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Kinetics of Decomposition of Washed Roasted Phosphoconcentrate in Hydrochloric Acid

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ABSTRACT: This article discusses the kinetics of decomposition of washed phosphoconcentrate in hydrochloric acid and the local raw material, i.e. thermo concentrate with hydrochloric acid, washing it twice with water and obtaining high-efficiency nitrogen-phosphorus and nitrogen-phosphorus-potassium complex fertilizers from the remaining residue.

KEYWORDS: *Agriculture, mineral fertilizers, waste, nitrogen, hydrogen, raw materials.*

INTRODUCTION

The depletion of arable land and water resources is exacerbating the problem of new types of fertilizer production worldwide. Today, one of the important tasks of the fertilizer industry and agriculture is to more fully meet the demand of the population for quality products. Providing agriculture with mineral fertilizers at a high level of efficiency is one of the most pressing issues today.

One of the most efficient methods of production is waste-free production. The use of waste in the production of mineral fertilizers leads to a significant reduction in material costs of a number of processes. It also allows for the cheap delivery of a unit of nutrients to the consumer. Allows efficient use of calcium compounds released as waste in the processing of phosphorites. Therefore, we set ourselves the goal of creating a scientific basis for the production of nitrogen-phosphorus, nitrogen-phosphorus-potassium fertilizers on the basis of waste-free technology. To do this, the kinetics of decomposition of thermoconcentrate from the Central Kyzylkum phosphorites in the process of obtaining a new type of fertilizer based on chlorophosphoric acid slurry, CAS and potassium chloride, decomposed in hydrochloric acid, was studied.

Object and methods of research

In the laboratory, the experiments were performed on a laboratory device consisting of a tubular glass reactor equipped with an electric motor-driven screw mixer. Central Kyzylkum washed phosphoconcentrate (thermoconcentrate) 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 broken down for 2.5–30 min with incomplete norms of 31.4% hydrochloric acid. The calculation of the amount of hydrochloric acid was based on the formation of monocalcium phosphate and calcium chloride salts by breaking down the phosphate, free calcium oxide and calcite minerals in the thermoconcentrate sample. The acid norm was 45, 55, 65, 75, 90, and 100% relative to stoichiometry. The temperature was 65-85 ^{o}C depending on the acid norm. The resulting chlorinated phosphoric acid slurry was neutralized with ammonia gas until the pH = 5.0–5.5 to prevent the loss of phosphorus oxide during the filtration of calcium chloride [1-5].

In the study of the kinetics of the decomposition of phosphate raw material with hydrochloric acid, n-butanol alcohol was used to stop the reaction. In this case, the remaining hydrochloric acid and the resulting phosphoric acid stop reacting with the phosphate raw material [6; S.47]. Experiments have shown that when 2.5 volumes of n-butanol alcohol are added to 1 volume of chlorophosphoric acid porridge, the reaction is practically completely stopped. After complete cessation of the process, the chlorophosphoric acid slurry is separated by filtration into a solid and a liquid phase. The wet residue (phosphoconcentrate) was washed with water in a ratio of FC: N_2O = 1: 2. The degree of decomposition of phosphate raw materials was determined by the following formula:

$$\gamma = 100 - \frac{m_{1P_2O_{5\text{general}}} - m_{P_2O_{5\text{suvdaer}}}}{m_{P_2O_{5\text{general}}}} \cdot 100,$$

Where $m_{1P_2O_{5\text{general}}}$ - total weight of R_2O_5 in wet residue, g;

$m_{P_2O_{5\text{suvdaer.}}}$ - the mass of R_2O_5 in the water-soluble form in the wet residue, g.

$m_{P_2O_{5\text{general}}}$ - total weight of R_2O_5 in the sample, g;

The stoichiometric norm of hydrochloric acid was calculated for the formation of monocalcium phosphate and calcium chloride from the phosphate and calcite (including free SaO raw) minerals in the washed phosphoconcentrate (thermoconcentrate).

Determination of chemical analysis, moisture and other parameters of all forms of nitrogen, phosphorus, potassium, calcium and chlorine in the porridge formed as a result of raw materials and decomposition [1-5; 7-15] are given in full in the works.

RESEARCH RESULTS AND DISCUSSION

The experimental results presented in Table 1 show that the rate of transition of R_2O_5 to the liquid phase increases with increasing stoichiometric norm of hydrochloric acid and the interaction time of the reacting components. For example, when the stoichiometric norm of acid is 45%, the rate of decomposition of R_2O_5 when exposed to hydrochloric acid with thermoconcentrate for 2.5 minutes is 39.52%. When the reaction time of hydrochloric acid with the thermoconcentrate lasts up to 30 minutes, the rate of transition of R_2O_5 to the liquid phase is 46.52%. When the exposure of the components is 2.5 minutes, the rate of transition of R_2O_5 to the liquid phase increases with increasing acidity. For example, when the acidity is 55 and 100%, the rate of transition of R_2O_5 to the liquid phase is 49.13% and 86.46%, respectively. The same relationship is repeated at other time values of the interaction.

From the results obtained, it was found that the rate of transition of R_2O_5 to the liquid phase depends mainly on the stoichiometric norm of hydrochloric acid.

TABLE 1 DEPENDENCE OF THE RATE OF TRANSITION OF R_2O_5 TO THE LIQUID PHASE ON THE NORM AND TIME OF HYDROCHLORIC ACID,%

Acid norm	Time, minutes (minutes)

	2,5	5	10	15	20	25	30
45	39,52	43,16	44,41	45,16	45,78	46,23	46,52
55	49,13	53,71	55,46	56,29	56,95	57,33	57,64
65	59,41	63,86	65,47	66,35	66,92	67,31	67,64
75	68,71	73,29	74,47	75,38	76,04	76,41	76,87
90	77,975	86,12	89,12	89,91	91,68	92,09	92,72
100	86,46	93,75	94,88	95,15	95,28	95,74	96,22

The results showed that in the first 15 min, the interaction of the components continued in the kinetic region and the reaction was completed in the diffusion region. The rate of transition of R_2O_5 from the thermoconcentrate to the liquid phase (Table 2) depends on the stoichiometric norm of hydrochloric acid. Calculations of the experimental results showed that the best rate of transition of R_2O_5 to the liquid phase (g / min) was observed in the first 2.5 minutes of the thermoconcentrate decomposition process.

TABLE 2 THE RATE OF TRANSITION OF R_2O_5 TO THE LIQUID PHASE DEPENDS ON THE RATE OF HYDROCHLORIC ACID AND TIME, G

Acid norm	Time, minutes						
	2,5	5	10	15	20	25	30
45	4,06	2,22	1,14	0,77	0,59	0,48	0,4
55	5,05	2,76	1,43	0,96	0,73	0,59	0,49
65	6,11	3,28	1,68	1,14	0,86	0,69	0,58
75	7,07	3,77	1,91	1,29	0,98	0,79	0,66
90	8,02	4,43	2,29	1,54	1,18	0,95	0,79
100	8,89	4,82	2,44	1,63	1,22	0,98	0,82

For example. The rate of transition of R_2O_5 to the liquid phase is 4.06 g / min at 75% acidity, 7.07 g / min at 75%, and 8.89 g / min at 100%. is formed.

CONCLUSION

Experimental results showed that the bulk of the thermoconcentrate (85-95%) decomposes in the first 15-20 minutes of component interaction. This means that the local raw material, ie the thermoconcentrate, is broken down by hydrochloric acid, washed twice with water, and the decomposition process is continued regardless of the acid content. It is advisable to take -25 minutes.

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