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KINETICS OF DECOMPOSITION OF DOLOMITE FROM THE SHORSU DEPOSIT BY NITRIC ACID

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Abstract
The kinetics was studied process of dolomite decomposition by nitric acid depending on concentration and temperature. The main kinetic parameters of the decomposition process are established and equations are derived for the dependence of the foam multiplicity constant on the acid feed rate.

Keywords: Dolomite, Nitric acid of ethylene producers, foam multiplicity. foaming decomposition of dolomite.

Introduction

The production of mineral fertilizers requires the availability of accessible raw materials that meet the quality requirements for their processing.

Objects and Methods of Research

The object of the research is dolomite. Dolomite is a mineral of the carbonate class ($CaCO_3$ and $Mg(ClO_3)_2$ contains impurities of divalent metals Fe , Mn , Co , Zn and Pb . The main deposits of dolomite are in Spain, Switzerland, the USA, Mexico, Canada and Russia. In Uzbekistan, dolomite is found in the Fergana, Navoi, Bukhara, Samarkand, Namangan, Tashkent and Kashkadarya regions.

Results and Discussion

Since dolomite contains such nutritional components as Ca and Mg , which are necessary for plant growth and development, this mineral can be used to obtain liquid fertilizer. By decomposing dolomite with nitric acid, a solution of calcium and magnesium nitrates can be obtained. By further enriching the resulting solution with components of mineral fertilizers, physiologically active substances, and microelements, a liquid fertilizer of complex action can be obtained.

Dolomites from various deposits are characterized by specific chemical and mineralogical composition. Research on hydrochloric acid, nitric acid, sulfuric acid and sulfur-hydrochloric acid decomposition of dolomites from various deposits was carried out by the authors of works [1-4]. Based on the work they carried out, it was recommended: obtaining a solution of magnesium nitrate for use as a conditioning additive in ammonium nitrate; magnesium sulfate; liquid nitrogen-calcium-magnesium fertilizer; bischofite; urea with the addition of magnesium sulfate and anti-

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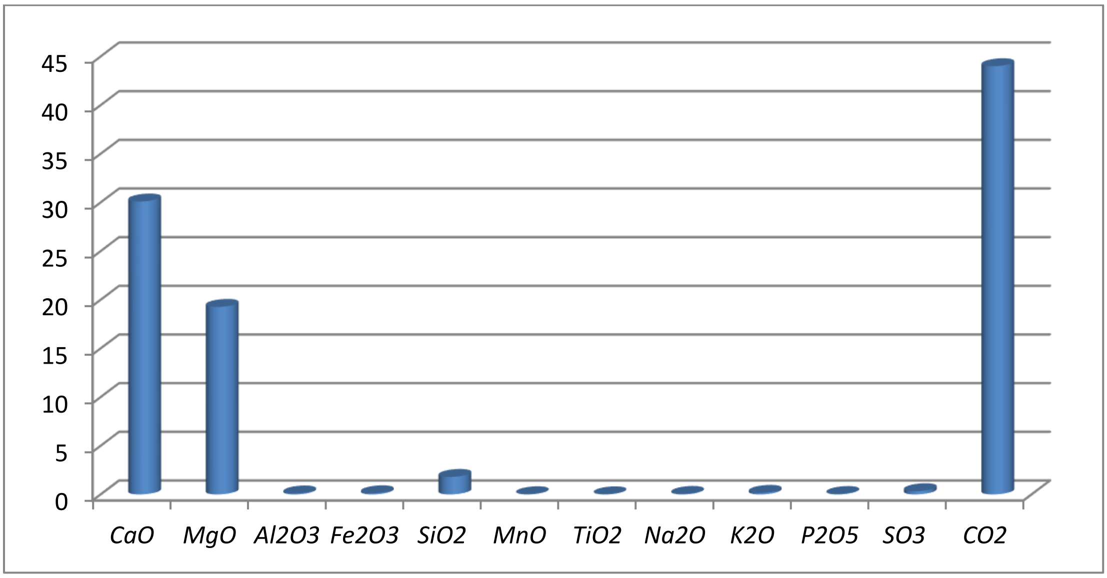
icing reagent; obtaining a new calcium-magnesium chlorate defoliant; obtaining a complex-action defoliant by involving urea and ethylene producers in its composition.

