalcium phosphates), but the so-called partially decomposed phosphorite. That is, after decarbonization of phosphate raw materials or decomposition of CO_2 groups from its structure, the phosphate mineral of the raw material becomes more active.

The purpose of the work. The purpose of this study is to develop highly effective complex phosphorus-potassium and nitrogen-phosphorus-potassium fertilizers with the necessary ratio of nutrients by nitric acid processing of high-carbonate phosphates of Central Kyzylkums.

Scientific novelty. Technological modes of obtaining PK- and TRK-fertilizers based on the decomposition products of phosphorites of Central Kyzylkums with solutions of nitric acid, potassium chloride, ammonium sulfate and nitrate and carbamide have been developed. The individuality of the decomposition products of phosphorites when mixed with potassium and nitrogen-containing fertilizers has been proved, i.e. after preliminary neutralization of acidic products, no interaction occurs. Technologies for obtaining RK- and RK-fertilizers by decomposition of high-carbonate phosphorites of Central Kyzylkums with solutions of nitric acid and mixing with potassium chlorides and nitrogen-containing fertilizers are proposed.

Features of the work:

The theoretical foundations for the creation of new types of granular complex fertilizers based on the decomposition products of high-carbonate phosphorite with an incomplete norm of nitric acid in the presence of potassium chloride and nitrogen-containing fertilizers have been identified;

Opens up the possibility of involving high-carbonate phosphorites of Central Kyzylkums in the industrial production of RK- and RK-fertilizers;

The implementation of the research results will increase the availability of phosphorus fertilizers for agriculture

Introduction. The production and use of complex and complex mineral fertilizers is growing all over the world. This is due to the need to provide the growing population of the planet with food. For the normal growth and development of plants, nitrogen, phosphorus and potash fertilizers are mandatory and only in the necessary proportions. With the correct application of mineral fertilizers, the yield increases by two or more times.

Currently, due to the depletion of rich deposits around the world, there is a search for acceptable technologies for involving poor phosphorites in industrial production, which are poorly amenable to enrichment, there are tasks to increase the efficiency of the use of mineral fertilizers and improve their production methods, as well as the introduction of advanced technologies, increasing the measures of scientifically based farming systems and environmental protection. One of the most effective ways to produce mineral fertilizers is to obtain their nutrients in the necessary proportions. In the production of such fertilizers, the reduction of a number of processes and the intensification of the decomposition of phosphorite flour leads to a noticeable reduction in costs. The high concentration of nutrients in their composition increases the efficiency of their delivery to consumers.

Methodology. The decomposition of phosphate raw materials with nitric and sulfuric acids was carried out with constant stirring in a glass reactor. The decomposition process was carried out in liquid-phase and solid-phase modes. Further, the decomposition products were mixed with potassium chloride, ammonium nitrate, urea and ammonium sulfate. The initial phosphate raw materials and the resulting intermediate and finished products were analyzed for the content of nitrogen, various forms of phosphorus, calcium, magnesium, sulfur, aluminum, iron, fluorine, carbonates, insoluble residue, water. Total nitrogen was determined by [1; 218 p., 2; 8 p.]. The method is based on the reduction of nitrate-nitrogen to ammonia with a Deward alloy, followed by ammonia distillation and titrimetric determination. Ammonia nitrogen was determined by [1; 218p., 3; 6p.]. The method is based on the oxidation of ammonia nitrogen by chloramine to elemental in the presence of a phosphate buffer solution with a pH of 6.7 and potassium bromide; excess chloramine is determined iodometrically. Nitrate nitrogen was determined by [4; 6p.]. The method is based on the reduction of nitrate nitrogen with a solution of iron (II) sulfate in an acidic medium in the presence of ammonium molybdate as a catalyst, followed by titration of excess iron (II) sulfate with a solution of potassium permanganate.

The determination of phosphates was carried out by the differential photometric method [1; 218 p., 5; 37 p.]. The method is based on the formation of a yellow-colored phosphor-vanadium-molybdenum complex and photometric measurement of the optical density of this complex at a wavelength of λ = 440 nm relative to a comparison solution containing a known amount of P_2O_5. The extraction of total phosphates was carried out with a solution of nitric acid, assimilable phosphates – citric acid, a solution of trilon B, water-soluble phosphates were carried out with water.

Calcium and magnesium were determined by the complexometric method [1; 218p., 6; 3p.], based on a change in the color of the indicator (fluorexone in the determination of calcium and acid chromium dark blue in the determination of magnesium) during the interaction of calcium and magnesium ions with trilon B.

Research results. To obtain granular complex fertilizers with satisfactory marketable properties and simultaneously improve the performance of the granulator-dryer drum, it is necessary to evaporate the nitrogen-phosphoric acid pulp to a humidity of 20-25% H_2O, i.e. until the pulp density reaches 1.65-1.75 g /sm^3.

In laboratory conditions, the evaporation process was carried out on an electric stove to the required humidity. The results of chemical analysis (Table 1) show that the evaporated nitric-phosphoric acid pulp at a rate of 40% nitric acid contains 5.47% nitrogen, 11.97% total phosphorus, of which 45.81% are in a form assimilable by plants, 4.78% in water-soluble form, 28.24% total calcium, of which 45.65% in digestible form, and 32.24% in water-soluble form, 23.72% water. The pulp, at a 50% acid rate, contains 6.28% nitrogen, 11.41% phosphorus, 26.86% calcium and 25.40% water. It was found that in the evaporated pulp, the decomposition coefficient of phosphorous, depending on the acid norm, increases by 2.55-4.57%.

Table 1

Chemical composition of evaporated nitric-phosphoric acid pulp depending on the acid norm, %

Acidnorm	The content of the main components								
	N	P_2O_5			CaO			H_2O	D.c.
		Total	assim.	water.	Total	assim.	water.		
40	5,47	11,97	15,96	0,60	28,24	13,49	9,85	23,72	45,81
50	6,28	11,41	16,59	0,94	26,86	15,88	11,47	25,40	54,34

Determination of rheological properties of evaporated nitric-phosphoric acid pulps shows (Table 2) that with an increase in temperature and acid norm, their density and viscosity decrease.

Table 2 Rheological properties of evaporated nitric-phosphoric acid pulps depending on the acid norm and temperature

Normsacid,%	temperature, °C						pH
	20	40	60	20	40	60	
	Density, g/cm^3			Viscosity, sDr			
40	1,7779	1,7376	1,6624	12,93	11,67	9,09	5,46
50	1,7324	1,6977	1,6349	13,25	12,46	9,32	5,21

For example, the density of evaporated nitric-phosphoric acid pulp with an increase in temperature from 20 to 60 ° C decreases from 1.7779 to 1.6624 g / cm^3, and the viscosity decreases from 12.93 to 9.09 sDr. This dependence is observed in the evaporated pulp obtained at a 50% acid rate.

To obtain a triple nitrogen-phosphorus-potassium compound fertilizer, an estimated amount of potassium chloride was injected into the evaporated pulp at a temperature of 60-70 ° C and constant stirring. After 30 minutes of stirring, the triple pulp was analyzed for the content of basic substances (Table 3) and its rheological properties were determined (Table 4).

