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Obtaining Nitrogen-Phosphoric-Potassium Fertilizers Based on Waste Thermal Concentrate, Ammonium Nitrate and Potassium Chloride

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ABSTRACT: Mineral fertilizers are known to be one of the most effective means of increasing crop yields. The solution to these problems is achieved by achieving the effectiveness of fertilizers and applying the most optimal methods of their use and improving their physicochemical properties.The article describes the process of obtaining a new type of complex fertilizer based on porridge with chloro-phosphoric acid, ammonium nitrate (nitrate) and potassium chloride decomposed in hydrochloric acid of Central Kyzylkum, washed and burned with thermo-concentrate. The process of producing complex fertilizers was carried out in a laboratory in a device consisting of a special glass reactor. For this purpose, Central Kyzylkum washed phosphate concentrate (WPC) with the content of P_2O_5 – 25,71 %; CaO – 55,68 %; CO_2 – 2,83 %; MgO – 1,19 %; R_2O_3 – 3,79 %; SO_3 – 5,01 %are treated for 1-2 hours with the incomplete norm of 31.4% hydrochloric acid. The results show that the total content of nitrogen, phosphorus and potassium was 13.77%, and the total content of calcium was 17.01% when the acid norm was 45%, and the nutrient ratio was N: P_2O_5: K_2O = 1:1:1. At the same time, 52.00% of total phosphorus and 31.51% of total calcium are in plant-absorbed form, which leads to an increase in acidity and an increase in their amount.

KEYWORDS: waste-free technology, complex fertilizers, calcined phosphoconcentrate, hydrochloric acid, acid rate, filtrate.

I. INTRODUCTION

The depletion of land and water resources exacerbates the problem of global production of new fertilizers.Today, one of the important tasks of the fertilizer and agriculture industry is to more fully meet the demand of the population for high-quality products.Providing agriculture with mineral fertilizers with high efficiency is one of the most pressing problems today.Today, one of the most environmentally and materially efficient methods of production is waste-free production.The use of waste, especially in the mineral fertilizer industry, prevents pollution of the environment by several processes, which leads to high material costs.Another achievement of wasteless technology is the ability to deliver a unit of nutrients to the consumer at a low cost.It allows efficient use of calcium compounds released as wastes in processing phosphorites.Therefore, we set ourselves the task of creating a scientific base for the production of nitrogen-phosphorus, nitrogen-phosphorus-potassium fertilizers based on waste-free technology.To this end, the processes of obtaining new types of fertilizers based on porridge from chloro-phosphoric acid, ammonium nitrate (nitrate) and potassium chloride decomposed in hydrochloric acid of Central Kyzylkum, washed and burned with thermo-concentrate were studied.

II. MATERIALS AND METHODS

In the laboratory, experiments were carried out on a laboratory device consisting of a tubular glass reactor equipped with a screw mixer with an electric motor. Central Kyzylkum washed phosphoconcentrate (WPC) for laboratory work (composition: P_2O_5 – 25,71 %; CaO – 55,68 %; CO_2 – 2,83 %; MgO – 1,19 %; R_2O_3 – 3,79 %; SO_3 – 5,01 %) was treated for 1-2 hours at an incomplete rate of hydrochloric acid 31.4%. The calculation of the amount of hydrochloric acid was based on the formation of mono-calcium phosphate and calcium chloride salts as a result of the decomposition

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of phosphate, free calcium oxides and calcite minerals in phosphorite samples. Acid norms were obtained at 45, 55, 65 and 75% relative to stoichiometry. The temperature was 55-75 °C depending on the acid norm. The resulting chlorophosphoric acid suspension was neutralized with ammonia gas to pH 5.0-5.5 to prevent loss of phosphorus oxide during filtration of calcium chloride. The neutralized chlorophosphoric acid suspension was filtered by adding water in a ratio of 1:1 to separate calcium chloride. The filtrate obtained in the first filtration process is used as a feedstock for producing chlorate-based defoliants.

The resulting calcium chloride-containing phosphoconcentrate was re-sulfated and filtered in a ratio of 1:1 to water for cleaner washing (this is the second filtration). The filtrate formed during the second filtration process is used for the first filtration of the newly formed suspension of hydrochloric acid and calcium chloride. In the laboratory, the phospho-concentrate obtained after the second filtration to obtain NPK fertilizers was dried under the influence of ammonium nitrate (ammonium nitrate) and potassium chloride produced by the Dehkanabad Potash Fertilizer Plant.

The obtained NPK fertilizers of all types P_2O_5 (general, resorbable and water-soluble) were determined by the photometric method in a photocolorimeter KFK-3 with wavelength λ=440 in a yellow phosphor-vanadium-molybdenum complex. The nitrogen content was determined by distillation of ammonia using the Keldal method and the chloramine method. All forms of calcium were determined by complexometric methods by Trilon-B titration in the presence of fluorine or chromium-orange. Chlorine was determined by the More method. The amount of potassium in the fertilizer was determined by the method. The process of filtration of the chlorophosphoric acid suspension by dilution with water was carried out in a vacuum pump of grade КСЛ-252. The results are shown in Table 1.

