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TREATMENT OF RED MUD FROM ALUMINA PRODUCTION BY HIGH–INTENSITY MAGNETIC SEPARATION

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Abstract: The paper gives attention to the possibilities of magnetic separation of red mud. The red mud can be characterised as an insoluble residue originated during the bayer method application in bauxite processing. Sample of red mud was obtained by leaching of bauxite from the Fria deposit (Guinea). The wet method of high–intensity magnetic separation was applied to the treatment. The magnetic product with the Fe content of 47% and recovery of 85% was obtained under magnetic field induction of 0.06 Tesla. The best results of magnetic separation were achieved by treating the size fraction $-125\ \mu m + 90\ \mu m$.

INTRODUCTION

During the alumina production from bauxite by the bayer method an insoluble residue of red mud is created. Composition of red mud depends on the kind, quality and type of deposit of bauxite. One tonne of bauxite produces on average 400 kg of red mud. It represents a waste material which is deposited by different methods at different locations, but it represents considerable devaluation and contamination of the environment for two main reasons. It occupies considerable land surface; for instance red much field in Žiar nad Hronom (Slovakia) occupies 34 hectares of arable land). Furthermore, red mud contaminates ground waters by the leaching of the alkaline components by atmospheric precipitation.

At the same time, red mud can be considered to be an interesting secondary raw material since it contains various precious components, for instance TiO_2, SiO_2, Fe_2O_3, but also Sc, Y and U. In spite of numerous investigations, industrial experiments into the utilisation of red mud were not successful, either technologically or economically] [1 to 7]. It transpired from the previous testwork that one of the possibilities for the treatment of utilisation of the components of red mud is magnetic separation.

EXPERIMENTAL

Red mud was prepared by leaching bauxite. Chemical composition of the FRIA bauxite (Guinea) is shown in Table 1.

Table 1 Chemical composition of the FRIA bauxite

Bauxite component	Content (weight %)
Loss by ignition	24,81
Total Al_20_3	47,69
SIO_2	2,84
Fe_2O_3	21,35
TiO_2	1,97
CaO	0,004
V_2O_5	0,10

The mineral composition of bauxite was analysed by the x–ray diffraction technique in DRON 2.0 apparatus, and by differential thermal analysis in Derivatograph–C instrument. The principal components of the FRIA bauxite were found to be gibbsite, hematite in small amount of kaolinite, anatase, rutile and flint. The element microanalysis by electron microscopy JSM 35CF with energy–dispersed analyser Link 100 was also carried out.

The leaching of bauxite was performed in a 800 ml beaker at atmospheric pressure at the temperature of 107°C by NaOH solution of concentration of 192 g/ℓ Na_2O_k for 3 hours. The chemical composition of the red mud produced by leaching the FRIA bauxite is summarised in Table 2.

Table 2 Chemical composition of red mud produced by leaching the FRIA bauxite

Red mud	Granulation [μm]	Content (weight %)			
		Fe_2O_3	Al_2O_3	SiO_2	TiO_2
Before circulation	0,0 - 160	43,89	23,88	3,89	4,23
After	+ 40	48,68	20,22	3,42	1,75
circulation	- 40	38,64	26,54	3,95	4,82

Red mud was, after sedimentation, treated by wet magnetic separation. It follows from the granulometric analysis summarised in Table 3 that compositions of individual size fractions do not differ significantly, although the iron oxide is concentrate mainly in the coarse fractions.

Table 3 Granulometric and chemical composition of red mud from the FRIA bauxite

Granulometry [μm]	$Fe_{tot.}$ [%]	Content [%]				
		Fe_2O_3	Al_2O_3	SiO_2	TiO_2	Na_2O
125 -180	36,80	52,57	21,22	3,68	1,60	1,33
90 - 125	33,88	48,40	23,22	3,58	1,70	0,88
80 - 90	34,29	49,41	22,56	3,23	1,79	0,41
71 - 80	35,29	50,41	21,88	3,37	1,92	1,61
50 - 71	34,77	49,67	21,54	3,26	2,10	1,01
40 - 50	33,66	48,09	20,54	3,26	2,61	1,00
- 40	27,05	38,64	26,54	3,95	4,82	1,66

The finest fraction – 40 μm contains only 38.64 % Fe_2O_3 while Al_2O_3 is concentrated mainly in this size fraction (26.54% Al_2O_3).