Table 3 Chemical composition of nitrogen-phosphorus-potassium pulps depending on the norm of nitric acid and potassium chloride, %

Mass ratio $N:P_2O_5:K_2O$	The content of the main components									
	N	P_2O_5			K_2O	CaO			H_2O	D.c.
		gen.	assim	water		gen.	assim.	water.		
The norm of nitric acid 40 %										
1:2,5:0,7	5,27	11,45	5,75	0,59	3,96	26,94	12,70	9,43	23,60	46,03
1:2,5:1,4	5,07	10,98	5,55	0,57	6,55	25,77	12,18	9,05	22,57	46,14
1:2,5:2	4,90	10,55	5,37	0,55	8,92	24,70	11,70	8,71	21,64	46,29
1:2,5:2,5	4,80	10,31	5,27	0,54	10,25	24,10	11,43	8,51	21,11	46,38
1:2,5:2,7	4,74	10,15	5,20	0,53	11,10	23,71	11,25	8,39	20,87	46,40
1:2,5:3,5	4,60	9,79	5,02	0,51	13,10	22,81	10,85	8,10	19,00	46,67
The norm of nitric acid 50 %										
1:2:0,6	6,03	9,92	6,15	0,90	3,96	25,63	15,08	10,98	24,14	55,58
1:2:1,2	5,81	10,47	6,22	0,90	6,55	24,52	14,44	10,53	23,10	55,74
1:1,8:1,7	5,60	10,06	5,00	0,89	8,92	23,50	13,86	10,11	24,94	55,79
1:2:2	5,19	9,84	5,89	0,88	10,25	22,93	13,54	9,89	21,61	55,91
1:2:2,3	5,11	9,69	5,83	0,87	11,10	22,57	13,33	9,74	21,28	56,16
1:2:2,9	5,24	9,35	5,85	0,86	13,10	21,78	12,84	9,40	20,46	56,25

Table 4 Rheological properties of nitrogen-phosphorus-potassium pulps depending on the acid norm and temperature

Mass ratio $N:P_2O_5:K_2O$	temperature, °C					
	20	40	60	20	40	60
	Density, g/cm^3			Viscosity, sDr		
The norm of nitric acid 40 %						
1:2,5:0,7	1,7990	1,7864	1,7721	10,56	8,99	7,82
1:2,5:1,4	1,8014	1,7885	1,7759	11,11	9,22	8,38
1:2,5:2	1,8033	1,7913	1,7788	11,86	9,82	8,64

1:2,5:2,5	1,8048	1,7912	1,7791	12,20	10,12	9,22
1:2,5:2,7	1,8062	1,7956	1,7718	12,77	10,73	9,86
1:2,5:3,5	1,8080	1,7961	1,7837	14,62	11,21	10,51
The norm of nitric acid 50 %						
1:2:0,6	1,7791	1,7720	1,1739	11,31	9,57	8,21
1:2:1,2	1,7817	1,7741	1,7658	12,84	11,02	9,78
1:1,8:1,7	1,7842	1,7777	1,7672	14,71	13,47	12,04
1:2:2	1,7858	1,7792	1,7687	15,34	13,97	12,19
1:2:2,3	1,7883	1,7892	1,7701	16,17	15,22	13,86
1:2:2,9	1,7919	1,7883	1,7720	18,81	15,84	14,68

The results of the chemical analysis of the triple complex pulp show that an increase in the norm of potassium chloride practically does not affect the degree of decomposition of the raw materials. For example, pulp with a ratio of $N:P_2O_5:K_2O$ = 1:2.5:0.7 contains 5.27% nitrogen, 11.45% total phosphorus, of which 46.03% in digestible form, 5.75% in water-soluble form, 3.96% potassium (K_2O), 26.94% calcium and 23.60% water. A pulp with a ratio of $N:P_2O_5:K_2O$ = 1:2.5:2.7 contains 4.74% nitrogen, 10.15% total phosphorus, of which 46.40% is in digestible form, 11.10% potassium and 20.78% water.

This dependence is also observed at a 50% norm of nitric acid. The decomposition coefficient increases from 55.58 to 56.25%.

The rheological properties of the complex pulp meet the technical requirements, i.e. they can be easily fed to the BGS using pumps to obtain granular products (Table 4).

To obtain triple complex NPK fertilizers in laboratory conditions, nitrogen-phosphorus-potassium pulps were evaporated (dried) to a residual humidity of 1-2% H2O at a temperature of 130-140^oC. In this case, calcium nitrate tetrahydrate passes into a two-water form. The quality of this product is significantly superior compared to a complex fertilizer containing calcium nitrate tetrahydrate.

Chemical analysis of NPK fertilizers, depending on the norm of nitric acid and potassium chloride (Table 5), shows that during the drying of complex pulp, the decomposition coefficient of phosphorite increases slightly.

For example, an NPK fertilizer obtained at a rate of 40% acid, with a ratio of $N:P_2O_5:K_2O$ = 1:2.5:0.7 contains 6.96% nitrogen, 14.20% total phosphorus, of which 45.19% is in digestible form, 4.96% in water-soluble form, 4.78% potassium, 33.80% total calcium, of which 44.89% in digestible form, 32.23% in water-soluble form. A fertilizer with a nutrient ratio of 1:2.5:2.5 contains 5.61% nitrogen, 12.53% total phosphorus, of which 45.77% is in digestible form, 4.99% in water-soluble form, 12.25% potassium, 29.14% total calcium, of which 44.90% in digestible form, 32.20% in water-soluble form.

Table 5 Chemical composition of NPK fertilizers depending on the norm of nitric acid and potassium chloride, %

Mass ratio $N:P_2O_5:K_2O$	The content of the main components, %								
	N	P_2O_5			K_2O	CaO			H_2O
		gen.	assim	water.		gen.	assim.	water.	
The norm of nitric acid 40 %									
1:2,5:0,7	6,96	14,20	7,02	0,70	4,72	33,80	15,78	10,54	1,94
1:2,5:1,4	6,06	13,45	6,69	0,66	7,91	31,93	14,95	9,93	1,88
1:2,5:2	5,79	12,76	6,41	0,63	10,75	30,23	14,18	9,39	1,95
1:2,5:2,5	5,61	12,33	6,24	0,61	12,25	29,14	13,69	9,03	2,50
1:2,5:2,7	5,53	12,13	6,13	0,60	13,29	28,67	13,47	8,89	2,09
1:2,5:3,5	5,31	11,57	5,94	0,57	15,55	27,25	12,84	8,43	2,33
The norm of nitric acid 50 %									
1:2:0,6	7,42	13,59	8,10	0,94	4,76	32,54	19,02	13,76	1,38
1:2:1,2	7,02	12,88	7,68	0,90	7,95	30,55	17,88	12,96	1,33
1:1,8:1,7	6,65	12,16	7,31	0,84	10,75	28,75	16,85	12,22	2,56
1:2:2	6,52	11,89	7,20	0,80	12,39	28,05	16,45	11,95	1,91
1:2:2,3	6,42	11,70	7,11	0,77	13,44	27,60	16,19	11,76	1,48
1:2:2,9	6,14	11,16	6,82	0,75	15,73	26,22	15,41	11,22	1,70

The same dependence is observed when obtaining a complex triple fertilizer obtained at a 50% rate of nitric acid 14.

Figures 1 and 2 show the dependences of the change in the digestible form of phosphorus and calcium in a complex NPK fertilizer on the norm of nitric acid and the ratio of the main nutrients.

The sum of the nutrient components N, P_2O_5, K_2O and CaO in the new complex fertilizer, depending on the norm of nitric acid and the ratio of nutrients is 37-45%.

The calculated salt composition of a complex NPK fertilizer (Table 6), depending on the norm of nitric acid and the ratio of nutrients, shows that the fertilizer mainly consists of calcium nitrate dihydrate, calcium chloride, potassium nitrate and a phosphate part consisting of monocalcium and dicalcium phosphates, undecomposed phosphorous in activated form and insoluble residue.