For our research, we selected dolomite from the Shorsu deposit in the Fergana region. The chemical composition of the Shorsu dolomite is shown in Figure 1.



Chemical composition of dolomite (mass %)

In order to develop a technology for obtaining a liquid fertilizer with a complex effect based on the products of nitric acid decomposition of dolomite from the Shorsu mine, it is necessary to study the decomposition process depending on the concentration of acid and temperature.

For this purpose, nitric acid solutions of 20, 30, 40, 57% concentration were used. The experiments were conducted in a thermostatted three-mountain glass reactor at temperatures of 20, 30, 40, 50 and 60°C. The calculated amount of crushed dolomite was immersed in the reactor, and then the calculated amount of nitric acid was gradually poured in at 100% stoichiometry. Thirty minutes after the decomposition process was complete, the content of CaO and MgO in the solution was determined using the complexometric analysis method [5], and the degree of extraction of CaO and MgO into the solution was calculated.

The experimental data results are shown in Table 2.

Table 2 Dependence of the degree of extraction of CaO and MgO into solution on temperature and concentration of nitric acid

Temperature, °C	Concentration of nitric acid, %							
	20		30		40		57	
	Degree of extraction into solution, %							
	CaO	MgO	CaO	MgO	CaO	MgO	CaO	MgO
20	68.53	70.14	81.30	82.42	89.3	90.42	89.29	91.33
30	70,74	71.23	88.32	89.61	97.3	89.42	97.41	98.50
40	71.38	72.08	89.34	90.48	98.54	99.0	98.62	99.23
50	72.04	72.56	90.28	91.39	98.82	99.35	98.90	99.47
60	72.58	73.17	91.34	91.97	99.24	99.46	99.31	99.56

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Table 2 shows the results of experimental data on the effect of acid concentration and temperature on the degree of extraction of calcium and magnesium oxides into the solution. The table shows that when decomposing dolomite with 20% nitric acid, as the process temperature increases from 20 to 60°C, the degree of extraction of CaO is 68.53÷72.58%, MgO 70.14÷73.17%. When decomposing dolomite with 30% HNO3 , the degree of extraction of CaO and MgO was 81.3÷91.34% and 82.44÷91.97%, respectively.

Decomposition of dolomite with 40% acid contributed to 89.3÷99.24% extraction of CaO into solution and 90.42÷99.46% extraction of MgO into solution .

The decomposition of dolomite with 57% nitric acid has shown that the degree of extraction of calcium and magnesium oxides into the solution reaches 89.29÷99.31% CaO and 91.33÷99.56% MgO , respectively. That is, increasing the acid concentration to more than 40% does not significantly increase the degree of extraction of CaO and MgO into the solution. Regarding the influence of the temperature of the nitric acid decomposition of dolomite, it can be said that the optimum temperature is t=30÷40°C. Increasing the temperature to 50 and 60°C is not advisable, since the degree of extraction of CaO and MgO into the solution changes insignificantly. Therefore, the optimum parameters of the nitric acid decomposition of dolomite are: nitric acid concentration - 40%, temperature 30÷40°C, time - 30 minutes.

It is known that the process of decomposition of dolomite with nitric acid, as well as with any other acid, is accompanied by abundant release of carbon dioxide, which leads to foaming. With abundant foaming, the foam can overflow through leaks and holes in the reactors, preventing uniform distribution of raw materials, which in turn leads to a decrease in the productivity of the main equipment, as well as to a deterioration in the environmental conditions of production.

The main parameter characterizing the foaming process during acid decomposition of dolomite is the foam multiplicity (K_p). The foam multiplicity is the ratio of the foam volume (V_p) to the liquid volume (V_{liq}) [6] .

$$K = \frac{V_п}{V_{ж}};$$

In order to reduce foaming during the decomposition of dolomite with nitric acid, the dependence of the foam multiplicity on the acid feed rate was studied.

The foaming process during the decomposition of dolomite from the Shorsu mine was studied by us using 40% nitric acid, since this concentration was accepted as optimal for decomposition.

The results of the study of the dependence of the foam multiplicity on different acid feed rates are shown in the figure and table 3.