The microelement analysis used to investigate the composition characteristics and distribution of elements Fe, Al, Si and Ti in red mud is instructive for understanding of the liberation of particles. It transpires that Fe, or its mineral, are closed in the grains of red much, rather than free. The results indicate that the separability of individual components of red mud is conditioned by the perfection of disconnection of the components of the grains in the process of grinding.

The following facts transpired from the study of separation of Fe, Si, Ti and other components of red mud, into magnetic and non–magnetic fractions, by polygradient Jones magnetic separator:

- Size distribution of the feed into the magnetic separator affects the mass yield into the magnetic product. This effect is illustrated in Figure 1. The maximum value was obtained by treating the –125 μm + 90 μm size fraction at the magnetic field of 0.06 Tesla.

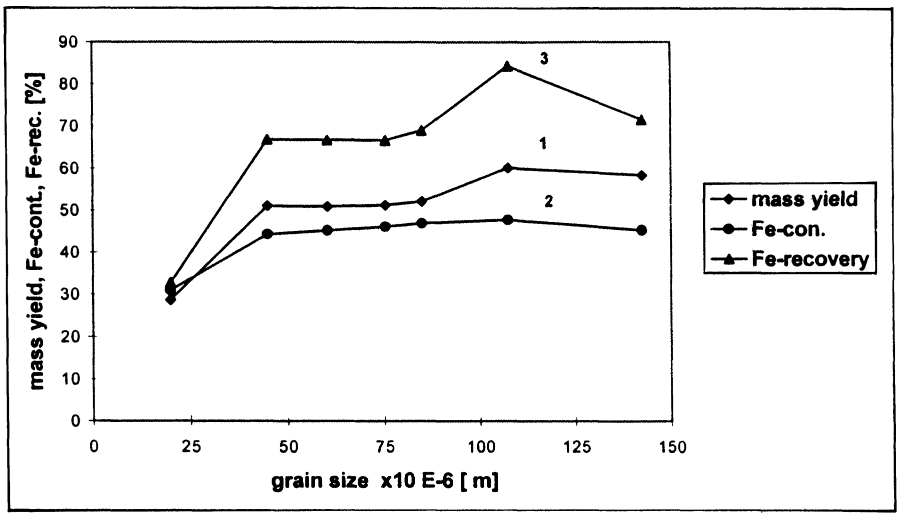

Fig. 1 The effect of particle size on results of magnetic separation of red mud.

– The course of curve 2 in Fig. 1 indicates that the concentration of iron in the magnetic fraction is approximately equally distributed (44 to 47%) in the entire particle size range (–125 μm + 40 μm).

– The maximum recovery of iron into the magnetic product (84%) was obtained when treating the size fraction of –125 μm + 90 μm at the magnetic field of 0.06 Tesla, as can be seen in Fig. 1.

– Significant effect of particle size distribution on the efficiency of magnetic separation is also demonstrated by the course of curve 2 in Figure 2. It can be seen that the maximum selectivity was achieved for particle size fraction of –125 μm + 90 μm at the magnetic field of 0.06 Tesla.

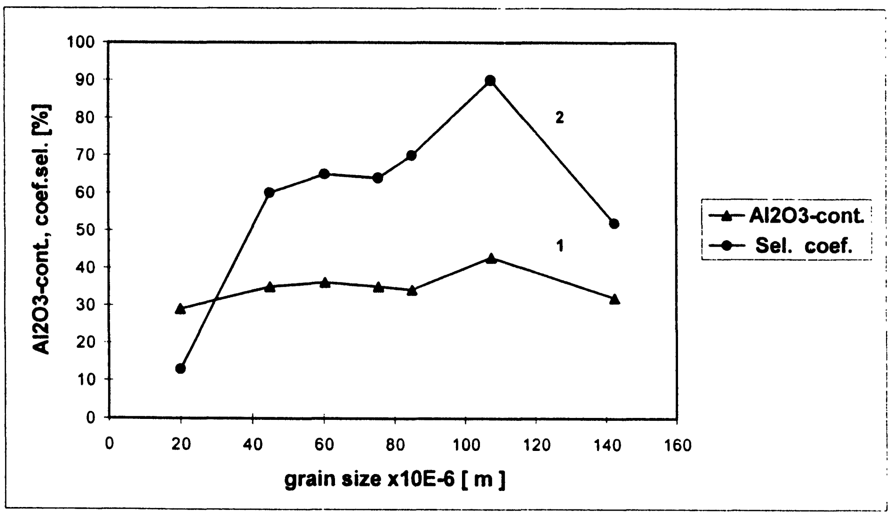

Fig. 2 Dependence of the Al_2O_3 concentration in the non–magnetic fraction, and of the selectivity coefficient on particle size

– The grade of Al_2O_3 in the non–magnetic fraction is also a function of particle size distribution, as can be seen from Fig. 2. The maximum grade of 42% Al_2O_3 was achieved for particle size fraction of –125 μm + 90 μm at the magnetic field 0.06 Tesla.

