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PHYSICAL CONCENTRATION METHODS

INVESTIGATION OF MAGNETIC ROASTING PROCESS OF AYATSK LIMONITE ORE WITH WATER-OIL EMULSION

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A process of reduction roasting of Ayatsk limonite ore with oil-water emulsion. Analysis of partial dependence and generalized equations allows determination of optimal conditions of magnetizing roasting and magnetic treatment of cinders. It was found that dehydration and magnetization occur at lower temperature 700-750°C within 60 min. Concentrate containing 62.3% of iron was obtained. Yield and extraction degree was 87.9-88.0 n 95.0-95.5%, respectively. Phase composition of initial ore and obtained products studied using thermographic, X-ray phase, magnetic and Mossbauer analyses.
***Keywords:** limonite ore, magnetic concentrate, roasting, magnetic enrichment, water-oil emulsion, magnetic separation.*

Limonite ores the Republic of Kazakhstan constitute the bulk of recorded reserves of iron ore raw materials, more than 60% of which are concentrated in Lisakovsk, Aiatsk, Kokbulak Kutanbulak and Taldyespe fields. One of the options for enrichment of these ores is scheme of magnetizing roasting [1],

Magnetizing roasting of limonite ores and concentrates on an Industrial scale is performed in rotary furnaces, where the reducing agent, such as milled brown coal or coke breeze, is introduced into the ore. However, their use in practice has revealed a number of disadvantages: high dust emissions of charge materials from the furnace area, the consequence of which is overrun of reducing agent, uneven roasting of material, etc. [2,3].

Investigations in the use as reducing agents liquid hydrocarbon during roasting different limonite ores showed in comparison with the solid reducing agents the following benefits: increase of the furnace capacity, increase of utilization degree of reducing agent during the roasting, reducing of heating temperature of charge at 100-150 °C [4],

In this paper investigated the possibility of using as a reducing agent low concentrated water-oil emulsion of Karazhanbas field with magnetizing roasting enrichment of Ayatsk limonite ores.

The elemental composition of the oil (wt.%): C-87: H-11.8; S-6.3; N-0.5; 0-1.25.

In order to reduce the content of slag-forming components investigated initial ore (Fe-37.89%; $Si0_2$-15.38%; Al_20_3-6.73%; P-O.37%) previously subjected to desliming, then desliming product after drying separated in a strong magnetic field (1.2 Tesla) by dry method. Obtained industrial product corresponding chemical composition, %: Fe-43.02; $Si0_2$-12.43; Al_20_3-6.13; P-0.52 was treated with 2% water-oil emulsion. During thermal analysis of industrial product detected endothermic effects at 150-170°C with significant weight loss ,which are typical in removing hygroscopic and hydrate moisture, 290-310 C associated with dehydration of goethite and hydrohematite with the formation of hematite according to reactions:

$$Fe_20_3\text{-}nH_20 \wedge Fe_20_3+H_20 \quad (1)$$

$$2FeOOH \text{->} Fe_20_3 + H_20 \quad (2)$$

Exothermic effects in the field of 240°C corresponding to the beginning of destruction water-oil emulsion with the formation of active hydrogen, products of steam conversion of free carbon, etc. With increasing temperature, the pyrolysis products of oil emulsion intensively interacting with active and form a strong magnetic Fe_30_4 according to the reaction:

$$3Fe_20_3 + H_2 \text{->} 2Fe_30_4 + H_20 \quad (3)$$

$$3Fe_20_3 + CO\text{-}{*}\ 2Fe_30_4 + C0_2 \quad (4)$$

Which is confirmed by Mossbauer spectroscopy and X-ray analysis of samples fixed in this temperature range.

Spectra recorded by the spectrometer MS-1104Em, source of gamma - quanta is Co^{57} in the rhodium matrix. Isomeric shift was determined relative to a-Fe. Analysis of the spectra carried out under the program Univem MS (Rostov State University, Rostov-on-Don).

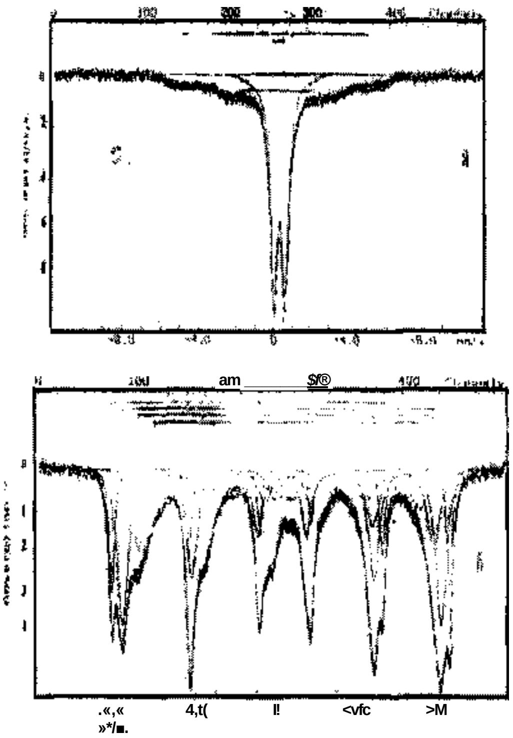

Figure 1, The Mossbauer spectra of the initial ore (a)
roasted ore pretreated with 2% water-oil emulsion (b)

Mossbauer spectra of ore and roasted ore are presented in Figure 1.