Table 6 The salt composition of a complex NPK fertilizer depends on the norm of nitric acid and the ratio of nutrients, %

$N:P_2O_5:K_2O$	Components

	$Ca(NO_3)_2 2H_2O$	Phosphate part and n.o..	KCl	$CaCl_2$	KNO_3	H_2O
The norm of nitric acid 40 %						
1:2,5:0,7	25,26	60,60	-	4,58	7,62	1,94
1:2,5:1,4	17,65	57,45	-	8,19	14,83	1,88
1:2,5:2	10,86	54,64	-	11,40	21,27	1,95
1:2,5:2,5	7,06	52,71	-	13,09	24,69	2,50
1:2,5:2,7	4,68	52,97	-	14,27	26,99	2,54
1:2,5:3,5	-	49,39	1,68	15,68	29,72	2,33
The norm of nitric acid 50 %						
1:2:0,6	30,40	54,87	-	4,63	7,72	1,38
1:2:1,2	23,20	51,72	-	8,23	14,92	1,93
1:1,8:1,7	15,90	48,89	-	11,40	21,25	2,56
1:2:2	12,07	47,81	-	13.25	24,86	1,91
1:2:2,3	9,62	47,13	-	14,44	27,33	1,48
1:2:2,9	3,78	45,00	-	17,02	32,55	1,70

X-ray phase analysis of the product shows that the interplane distances 3,77, 302, 2,77, 2,19, 1,76, 1,54 refer to potassium nitrate, interplane distances 2,23, 1,90, 1,78, 1,51, 1,49, 1,21Å – calcium chloride, and 3.40, 2.53, 2.19, 1.78, 1.69Å - residual calcium nitrate. The data show that the injected potassium chloride completely interacts with the calcium nitrate of the pulp. For example, a fertilizer with a ratio of basic nutrients of 1:2.5:0.7 obtained at a 40% rate of nitric acid contains 25.26% $Ca(NO_3)2*2H_2O$, 4.58% $CaCl_2$, 7.62% KNO_3, 60.60% phosphate component. A decrease in the content of calcium nitrate with an increase in the norm of potassium chloride was found. And in a complex fertilizer with a ratio of 1:2.5:3.5, there is no calcium nitrate, it contains 1.68% free potassium chloride. The formation of potassium nitrate in the process of obtaining a complex fertilizer was identified by X-ray phase analysis. On the radiograph (appendix), the interplane distances Å refers to potassium nitrate.

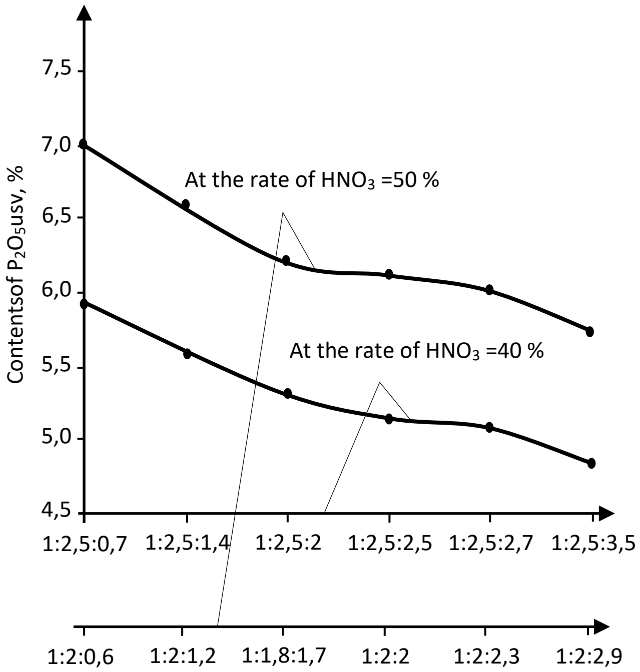

Fig.1 Change in the digestible form of phosphorus depending on the norm of nitric acid and the ratio $N:P_2O_5:K_2O$

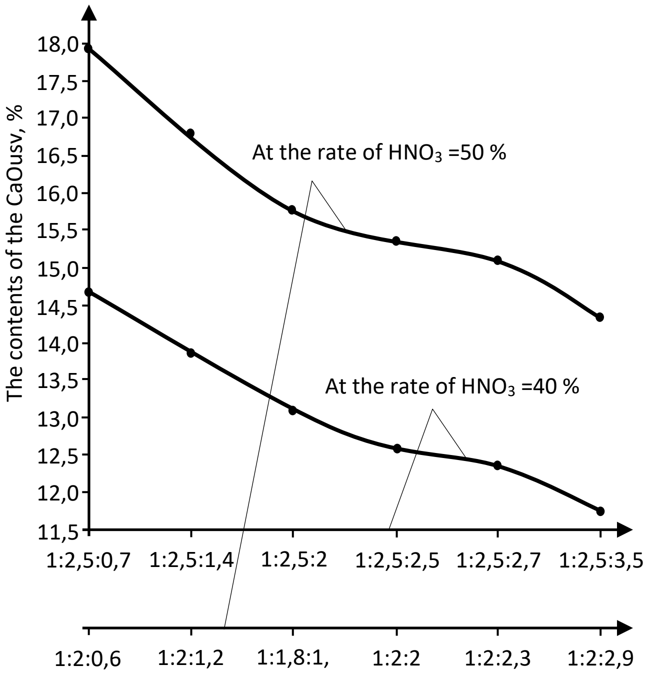

Fig. 2 Change in the digestible form of calcium depending on the norm of nitric acid and the ratio $N:P_2O_5:K_2O$