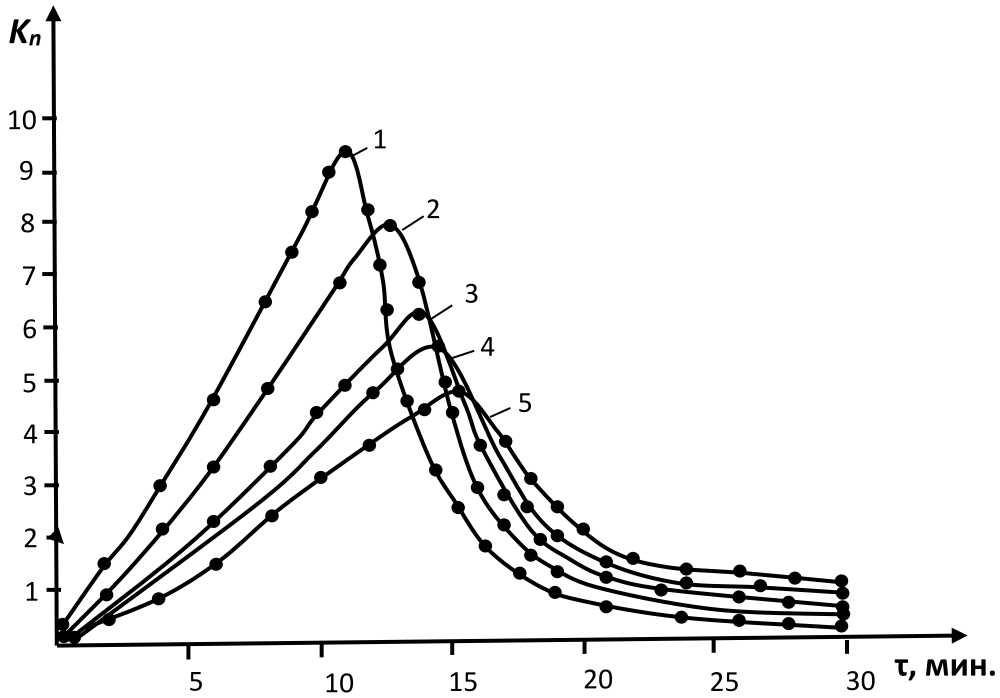

Fig. 2. Dependence of the change in foam multiplicity on time and the rate of nitric acid supply during the decomposition of dolomite of the Shorsu field

1– at V=20 g/min; 2 – at V=18 g/min; 3– at V=16.5 g/min;
4 – at V=10 g/min; 5– at V= 8 g/min .

Table 3 Dependence of the change in foam multiplicity on the acid feed rate during the decomposition of dolomite from the Shorsu mine with 40% nitric acid

No. p/p	Acid feed rate V , g/min.	Volume liquids, ml	Volume foam, ml	Foam multiplicity, To $_p$
1	6.5	26.5	111	4.10
2	8.0	-//-	130	4.90
3	10.0	26.5	150	5.66
4	16.5	26.5	168	6.30
5	18.0	26.5	212	8.00
6	20.0	26.5	250	9.43

From the data given in the figure and the table, it follows that during the decomposition of dolomite with 40% nitric acid at an acid feed rate of V = 6.5 g/min. the maximum foam multiplicity is K_p = 4.1. During the decomposition of dolomite with nitric acid fed at a rate of V = 8.0 g/min. the maximum foam multiplicity was K_p = 4.90. And at an acid feed rate of V = 20.0 g/min. the maximum foam multiplicity was K_p = 9.43. This indicator is undesirable. As the acid feed rate increases from V = 6.5 to V = 20 g/min. K_p increases from 4.1 to 9.43. That is, the higher the acid feed rate, the more abundant the foaming.

From the data in the table and Figure 2 it follows that the optimal rate of acid supply in the process of decomposition of dolomite with 40% nitric acid is V = 10÷16.5 g/min, at which the maximum foam multiplicity is K_p = 5.66÷6.30.

Conclusion

Thus, based on the conducted studies on the decomposition of dolomite m.r. "Shorsu" with nitric acid, the optimal process parameters were established: nitric acid concentration - 40%, process temperature 30 ÷ 40 ° C, acid feed rate V = 10 ÷ 16.5 g / min., at which the maximum foam multiplicity is K_p = 5.6 ÷ 6.30.

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