III. RESULTS AND DISCUSSION

When the washed phospho-concentrate is treated with hydrochloric acid, the following reactions result in the formation of partial mono-calcium phosphates and dicalcium phosphates:

$$2Ca_5F(PO_4)_3 + 14HCI = 3Ca(H_2PO_4)_2 + 7CaCI_2 + 2HF \quad (1)$$

$$2Ca_5F(PO_4)_3 + 8HCI = 6CaHPO_4 + 4CaCI_2 + 2HF \quad (2)$$

As a result of neutralization with ammonia, the following reaction occurs between $Ca(H_2PO_4)_2$, $CaCI_2$ and NH_3:

$$Ca(H_2PO_4)_2 + CaCI_2 + 2NH_3 \rightarrow 2CaHPO_4 + 2NH_4CI \quad (3)$$

As a result of the third reaction, the amount of phosphorus lost during filtration is drastically reduced. The results are shown in Table 1.

Table 1. Chemical composition of NPK fertilizers in chloro-phosphoric acid, porridge, ammonium nitrate and potassium chloride,%.

N:P_2O_5:K_2O	N			P_2O_5			CaO			K_2O	H_2O
	ум.	амм.	нитр.	ум.	ўзл.	сувл.	ум.	ўзл.	сувл.		
when the stoichiometric acid rate is 45%											
1:2:1	10,41	5,81	4,59	18,38	9,37	-	25,09	7,48	0,09	10,41	0,78
1:1:2	11,20	5,94	5,25	10,5	5,51	-	13,84	4,40	0,05	22,40	0,52
1:1:1	13,77	7,31	6,45	13,71	7,13	-	17,01	5,36	0,07	13,77	0,63
1:0,7:0,5	17,64	9,22	8,42	11,8	6,25	-	15,26	4,99	0,06	8,82	0,65
2:1:1	19,44	10,03	9,41	9,41	5,08	-	11,97	4,05	0,04	9,72	0,59

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when the stoichiometric acid rate is 55%											
1:2:1	9,74	5,16	4,57	19,49	11,89	-	23,31	9,52	0,14	9,75	0,79
1:1:2	10,98	5,65	5,32	10,98	6,86	-	13,14	5,49	0,08	21,97	0,53
1:1:1	13,45	6,92	6,51	13,45	8,34	-	16,09	6,67	0,10	13,45	0,65
1:0,7:0,5	17,38	8,87	8,5	12,16	7,66	-	14,55	6,13	0,09	8,69	0,66
2:1:1	19,28	9,78	9,49	9,63	6,16	-	11,53	4,93	0,06	9,63	0,60
when the stoichiometric norm of acid is 65%											
1:2:1	10,16	5,54	4,6	20,33	14,43	2,03	20,64	12,37	0,98	10,16	1,16
1:1:2	11,25	5,88	5,36	11,25	8,15	1,18	11,42	6,99	0,56	22,50	0,72
1:1:1	13,84	7,24	6,6	13,84	9,96	1,38	14,06	7,43	0,66	13,84	0,89
1:0,7:0,5	17,84	9,21	8,63	12,48	9,11	1,25	12,68	6,81	0,60	8,92	0,88
2:1:1	19,68	10,06	9,61	9,83	14,56	0,98	9,99	6,05	0,47	9,83	0,77
when the stoichiometric norm of acid is 75%											
1:2:1	10,51	5,86	4,64	21,02	17,03	2,73	16,77	14,60	1,17	10,51	1,50
1:1:2	11,45	6,05	5,39	11,45	9,44	1,54	9,14	8,11	0,66	22,91	0,90
1:1:1	14,16	7,48	6,66	14,16	11,61	1,84	11,29	8,49	0,78	14,16	1,11
1:0,7:0,5	18,21	9,47	8,73	12,74	10,57	1,65	10,17	7,74	0,70	9,10	1,08
2:1:1	20,00	10,28	9,71	10,00	8,40	1,30	7,97	7,18	0,55	10,00	0,93

The results showed that when the acid norm is 45%, and the nutrient ratio is $N:P_2O_5:K_2O=1:1:1$, the total content of nitrogen, phosphorus and potassium is 13.77%, and the total content of calcium is 17.01%. At the same time, 52.00% of total phosphorus and 31.51% of total calcium are in plant-absorbed form. The ammonia and nitrate forms of nitrogen are 7.31 and 6.45%, respectively. The total amount of nutrients is 46.61%. When the stoichiometric norm of acid increases from 55 to 75%, the form of phosphorus and calcium absorbed by plants increases by 1.17-1.63 and 1.24-1.58 times, respectively. The total amount of nutrients will increase to 47.02-50.97%. Experiments have shown that when porridge with chlorophosphoric acid is obtained at high stoichiometric standards of hydrochloric acid, it contains a large amount of calcium chloride, and when it is filtered, calcium is released into the filtrate as a solution of calcium chloride. This increases the total phosphorus content of the phospho-concentrate. This also justifies a 1.05-1.51 reduction in total calcium intake. Nitrogen and potassium in fertilizer are in the form of complete assimilation of plants, their content is 9.74-20.00 and 8.82-22.91%, respectively.

IV. CONCLUSION

Possibility of obtaining complex nitrogen-phosphorus-potassium fertilizers by the effect of ammonium nitrate and potassium chloride on phosphoconcentrate obtained during the first and second washing and drying of phosphoconcentrate washed by central Kyzylkum with hydrochloric acid was experimentally determined.The filtrate formed during the first washing of the chlorophosphoric acid suspension with water is used as a sweetener for producing chlorate-based defoliants.

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