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STUDY OF THE PROCESS OF ISOLATION OF MAGNESIUM COMPOUNDS FROM SERPENTINITE

Abstract. This paper provides data on the study of treatment of serpentinite with nitrate acid in the Karakalpak field. According to the chemical analysis, the composition of the raw material containing 33–35% MgO was determined. The results of the study showed that in the studied ranges of variation, the technological parameters of the MgO content in the liquid phase did not exceed 1.69 (in the ranges of temperature 40–80 °C), and with an increase in temperature by 95 °C, the content and yield of magnesium oxide increased by 2 times, respectively, by 2.99% and 24.4%.

Keywords: Serpentinite, magnesium nitrate, nitric acid, decomposition, acid leaching

Introduction. To obtain granular ammonium nitrate, which does not cake for long storage, a conditioning additive of magnesium nitrate is introduced into the ammonium nitrate solution before granulation, which, in an anhydrous state, can attach up to six water molecules to form magnesium nitrate hexahydrate – $Mg(NO_3)_2*6H_2O$. The most common magnesium compounds are volcanic formations – primary silicate and aluminosilicate rocks [1]. Based on this, the research aimed at the development of the technology of processing serpentinite of the Karakalpak deposit into magnesium nitrate with the simultaneous production of nitrogen fertilizers is very relevant, which is one of the main tasks of this work.

Natural serpentinites, in addition to the main mineral serpentine $Mg_2 3Si_2O_5 (OH)_4$ (density 2.2–2.9 g/cm^3, hardness 2.5–4), have impurities of different ore minerals giving the rock a different color. There are many serpetinite deposits in different regions of the country.

Composition of starting serpentinite:

- mass fraction of magnesium in terms of MgO 33.70–34.07%
- mass fraction of calcium in terms of CaO 0.86–0.70%
- mass fraction of silicon in terms of SiO2 40.26–39.98%
- mass fraction of iron in terms of iron oxide 8.83–8.75%

There are many ways to process serpentines [2]. For laboratory experiments, two schemes were chosen:

1) acid leaching at various temperatures → ammonization of the suspension after completion of the filtratsii→ evaporation process before crystallization

2) thermal activation of serpentinite → acid leaching at temperature 70–95 °C → ammonisation of suspension till precipitation of iron oxides, alyuminiya→ evaporation till crystallisation.

To select the optimal leaching conditions under which all valuable components are extracted from serpentinite as much as possible, the effect of the process temperature, its duration, the initial concentration of nitrate acid on the concentration of magnesium and iron ions in the solution, the filtration coefficient and the sedimentation of the solid phase of the suspension were studied. Process parameters varied in the ranges nitric acid concentration 30––50%, process temperature 40–95 °C, process duration 30–240 min, nitric acid norm was 100% relative to the total metal oxide.

A mixing reactor was used for leaching: a flask reactor into a thermostat, where nitrate acid of a certain concentration was poured, the acid was supplied based on the calculation of the dissolution of all metals in serpentinite. Serpentinite of < 0.315 mm was then added when the desired temperature was reached. After acid treatment, the resulting suspension was separated from the insoluble silica residue by filtration.

From (Fig 1) it can be seen that in the studied ranges of variation, the technological parameters of the content of MgO in the liquid phase did not exceed 1.69 in the ranges of temperature 40–80 °C, and by increasing the temperature by 95 °C, ensure an increase in the content and yield of magnesium by 2 times, respectively, by 2.99% and 24.4%.