The spectra are for the original ore (Figure 1, a) - doublet, and for the roasted ore (Figure 1, b) -complex six peak line, whose parameters match - magnetite, hematite and residual iron hydroxide.

X-ray analysis for the roasted ore formed on the -X-ray diffractometer with a basic package of processing programs - EVA (PDF - 2) confirms the presence of magnetite, hematite, and aluminum and silicon oxides. In order to determine the optimal parameters of magnetizing roasting of industrial product performed experiments studied the factors and their values, which are shown in Table 1, the plan of experiments in Table 2. Experiments carried out in a muffle furnace, charge roasting in alundum crucible with a lid, samples of 200 grams.

The magnetization degree of roasted ore were determined by overcome of magnetic fraction (Y) at a magnetic field of 0.08 Tesla. Magnetic separation performed on the analyzer UEM-1T by dry method.

Table 1, Factors and their values

N <	Factor	Indie ation	Values				
			1	2	3	4	5
1	Tempera ture, °C	**(XO**	600	650	700	750	800
2	Concent ration of water-oil emulsion **,%**	(X_2)	1	2	3	4	5
3	Duration , min	(X_3)	30	45	60	75	90

Table 1, Plan of experiments

Isle of experiment	Xi	X_2	$\mathbf{X_3}$
1.	600	2	60
2.	650	2	60
3.	700	2	60
4.	750	2	60
5.	800	2	60
6.	750	1	60
7.	750	2	60
8.	750	3	60
9.	750	4	60
10.	750	5	60
11.	750	2	30
12.	750	2	45
13.	750	2	60
14.	750	2	75
15.	750	2	90

By selecting the experimental data are constructed point dependence , in the processing of which obtained the following partial empirical equations of magnetic fraction output:

$Y_T = 88{,}0-0{,}0015\,(X_r750)^2\ y_2= 87{,}9-0{,}9$ (5)

$(X_2-2)^2\ y_3 = 87{,}8-0{,}026\,(X_3-60)^2$ (6)

The correlation coefficients (R) of (7) significance (TR) equations calculated by [5.6] are equal 0.99, 0.98, 0.97 and 85.6, 42.5, 28.0, respectively.

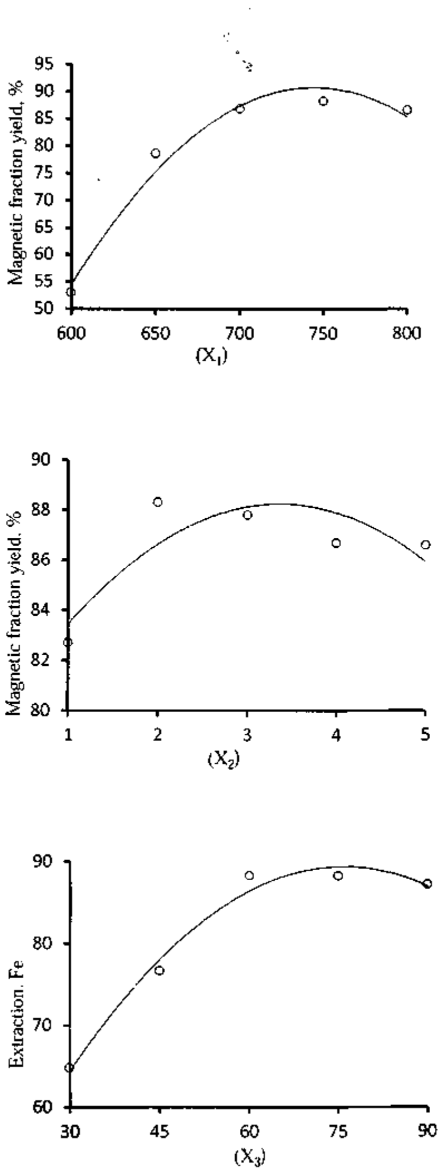

Figure 2, Dependence of magnetic fraction yield from the temperature (X1), concentration of water-oil emulsion (X2), and duration of roasting (X3)

By combining partial equations 5, 6 and 7 obtained a generalized multifactor equation of magnetic fraction yield:

$$y=0,127\cdot10^{-3}\{[88.0-0.0015\,(X_1-750)^2][87.9-0.9\,(X_2-2)^2][87.8-0.026\,(X_3-60)^2]\}$$

$t_R = 164.5$ $R=0.99$ (8)

Analysis of the equation (8) allowed to determine the optimal conditions magnetizing roasting enrichment of Ayatsk limonite ore with water-oil emulsion (WOE): temperature - 750 0 C; concentration of WOE - 3%: time - 60 min. Under these conditions, obtained magnetic concentrate of the following composition, %: Fe - 62.30; Al_20_3 -5.78; $Si0_2$ - 10.59; P - 0.50.

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