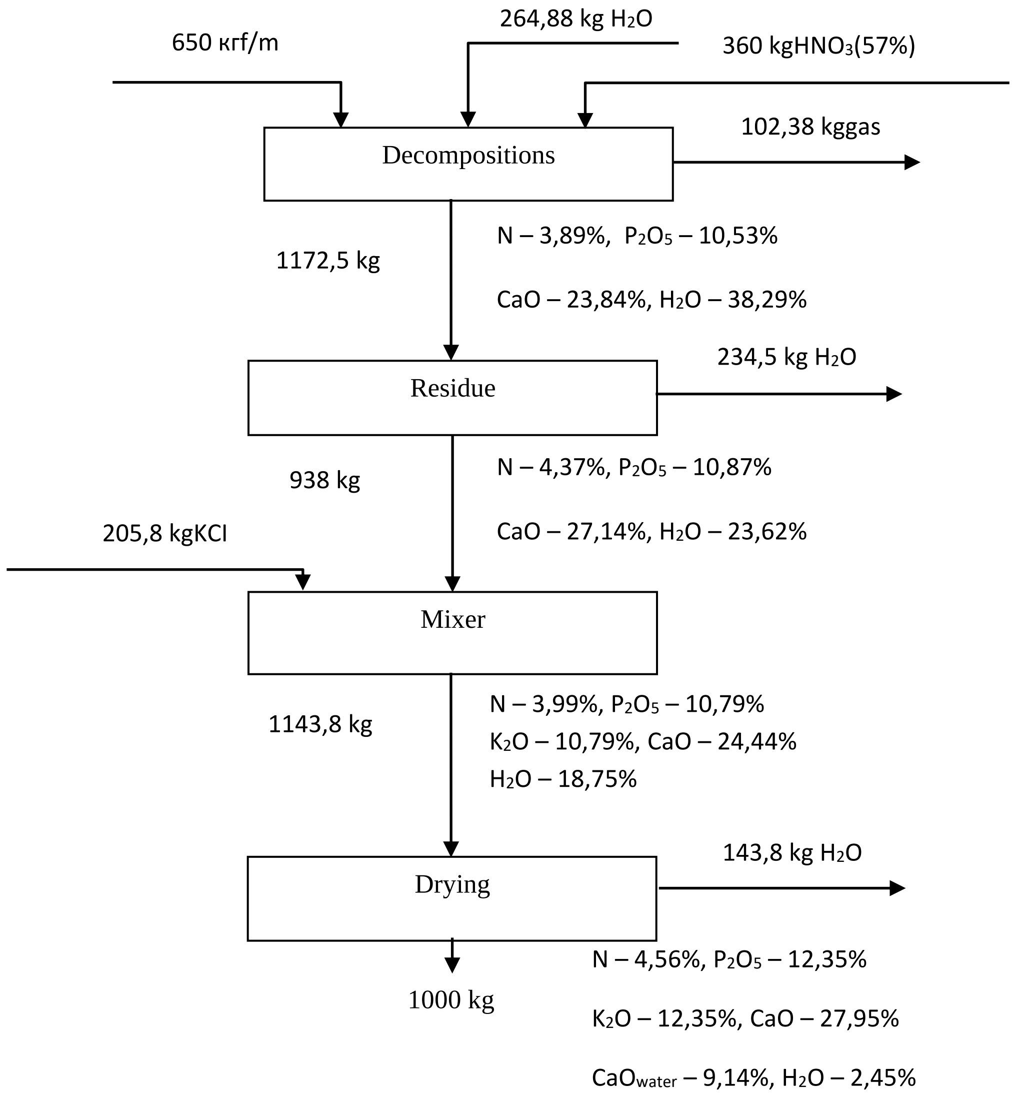

Fig. 3. Material balance of NPK fertilizer production

Based on the experimental data obtained, the material balance was calculated (Fig. 3) for the production of a complex triple fertilizer from the products of nitric acid decomposition of unenforced Kyzylkumfosmuka and potassium chloride of the UP "DZKU". To obtain 1 ton of the finished product containing N – 4.56%, P_2O_5 – 12.35%, K_2O – 12.35%, SaOvod – 9.14%, 650 kg of phosphorous, 360 kg of non-concentrated nitric acid and 205.8 kg of potassium chloride are required.

Currently, Samarqandkimyo JSC produces nitrocalcium phosphate fertilizer - nitrophos according to classical technology, i.e. based on the decomposition of phosphorous flour with an incomplete norm of nitric acid. The technology is carried out without the release of calcium nitrate from nitrogen-phosphoric acid pulp. The finished granular product is obtained from the pulp after its neutralization, evaporation, drying and granulation.

The technological process of obtaining a complex NPK fertilizer developed by us consists of the following main stages:

- reception, storage and transportation of phosphate raw materials;

- reception and storage of nitric acid;

- reception, storage and transportation of potassium chloride;

- decomposition of phosphoric flour with unconcentrated nitric acid to produce nitric-phosphoric acid pulp;

- nitrogen-phosphoric acid pulp residue;

--production of nitrogen-phosphorus-potassium pulp;

- - granulation and drying of nitrogen-phosphorus-potassium pulp;

- classification of the resulting complex fertilizer and crushing of a large fraction;

- absorption of gases after decomposition of fossils;

- gas purification after decomposition of the raw materials, granulation and drying of the finished product;

- warehousing and packaging of the finished product.

To obtain nitrogen-phosphoric acid pulp from high-carbonate phosphorous, existing equipment of the extraction workshop of JSC Samarqandkimyo is used (Fig.4).

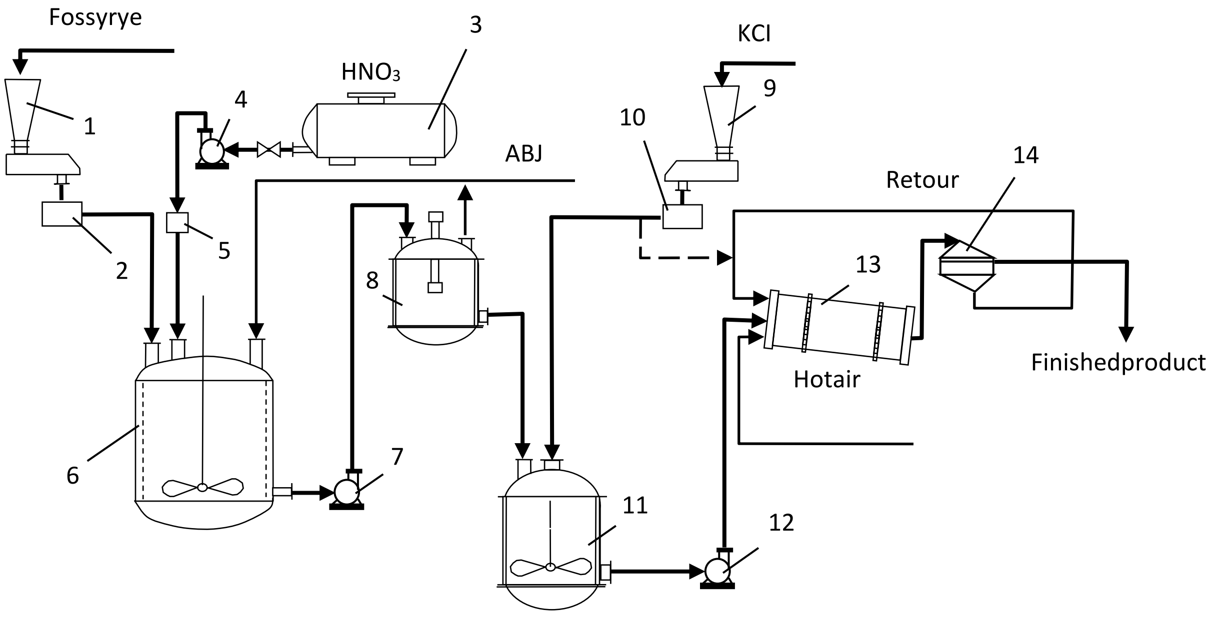

Fig. 4 Technological scheme for obtaining NPK fertilizers according to the classical method: 1-a waste bin; 2-a dispenser; 3-a storage of nitric acid; 4- a pump; 5- a flow meter; 6- a reactor; 7- a pump; 8-a vaporizer; 9- a potassium chloride hopper; 10-a dispenser; 11-a collection of evaporated pulp; 12-a pump; 13- BGS; 14-a classifier

According to the scheme, the feedstock from the raw materials warehouse, with the help of pneumatic pumps, enters the flow hopper (1). From the flow hopper, it is dispensed using a dispenser (2) and fed into the reactor (6) by a scraper conveyor. The reactor is a container lined from the inside, with a volume of 450 m3. The reactor is equipped with seven agitators (one central and six peripheral). Nitric acid (at least 57% HNO_3) is supplied from the acid warehouse from the storages (3) by means of a pump (4) to the pressure tank. The flow of nitric acid into the reactor (5) is carried out through a flow meter. In the reactor (6), the decomposition of the components of the phosphorous with nitric acid occurs with the formation of a nitric-phosphoric acid pulp. To obtain a pulp with a density of 1.5-1.6 g / cm3, an absorption liquid (ABL) is added to the reactor (6) after capturing the exhaust gases from the decomposition reactor and BGS in the absorber.

The released dust-vapor-gas phase formed during decomposition from the reactor is sent for purification. Nitrogen-phosphoric acid pulp with a pH of 3.5-4.5 and a temperature of 35-40 0C is pumped into the pulp collector into the pulp residue department of the mineral fertilizers workshop using a pump. Pulp evaporation is carried out in a bubbling evaporation unit - BVU (8), consisting of a separation chamber, a bubbler lowered into it, a gas heater and an air supply fan for gorenje natural gas. The flow rate of acid pulp is recorded using an induction flow meter IR-61. Part of the pulp from pumping the pump is returned to the reactor for better mixing and elimination of clogging of the pumping pulp pipeline.

Nitrogen-phosphoric acid pulp in contact with flue gases with a temperature of 600-800^oC is evaporated to a residual moisture content of 20-25% H_2O. At the same time, the density of the evaporated pulp increases to 1.60-1.75 g / cm3. The pulp temperature rises to 70-80^oC. The resulting pulp enters the collection of evaporated pulp (11). Fine-grained crystalline potassium chloride is fed from the discharge hopper (9) and with the help of a dispenser (10) into the collection of evaporated pulp. When nitrogen-phosphoric acid pulp is mixed with potassium chloride, due to the interaction of the latter with calcium nitrate contained in the nitrogen-phosphoric acid pulp, potassium nitrate and calcium chloride are formed.