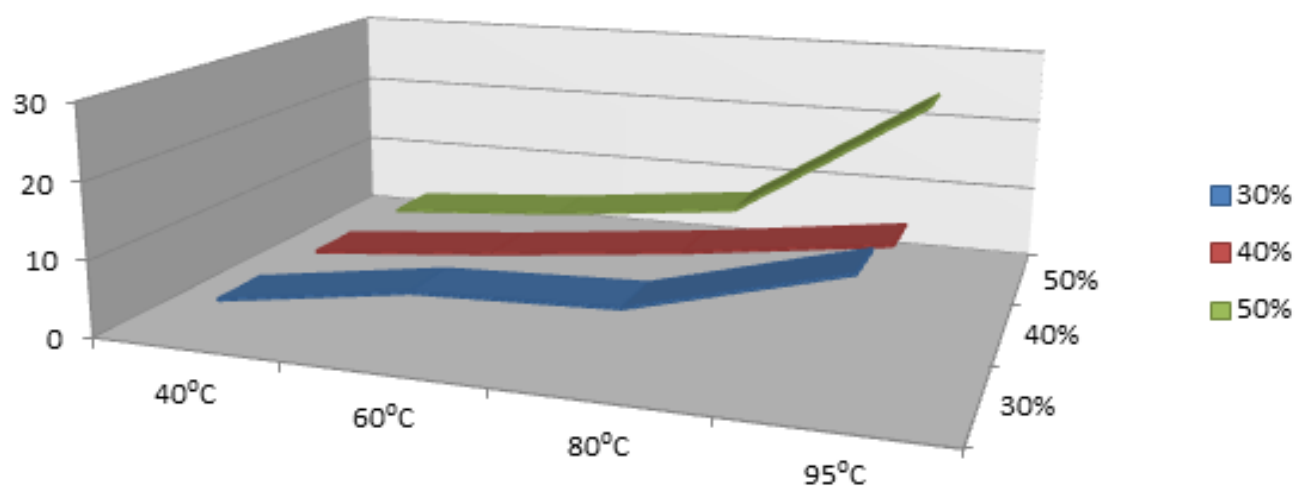

Figure 1. Degree of transition of MgO into liquid phase depending on decomposition temperature

