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EXTRACTION OF RARE EARTH METALS FROM MAGNET WASTE

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In current time production of permanent magnets based on Nd–Fe–B and Sm–Co alloys is the most advanced field of rare earth metals industry. However, a magnet production is a process generates a large amount of waste. Up to 40 % of the magnetic material is lost with waste. Due to this problem, recycling of rare earth metals is in the scope of interest.

The aim of this work is to study parameters of extraction of rare earth metals from magnet waste.

Objectives of the work are:

1. Selection of the agent for the extraction.
2. Investigation of the effect on the process the following factors: acid concentrations, temperature and process time.

In this paper the waste of magnets from the JSC "Uralredmet" company were used. Elemental composition of it was determined by atomic emission spectrometer iCAP 6300 Duo. Obtained data are presented in table 1.

For the selecting of the best agent, extraction was performed by aqueous solutions of acids, hydrochloric acid, and sulfuric acid in a wide range of concentrations (20, 40, 60 and 80 %).

It was shown that dissolving the waste in all these acids generates a large amount of hydrogen that indicates of presenting of metallic phase in the waste.

Obtained solutions were investigated by physicochemical analysis.

Nonsignificant difference in extracting ability of the acids was shown. Sulfuric acid is one of the most widely used acids in different industries due to low cost and technological effectiveness, while the use of such a reagent as chlorazotic acid on an industrial scale leads to difficulties due to corrosion.

The effect of concentration of sulfuric acid on extraction was studied. The process was carried out under elevated temperatures for better dissolution of the precipitate. The results are presented in Fig. 1.

As can be seen from Fig. 1, at concentration of sulfuric acid is equal 20 %, the extraction was 62.65 %, at concentrations in range from 40 to 80 % ≈ 80 %. It should be noted that a further increase of concentration did not lead to the significant changes of the extraction.

Consequently, the most suitable concentration of sulfuric is 40 %, which also allows avoid precipitation of double sulphates.

The influence of temperature on extraction of rare earth metals from waste was studied in a thermostat at isothermal conditions.

Samples (2 g) were dissolved in 40 % sulfuric acid, at different temperatures – 20 °C, 30 °C, 40 °C, 60 °C, 70 °C. Time of each experiment was 10 minutes.

As a result of these experiments, precipitates of

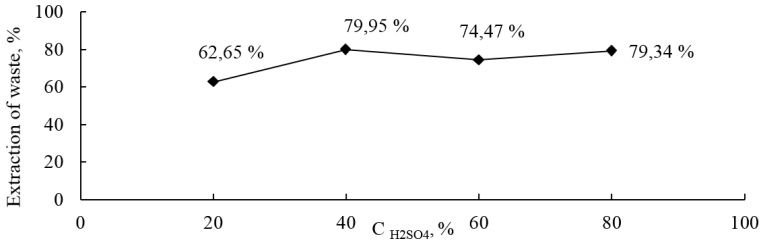

Fig. 1. *Extraction of waste, %, vs. concentration of sulfuric acid, %*

Table 1. The elemental composition of the waste from the JSC "Uralredmet"

Element	Fe	Co	Sm	Nd	Ce	Pr	Er	Dy	Zr	Gd	Tb	Al
Content, %	29.38	25.66	22.21	8.23	6.51	2.71	1.75	1.59	1.33	0.41	0.27	0.28

various masses were obtained. So, at 20 °C the mass of precipitation was 1.1 g, at 30 °C – 1.2 g, at 40 °C – 1 g, at 60 °C and 70 °C – 0.6 g.

Data show, that at high temperatures, the extraction proceeded most completely (the mass of the precipitate was 0.6 g). Therefore, for this case, 90 °C is an ample suitable temperature. The influence of interaction time of the acid with the waste in the process was investigated. It was established that after 35 minutes, at 50 °C in a sulfate medium, 45 % solid phase dissolution achieved.

Thus, in this work was shown that it is possible to select of the conditions for the extraction of rare earth metals from Nd–Fe–B and Sm–Co magnets waste by varying the agent for the extraction, temperature and time. The obtained data can be a base for further study of parameters of chemical separate precipitation of rare earth elements with their subsequent purification.

NEUTRALIZATION OF WHITE PHOSPHORUS BY MICROBIAL CULTURE

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For the first time, microbial cultures from various taxonomic groups have been generated, using synthetic culture media containing white phosphorus as the sole source of phosphorus. A search for metabolites of white phosphorus has been conducted. The highest concentration corresponds to an increase in the threshold limit value (TLV) of white phosphorus in sewage by 5000 times!

White phosphorus P_4 is one of the most dangerous pollutants of the environment. Nevertheless, it is used in industry and for military purposes, so it cannot be ruled out that this substance is exposed to the environment. Consequently, methods of detoxifying P_4 are needed, including biological means.

For the first time, we have successfully cultured microbes (mold fungus of the genus Aspergillus) in a medium containing P_4 as the sole source of phosphorus. In this novel medium, the microorganism grew and did not experience phosphorous starvation. That is, the fungus oxidized white phosphorus to phosphate, which is a primary necessity for life! Aspergillus grows in a medium with white phosphorus concentration of up to 1 %. This exceeds the TLC of P_4 in wastewater by about 5000 times! Across the Globe, this is the first example regarding the inclusion of white phosphorus into the biospheric cycle of elemental phosphorus [1].

We identified this microorganism as a new strain of A. niger. The strain was designated as *A*. niger AM1. The nucleotide sequence of the strain is published in the GenBank database, where it is assigned the number KT805426.

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