The resulting pulp of the finished product is sprayed through an induction flow meter using a pneumatic nozzle into a retour curtain created when the BGS apparatus rotates. Granulation and drying are carried out in BGS (13). It (drum granulator dryer) is a cylindrical drum tilted at an angle of 30 to the horizon in the direction of unloading. The length of the device is 16 m, diameter 4.5 m. The rotation speed of the drum is 3.5 rpm.

To spray the pulp, compressed air is supplied to the pneumatic nozzle with a pressure of 0.2-0.4 MPa. The granulation process consists in the fact that when the drum rotates, a curtain of retour is created in the granulation zone, on which evaporated pulp is sprayed, supplied from a pneumatic nozzle. Small retour granules are the centers of granulation, the granules are enlarged, acquire a spherical shape, are compacted and dried. As a retour, a fine fraction of the finished product is used, coming from the classification node in a mixture with dust caught in a cyclone.

Drying of nitrophos granules is carried out by supplying flue gases with a temperature of 350-400°C to the BGS. Drying of granules of finished products is carried out to the content of the mass fraction of moisture not more than 1%. The dried granulated product is then transferred through the heat of the unloading hopper of the BGS apparatus to the classification unit in screens (14), the commodity fraction with granule sizes of 1-4 mm is sent to the finished product warehouse. The dust of the product from the exhaust gases is captured in a cyclone and an absorber. The purified gases passed through the high-rise structure are released into the atmosphere.

Due to the presence of chloride and calcium nitrate crystallohydrates in the composition of a complex triple fertilizer, it has the property of hygroscopicity. The hygroscopic point of nitrophos granules with sizes from 1 to 4 mm is in the range of 40-65% relative humidity. Therefore, in areas with a dry climate, where the relative humidity of the air does not exceed 60%, it can be transported and stored in bulk. In such conditions, granular nitrophos in warehouses in bulk should be kept in the form of a well-formed pile (a conical pyramid). In this case, even if the relative humidity of the air slightly exceeds 65%, due to the formation of a thin moisture-proof layer of crust on the cone surfaces over time, the granular product in the pile retains good friability, does not stick.

One of the ways to prevent or reduce hygroscopicity and preserve the friability of granular fertilizer is to transport and store it packed in polyethylene or polypropylene bags. At the same time, the product can be transported in any weather conditions and stored in warehouse conditions.

The technology of obtaining a complex nitrogen-phosphorus-potassium fertilizer containing 5 ± 1% nitrogen (N), 14 ± 1% phosphorus (P_2O_5), 12 ± 1% calcium (CAO), 14 ± 1% potassium (K_2O) was tested on a pilot scale at Samarqandkimyo JSC, and 6800 tons of fertilizer worth 8840 million soums were produced on the operating equipment.

To obtain a complex NPK fertilizer with balanced nutrient ratios, an estimated amount of ammonium nitrate or urea was injected into the evaporated nitrogen-phosphorus-potassium pulp. The resulting pulp after evaporation was granulated and dried at a temperature of 100-105°C.

Table 7 shows the chemical compositions of nitrogen-phosphorus-potassium pulps depending on the norm of nitric acid and ammonium nitrate. It is shown that a complex pulp obtained at a 40% rate of nitric acid and a pulp ratio:ammonium nitrate = 100:5, i.e. having 4.76% ammonium nitrate of its weight, contains 5.17% total nitrogen, of which 14.22% is in ammonium form, 85.78% in nitrate form, 8.77% total phosphorus, 8.71% potassium, 21.90% total calcium and 20.01% water. And the pulp of a complex fertilizer with a ratio of the main nutrient components of 1:1:1 (the amount of ammonium nitrate is 13.04% of the pulp weight) contains 7.72% total nitrogen, 2.01% ammonium nitrogen, 5.71% nitrate nitrogen, 8.02% phosphorus, 7.98% potassium, 20.14% calcium and 17.68% water. An increase in the norm of ammonium nitrate has practically no effect on the decomposition coefficient of fosmuki.

Table 7

Chemical composition of nitrogen-phosphorus-potassium pulps depending on the norm of nitric acid and ammonium nitrate, %

Mass ratio $N:P_2O_5:K_2O$	The content of the main components									
	N	P_2O_5			K_2O	CaO			H_2O	D.c.
		gen.	assim	water		gen.	assim.	water.		
The norm of nitric acid 40 %										
1:2,5:2,5	3,70	9,21	4,17	0,46	9,15	23,00	10,33	7,41	20,01	45,28
1:1,7:1,7	5,17	8,77	3,98	0,44	8,71	21,90	9,85	7,06	19,09	45,38
1:1,3:1,3	6,50	8,37	3,80	0,43	8,33	20,95	9,41	6,74	18,21	45,40
1:1:1	7,72	8,02	3,65	0,41	7,98	20,14	8,99	6,45	17,68	45,51
1:0,9:0,9	8,85	7,68	3,50	0,39	7,63	19,18	8,63	6,19	17,25	45,57
The norm of nitric acid 50 %										
1:2:2	4,39	8,74	4,79	0,80	9,15	21,83	12,44	8,79	20,51	54,81
1:1,4:1,4	5,82	8,32	4,57	0,77	8,71	20,80	11,86	8,36	19,58	54,92
1:1:1	7,13	7,94	4,37	0,73	8,33	19,85	11,32	7,62	18,99	55,03
1:0,9:0,9	8,32	7,61	4,19	0,71	7,98	18,99	10,82	7,65	18,68	55,06

A complex pulp with a nutrient ratio of 1:1:1 (the norm of ammonium nitrate is 9.09% of the pulp weight), obtained with a 50% norm of nitric acid, contains 7.13% of total nitrogen, of which 19.21% is in ammonium, and 80.79% in nitrate forms, 7.94% total phosphorus, 8.33% potassium, 19.85% total calcium and 18.99% water.

A complex NPK fertilizer obtained after drying the pulp at a temperature of 125-135oC was granulated on a laboratory plate granulator. The results of chemical analysis show (Table 8) that the finished product at a ratio of $N:P_2O_5:K_2O$ = 1:1:1 contains 9.53% of total nitrogen in the form of calcium, potassium and ammonium nitrates, 9.90% of total phosphorus in the form of mono- and dicalcium phosphates, and undecomposed, but in the activated form of phosphorous, 9.85% of potassium in the form of potassium nitrate, 24.86% of total calcium in the form of nitrates and calcium chlorides. The sum of nutrients ($N+P_2O_5+K_2O+C_AO$) is 54.14%.

Table 8 Chemical composition of NPK fertilizers depending on the norm of nitric acid and ammonium nitrate, %

Mass ratio $N:P_2O_5:K_2O$	The content of the main components								
	$N_{gen.}$	P_2O_5			K_2O	CaO			H_2O
		gen.	assim.	water.		gen.	assim.	water.	

The norm of nitric acid 40 %									
1:2,5:2,5	4,57	11,37	5,15	0,57	11,30	28,40	12,75	8,15	1,23
1:1,7:1,7	6,38	10,83	4,91	0,54	10,75	27,04	12,16	8,72	1,14
1:1,3:1,3	8,03	10,33	4,69	0,53	10,28	25,86	11,62	8,32	1,06
1:1:1	9,53	9,90	4,51	0,51	9,85	24,86	11,10	7,96	1,11
1:0,9:0,9	10,93	9,48	4,32	0,48	9,42	23,68	10,65	7,64	1,18
The norm of nitric acid 50 %									
1:2:2	5,42	10,79	5,91	0,99	11,30	26,95	15,36	10,85	1,20
1:1,4:1,4	7,18	10,27	5,64	0,96	10,75	25,68	14,64	10,32	1,19
1:1:1	8,80	9,80	5,40	0,90	10,28	24,51	13,96	9,40	1,14
1:0,9:0,9	10,27	9,39	5,17	0,88	9,85	23,44	13,36	9,45	1,17

A complex NPK fertilizer with a ratio of nutritional components 1:1:1, obtained at a 50% rate of nitric acid, contains 8.80% nitrogen, 9.80% phosphorus, 10.28% potassium and 24.51% calcium. The amount of nutrients is 53.39%.