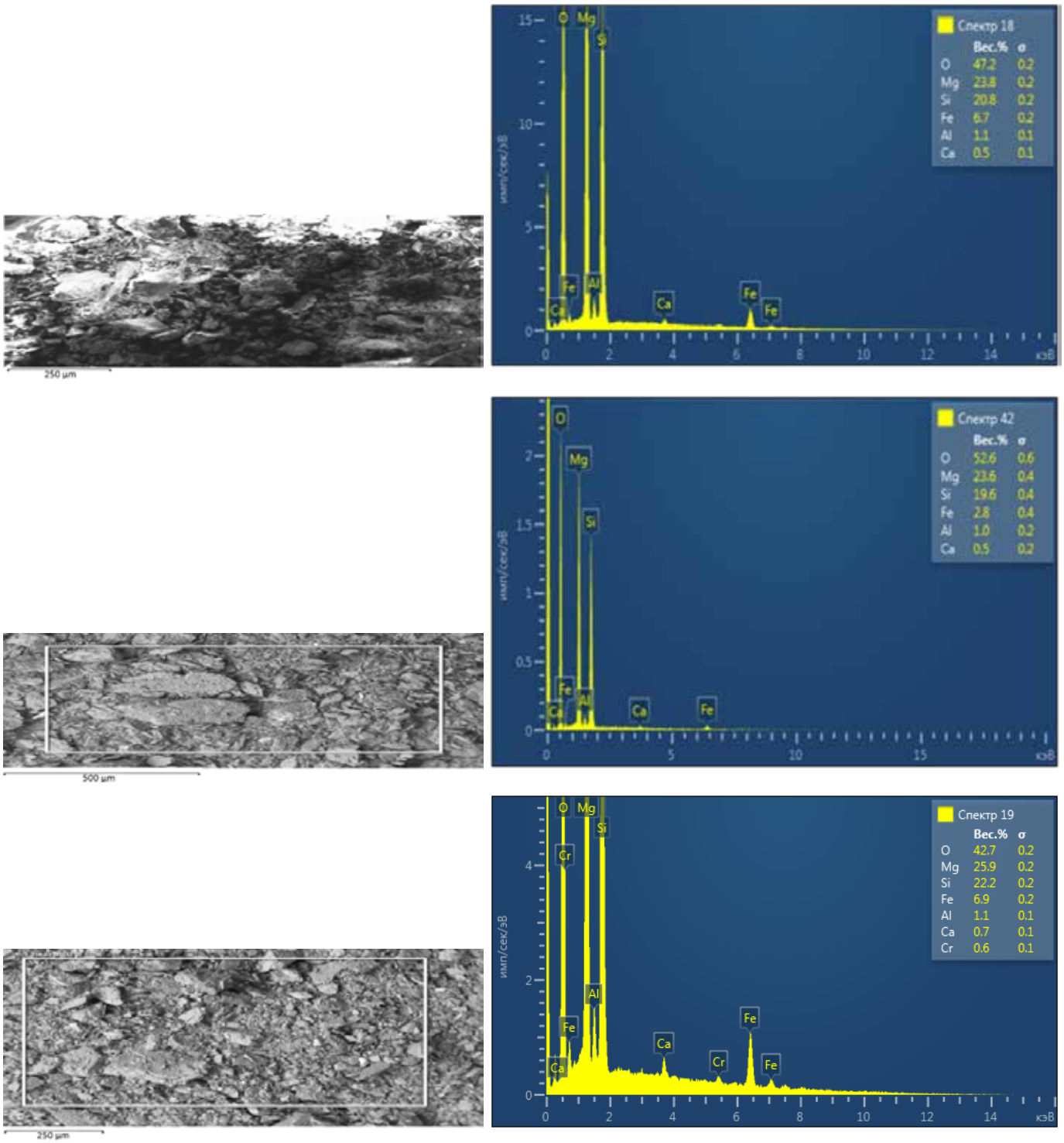

Figure 2. Energy-dispersed spectrum of samples. Initial and heat treated at 178 °C and 800 °C

Table 1.– Elemental Composition of Starting and Heat-Treated Serpentinite by Energy-Dispersive X-ray Spectroscopy

№	element	content by weight%		
		initial	heat treated	
			178 °C	800 °C
	O	52.6	47.18	42.69
	Mg	23.6	23.77	25.89
	Al	1.0	1.09	1.07
	Si	19.6	20.78	22.20
	Ca	0.45	0.47	0.67
	Fe	2.72	6.71	6.92

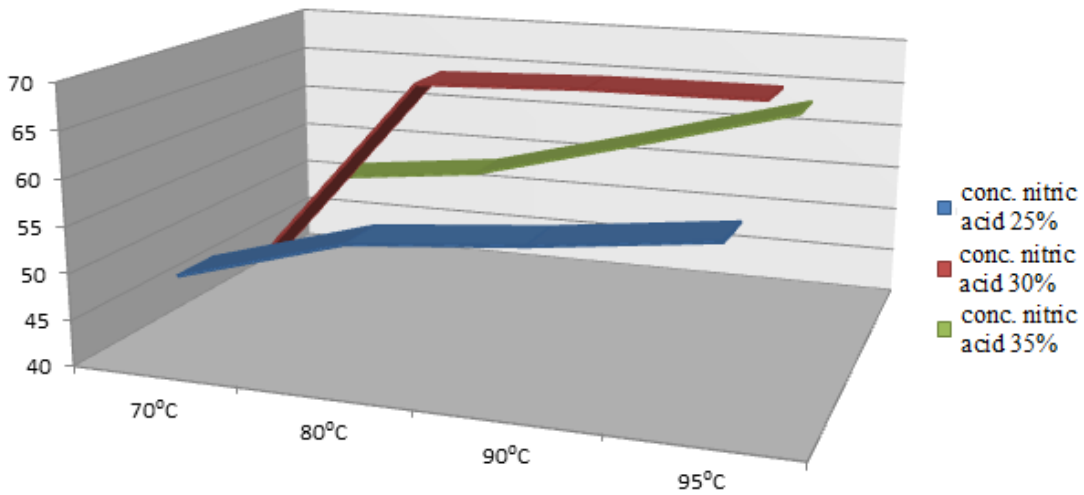

Figure 2. Degree of transition of MgO thermoactivated serpentinite liquid phase depending on temperature and concentration of nitric acid

These data show that the reactivity of magnesium minerals included in the composition of serpentinite with nitric acid is very low, in the ranges of varying technological parameters, it is not desirable from a technological and economic point of view. According to this, we have studied the effect of temperature and the duration of heat treatment of serpentinite on its reactivity of inorganic acids. The analysis results are shown in (table 1).

As can be seen from Table 1, the adsorption and crystallization waters are removed by calcination of serpentinite, and magnesium is converted to the active form. So at a temperature of 750 °C, the mass fraction of magnesium in terms of MgO increases by 2.45–2.8 at 800 °C, the mass fraction of magnesium increases by 9.63–9.98%.

Next, acid leaching of the calcined one according to the above method [3] was carried out. Process parameters varied in ranges of rate and concentration of nitric acid 100–120 and 25–35%, process temperature 70–95 °C, process duration 30–120 min.

Conclusions: As noted above, in the decomposition of the starting serpentinite, the content and yield of magnesium oxide in the form of magnesium nitrate are 2.99 and 24.4%, respectively, and in the use of heat-treated serpentinite, depending on the temperature and their value increases 8.46 and 70%.

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