Similar results (Tables 9, 10) were obtained with carbamide. Carbamide practically does not affect the degree of decomposition of phosphorous. But carbamide with calcium nitrate of the pulp forms a complex compound, which significantly improves the physico-chemical and commercial qualities of the finished product.

A complex NPK fertilizer with a nutrient ratio of 1:1:1 (the amount of urea is 9.09% of the pulp weight), obtained at a 40% rate of nitric acid, contains 9.32% of total nitrogen, of which 50.97% is in amide and 49.03% in nitrate forms, 10.33% of total phosphorus, 10.28% potassium, 25.86% total calcium. The amount of nutrients is 55.79%. Such a complex fertilizer, obtained at a 50% rate of nitric acid, contains 10.07% total nitrogen, 9.81% total phosphorus, 10.28% potassium and 24.52% calcium.

Table 9 Chemical composition of nitrogen-phosphorus-potassium pulps depending on the norm of nitric acid and carbamide, %

Mass ratio eN:P_2O_5: K_2O	The content of the main components									
	N	P_2O_5			K_2O	CaO			H_2O	D.c.
		gen.	assim	water		gen.	assim.	water.		
The norm of nitric acid 40 %										
1:2,5:2,5	3,70	9,21	4,17	0,46	9,15	23,00	10,33	7,41	20,01	45,28
1:1,7:1,7	5,72	8,77	3,99	0,44	8,71	21,90	9,85	7,06	19,09	45,49
1:1:1	7,55	8,37	3,81	0,43	8,33	20,95	9,41	6,74	18,21	45,51
1:0,8:0,8	9,22	8,02	3,65	0,41	7,98	20,14	8,99	6,45	17,68	45,52

The norm of nitric acid 50 %										
1:2:2	4,39	8,74	4,79	0,80	9,15	21,83	12,44	8,79	20,51	54,81
1:1,3:1,3	6,37	8,33	4,57	0,78	8,71	20,36	11,86	8,39	20,00	54,86
1:1:1	8,16	7,95	4,37	0,74	8,33	19,86	11,32	8,01	19,62	54,87
1:0,8:0,8	9,82	7,60	4,17	0,71	7,96	18,99	10,86	7,65	19,47	54,88

Table 10 Chemical composition of NPK fertilizers depending on the norm of nitric acid and carbamide, %

Mass ratio $N:P_2O_5:K_2O$	The content of the main components								
	N	P_2O_5			K_2O	CaO			H_2O
		gen.	assim.	water.		gen.	assim.	water.	
The norm of nitric acid 40 %									
1:2,5:2,5	4,57	11,37	5,15	0,58	11,29	28,40	12,75	9,15	1,19
1:1,7:1,7	7,06	10,83	4,93	0,54	10,75	27,04	12,16	8,72	1,25
1:1:1	9,32	10,33	4,70	0,53	10,28	25,86	11,62	8,32	1,18
1:0,8:0,8	11,38	9,90	4,51	0,51	9,85	24,86	11,10	7,96	1,11
The norm of nitric acid 50 %									
1:2:2	5,42	10,79	5,91	0,99	11,30	26,95	15,36	10,85	1,20
1:1,3:1,3	7,86	10,28	5,64	0,96	10,75	25,15	14,64	10,36	1,13
1:1:1	10,07	9,81	5,40	0,91	10,28	24,52	11,98	9,89	1,09
1:0,8:0,8	12,12	9,38	5,15	0,88	9,83	23,45	13,41	9,44	1,17

The amount of nutrients is 54.68%. In a carbamide-containing compound fertilizer, nitrogen is in the form of calcium and potassium nitrates, a complex compound of carbamide with calcium nitrate, the phosphate part in the form of mono- and dicalcium phosphates, and activated phosphorous, calcium chloride.

Table 11 shows the results of chemical analysis of a complex NPK fertilizer obtained on the basis of a ready-made nitrogen-phosphorus fertilizer and potassium chloride. Crystalline potassium chloride is mixed with a retour of nitrogen-phosphorus fertilizer and the resulting mass is granulated with the finished nitrogen-phosphorus fertilizer. Compound fertilizer with a ratio of N:P2O5:K2O = 1:2.8:0.5, obtained at a 40% rate of nitric acid, contains 5.33% nitrogen, 15.18% total phosphorus, of which 39.06% is in digestible form, 5.47% in water-soluble form, 2.86% potassium and 33.13% total calcium, of which 45.64% is in digestible and 32.27% in water-soluble forms.

Table 11 The chemical composition of a complex NPK fertilizer from NP fertilizer and potassium chloride, depending on the norm of nitric acid and potassium chloride, %

Mass ratio $N:P_2O_5:K_2O$	The content of the main components								
	N	P_2O_5			K_2O	CaO			H_2O
		gen.	assim	water		gen.	assim.	water.	
The norm of nitric acid40 %									
1:2,8:0	5,60	15,94	7,23	0,87	-	34,79	15,88	11,22	1,09
1:2,8:0,5	5,33	15,18	5,93	0,83	2,86	33,13	15,12	10,69	1,04
1:2,8:1	5,09	14,49	5,66	0,79	5,46	31,63	14,44	10,20	1,00
1:2,8:1,6	4,87	13,86	5,42	0,76	7,83	30,25	13,81	9,76	1,07
1:2,8:2	4,67	13,28	5,19	0,72	10,10	28,99	13,23	9,35	1,10
1:2,8:2,7	4,48	12,75	4,98	0,70	12,06	27,83	12,70	8,98	0,96
The norm of nitric acid50 %									
1:2,3:0	6,79	15,53	8,20	1,23	-	33,81	19,40	13,61	1,16
1:2,3:0,4	6,46	14,79	6,85	1,17	2,86	32,20	18,48	12,96	1,10
1:2,3:0,9	6,17	14,12	6,54	1,12	5,45	30,74	17,64	12,37	1,05
1:2,3:1,3	5,90	13,50	6,26	1,07	7,83	29,40	16,87	11,84	1,01
1:2,3:1,8	5,65	12,94	6,00	1,02	10,02	28,18	16,17	11,34	1,09
1:2,3:2,2	5,43	12,42	5,76	0,98	12,07	27,05	15,52	10,89	0,93

A complex fertilizer with a ratio of N:P2O5:K2O = 1:2.8:2.7 contains 4.48% nitrogen, 12.75% total phosphorus, 12.06% potassium and 27.83% total calcium. The sum of nutrients, depending on the ratio of nutrients, is 46.50-57.12%.

A complex fertilizer obtained at a 50% rate of nitric acid, with a ratio of N:P2O5:K2O = 1:2.3:2.2 contains 5.43% nitrogen, 12.42% total phosphorus, 12.07% potassium and 27.05% total calcium. During solid-phase mixing, potassium chloride partially interacts with calcium nitrate. Therefore, a complex fertilizer mainly consists of calcium nitrate, unreacted potassium chloride, formed potassium nitrate and mono- and dicalcium phosphates, and activated phosphorous.

To intensify the process of obtaining nitric-phosphoric acid pulp, the decomposition of phosphoric acid with nitric acid under intensive mixing was studied, i.e. the interaction of phosphoric acid with acid was carried out in a "solid-phase" mode.

The decomposition of phosphorous with nitric acid was carried out in a glass reactor at 30-40oC and constant stirring. The calculated amount of nitric acid was fed into the phosphate feedstock for 3-5 minutes. At the same time, an intensive interaction of acid with components of high-carbonate phosphate raw materials took place in the reactor. The temperature, depending on the norm of nitric acid, rises to 40-45oC. Upon contact of high-carbonate phosphor with an incomplete norm of nitric acid, there was practically no abundant foaming, since there was practically no liquid phase.

When studying the process of obtaining nitrogen-phosphorus-potassium fertilizer, unenforced phosphorite flour, 59% nitric acid was used. The norm of nitric acid (20-80%) was calculated for the content of phosphate and carbonate minerals of phosphorous by stoichiometry before the formation of monocalcium phosphate and calcium nitrate. The calculated amount of phosphorite was treated with nitric acid with intensive and thorough stirring for 10-20 minutes. The resulting mass was subjected to chemical analysis after cooling. The results of the experiment are shown in Table 12.

Table 12 The influence of the nitric acid norm on the chemical composition of NP-fertilizers and the degree of decomposition of phosphorous

Norm HNO_3, %	The content of the main components, %									Kp	D.c	Σ NPCaO
	N	P_2O_5			CaO			CO_2	H_2O			
		gen.	assim.	water	gen.	assim..	water					
20	2,72	14,07	3,68	0,46	34,21	8,23	5,58	9,02	3,33	26,15	35,06	25,02
30	3,93	13,66	5,27	0,90	33,22	11,87	8,11	7,70	2,73	38,96	46,72	29,46
40	5,14	13,25	6,86	1,41	32,23	15,52	10,67	6,38	2,14	51,77	58,38	33,91
50	5,85	12,27	7,73	2,46	29,84	17,60	12,32	5,00	1,81	63,97	68,11	35,73
60	6,57	11,29	8,60	3,52	27,46	19,69	13,98	3,62	1,48	76,17	77,85	37,55
70	7,12	10,59	9,00	4,73	25,76	21,42	15,50	2,61	2,22	85,55	83,95	39,14
80	7,68	9,90	9,40	5,95	24,17	23,16	17,02	1,60	2,96	94,94	90,05	40,74

It was found that with an increase in the norm of nitric acid, the degree of decomposition of phosphorite increases. When the acid rate changes from 20 to 80%, the Kr increases from 26.15 to 94.94%. The nitric-phosphoric acid product obtained at a 20% acid rate contains 2.72% nitrogen in the form of calcium nitrate, 14.07% total phosphorus, of which 26.15% is in a form digested by plants, mainly in the form of dicalcium phosphate, 2.78% in a water-soluble form in the form of monocalcium phosphate, 34.21% total CaO, of which 26.63% in a digestible form, 15.49% in a water-soluble form, 9.02% CO2 and undecomposed phosphorite in activated form. The degree of decarbonization of the phosconcentrate is 35.06%. The sum of nutrients (N+P+CAO) is 25.02%. In the product, nitrogen is in the form of highly hygroscopic calcium nitrate 15; p. 30-37.

With an increase in the rate of nitric acid, the coefficient of decomposition of phosphorous increases. For example, at a rate of 40% of stoichiometry, the decomposition coefficient is 51.77%, at a rate of 60% ⍰ 76.17%, at 80% ⍰ 94.94%. Simultaneously with an increase in the acid norm, the content of the digestible form of phosphorus increases. At a rate of 40%, the product contains 13.25% of total phosphorus, of which 51.77% is in a digestible form. The sum of the nutritional components is 33.91%.

A further increase in the rate of HNO3 leads to the formation of a smearing mass at first, then a dense pulp that is difficult to transport. With intensive mixing and a rate of nitric acid of 20-60%, foaming is practically not observed. At an 80% acid rate, the decomposition process of the phosphorous must be carried out in the presence of a retour.

To obtain nitrogen-phosphorus-potassium fertilizers with different ratios of nutrients, the products of nitric acid decomposition of phosphorous were mixed with potassium chloride and ammonium nitrate or urea. The resulting mass was granulated on a laboratory plate granulator and dried at 90-105oC. Chemical and salt compositions of new types of complex fertilizers with ammonium nitrate are given in Tables 13-14.

Table 13 Change in the chemical composition of a complex NPK fertilizer from unenforced phosphorous, potassium chloride and ammonium nitrate, depending on the norm of nitric acid and the ratio of nutrients

$N:P_2O_5:K_2O$	Chemicalcomposition, mass. %												Σ NPKCa
	N	P_2O_5			K_2O	CaO			CO_2	H_2O	Kp	Kд	
		gen	assim	water		gen.	assim	water					
The norm of nitric acid– 40 %													
1:1:1	9,00	9,11	5,26	2,30	9,31	22,16	16,68	7,71	4,37	1,47	57,74	66,00	44,10
1:0,7:0,5	12,18	9,02	4,88	2,15	6,09	21,89	8,15	7,16	4,10	1,38	54,10	68,12	35,44
1:0,7:0,3	12,72	8,91	4,67	2,10	3,81	21,66	8,02	7,01	4,28	1,44	52,41	66,72	33,46
The norm of nitric acid– 60 %													
1:1:1	8,16	8,53	7,18	4,30	8,21	20,74	15,07	11,02	2,27	1,11	85,17	78,30	39,97
1:0,7:0,5	11,45	8,22	6,81	4,20	5,72	20,50	14,56	10,79	2,25	1,05	82,84	82,50	39,95
1:0,7:0,3	11,93	8,10	6,48	4,15	3,58	20,31	13,98	10,38	2,22	1,09	80,00	82,73	37,59

It is shown that a granular complex nitrogen-phosphorus-potassium fertilizer obtained at a rate of 40% nitric acid, depending on the ratio of nutrients N:P2O5:K2O = 1:(1-0,7):(0,3-1) it contains 9.00-12.72% nitrogen in ammonium and nitrate forms, 9.11-8.91% total phosphorus, of which 52.41-57.74% is in digestible form, 29.96-18.01% in water-soluble form, 3.81-9.31% K2O, 21.66-22.16% total CaO, of which 52.41-57.74% is in digestible and 33.68-35.71% in water-soluble forms.

Table 14 Salt composition of nitrogen-phosphorus-potassium fertilizer based on decomposition products of unenforced phosphorous, potassium chloride and ammonium nitrate, depending on the norm of nitric acid

Massratio$N:P_2O_5:K_2O$	Saltcomposition, mass. %					
	NH_4NO_3	KCl	$Ca(NO_3)_2$	$CaHPO_4$	$Ca(H_2PO_4)_2$	Activated Phosphorite
The norm of nitric acid– 40 %						
1:1:1	15,93	15,18	20,71	5,66	3,79	38,59
1:0,7:0,5	25,36	10,14	20,25	5,22	3,54	35,36

1:0,7:0,3	26,48	6,36	19,39	4,92	3,46	39,26
The norm of nitric acid– 60 %						
1:1:1	10,19	14,22	29,09	5,51	7,08	33,72
1:0,7:0,5	19,40	9,54	28,48	5,00	6,92	30,51
1:0,7:0,3	20,20	5,96	27,34	4,46	6,83	35,06

The amount of nutrients is 33.46-44.10%. The product consists mainly of 15.93-26.48% ammonium nitrate, 6.36-15.18% potassium chloride, 19.39-25.67% calcium nitrate, 44.92-10.44% dicalcium phosphate, 2.32-3.46% monocalcium phosphate and 39.26-61.35% undecomposed phosphate in activated form.

The physico-mechanical and marketable properties of the nitrogen-phosphorus-potassium fertilizers obtained (at a rate of nitric acid above 60%) with relative high humidity and long-term storage do not meet the requirements of agriculture, since the simultaneous presence of hygroscopic salts, namely calcium nitrate and ammonium nitrate in the system increases the moisture capacity of the finished product.

It is known that carbamide with calcium nitrate form complex compounds of Ca(NO3)2·4CO(NH2)2 and Ca(NO3)2·CO(NH2)2. These complex salts are practically non-hygroscopic, do not stick at relatively high humidity and have good marketable properties.Granular complex carbamide-containing nitrogen-phosphorus-potassium fertilizer (Table 15), obtained at a rate of 40% nitric acid, depending on the ratio of nutrients N:P2O5:K2O = 1:(1-0,7):(0,3-1) it contains 9.12-13.55% nitrogen in amide and nitrate forms, 8.71-9.02% total phosphorus, of which 51.76-56.87% is in digestible form, 28.45-24.46% in water-soluble form, 4.02-9.25% K2O, 22.07-23.07% total CaO, of which 40.82-37.71% is in digestible and 35.69-30.35% in water-soluble forms. The amount of nutrients is 36.43-38.80%.

Table 15 Change in the chemical composition of a complex NPK fertilizer from unenforced phosphorous, potassium chloride and urea depending on the norm of nitric acid and the ratio of nutrients

$N:P_2O_5:K_2O$	Chemicalcomposition, mass. %												
	N	P_2O_5			K_2O	CaO_O			CO_2	H_2O	Kp	Kд	∑ NPKCa
		gen.	assim.	water.		gen.	assim.	water.					
The norm of nitric acid – 40 %													
1:1:1	9,12	9,02	5,13	2,28	9,25	23,07	11,41	8,00	5,02	1,54	56,87	60,96	38,80
1:0,7:0,5	13,01	8,84	4,77	2,16	6,40	22,16	10,67	7,86	4,96	1,47	53,95	61,43	38,92
1:0,7:0,3	13,55	8,71	4,50	2,08	4,02	22,07	10,15	7,65	4,87	1,54	51,76	62,13	36,43
The norm of nitric acid – 60 %													
1:1:1	8,36	8,46	7,04	4,28	8,30	21,31	15,28	11,28	2,80	1,14	83,21	78,22	40,40
1:0,7:0,5	12,00	8,10	6,61	4,17	5,50	20,41	14,63	10,25	2,76	1,01	81,60	78,53	40,23

1:0,7:0,3	12,50	7,96	6,33	4,12	3,75	21,31	13,28	9,81	2,71	1,14	79,52	78,92	37,49

The carbamide introduced into the system, interacting with calcium nitrate, forms a complex salt. After drying and granulation, a complex nitrogen-phosphorus-potassium fertilizer is obtained that meets the requirements of agriculture.

We have studied the marketable properties of nitrogen-phosphorus-potassium fertilizer by nitric acid processing of unenforced Kyzylkum phosphorous, potassium chloride, ammonium nitrate and urea (Table 16).

Table 16 Commercial properties of NPK fertilizers from unenforced phosphorous

MassratioN:P_2O_5:K_2O	H_2O %	Volume. weight, g/cm^3	Granulestrength, мПа/см^2	Flowabilit, %	Slopeangle, °C	Fluidity, c	Hygroscopicity. point, %
NPK fertilizer based on ammonium nitrate							
The norm of nitric acid – 40 %							
1:1:1	1,47	0,84	1,65	100	41	18,02	52
1:0,7:0,5	1,38	0,85	1,71	100	42	17,42	50
1:0,7:0,3	1,44	0,96	1,73	100	43	17,11	50
The norm of nitric acid – 60 %							
1:1:1	1,11	0,86	1,72	100	43	17,90	51
1:0,7:0,5	1,05	0,95	1,85	100	44	17,15	50
1:0,7:0,3	1,09	0,96	1,92	100	44	16,54	50
NPK fertilizer based on carbamide							
The norm of nitric acid – 40 %							
1:1:1	1,54	0,83	1,64	100	41	17,56	71
1:0,7:0,5	1,47	0,84	1,68	100	42	17,08	69
1:0,7:0,3	1,54	0,94	1,69	100	42	16,16	67
The norm of nitric acid – 60 %							
1:1:1	1,14	0,85	1,70	100	42	17,82	70
1:0,7:0,5	1,01	0,92	1,80	100	43	17,01	65
1:0,7:0,3	1,14	0,93	1,90	100	43	16,44	60

Based on the results obtained, a block diagram (Fig. 5) of the production of NPK fertilizers by an intensive method is proposed.

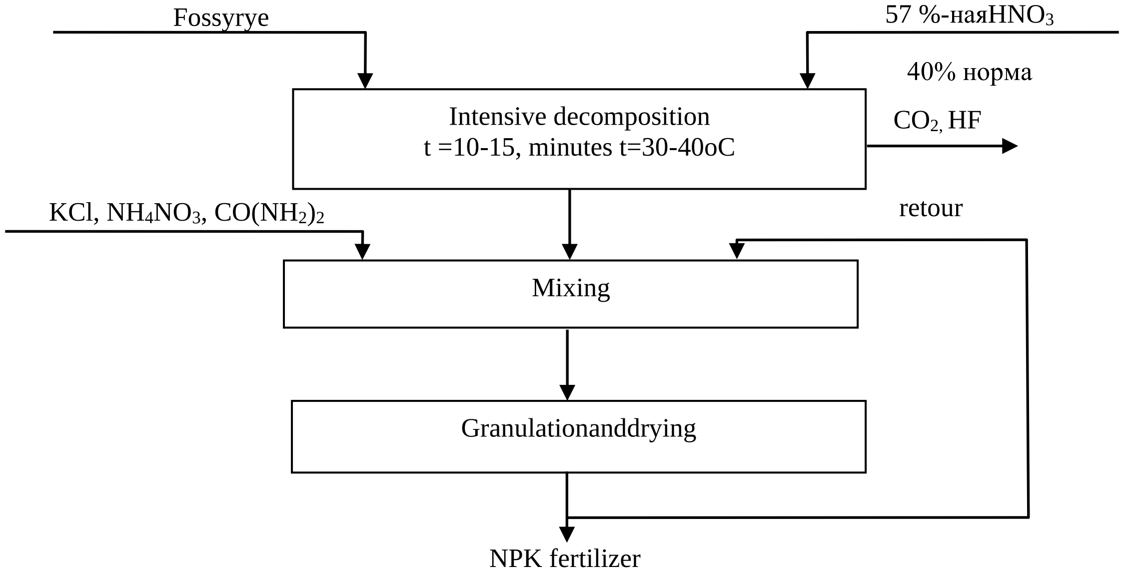

Fig. 5. The basic technological scheme for obtaining nitrogen-phosphorus-potassium fertilizer by the intensive method

The received data. Thus, as a result of the conducted research. after the decomposition of the phosphorous, an estimated amount of water was added to the resulting pulp to obtain 72-80% fertilizer pulp, i.e. the pulp moisture was constantly maintained within 20-28% H_2O.

It has been established that the chemical composition and rheological properties of nitrogen-sulfuric acid pulp by the intensive method are similar to the classical products of nitric acid decomposition of phosphorous. The nitric-phosphoric acid product obtained at a 40% rate of nitric acid contains 5.65% nitrogen, 14.04% total phosphorus, of which 40.17% is in digestible form, and 4.84% in water-soluble form, 35.05% total calcium, of which 44.94% is in digestible, and 32.78% in water-soluble forms. The product obtained at a 50% rate of nitric acid contains 6.77% nitrogen, 13.45% total phosphorus, 50.41% of them is in digestible form, and 9.0% in water-soluble form, 33.60% total calcium, of which 57.02% is in digestible, and 41.04% in water-soluble forms.

Thus, the principal possibility of obtaining a complex nitrogen-phosphorus-potassium fertilizer by nitric acid processing of Kyzylkum phosphorites and potassium chloride using rational technology is shown.

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