– The influence of the magnetic field strength was studied in the range from 0.05 T to 0.1 T. As can be seen from Figures 3 and 4, the mass yield into the magnetic product increases with the increasing field strength. The best results, from the point of view of the product grade and of the recovery of Fe and Al_2O_3 to magnetic and non–magnetic fractions, respectively, were obtained at the magnetic field strength of 0.06 Tesla.

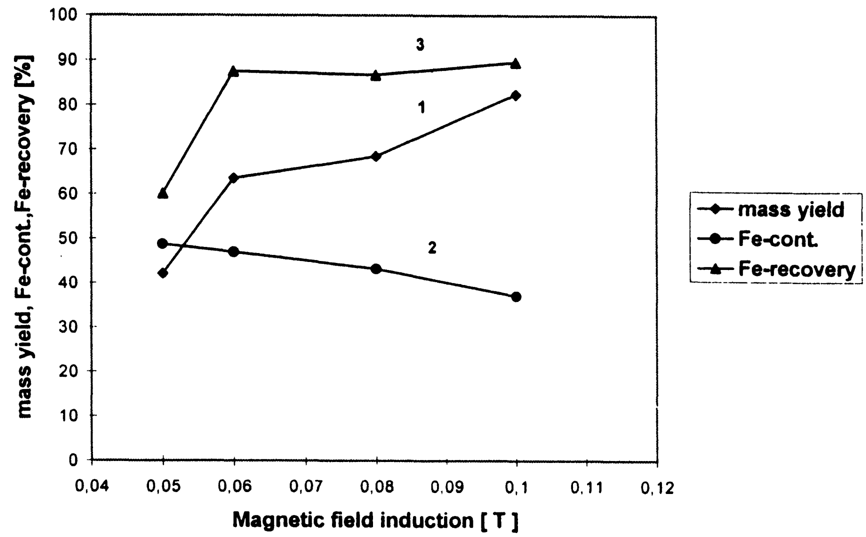

Fig. 3 The effect of magnetic field strength on the results of magnetic separation of red mud

DISCUSSION

It transpires from the experimental study of separation of red mud obtained by leaching the FRIA bauxite that:

– It is possible, by the application of wet magnetic separation in polygradient Jones magnetic separator, to obtain magnetic and non–magnetic products that can be further treated and utilised.

– Particle size distribution of the feed is an important parameter which affect the efficiency of magnetic separation. The best results were achieved for the size fraction of –125 μm + 90 μm. The magnetic product of this size fraction contained 47% Fe with the recovery of 85%. The grade of the non–magnetic product of this size fraction was 42% Al_2O_3.

– Another important parameter is the magnetic field strength in the separation zone of the separator. For the treatment of red mud, the optimum magnetic field was found to be 0.06 Tesla.

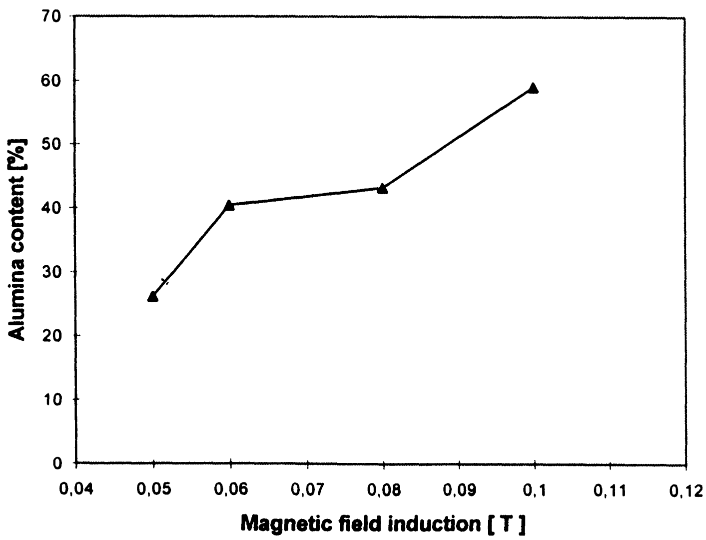

Fig. 4 Dependence of the alumina content in the non–magnetic product on the magnetic induction.

CONCLUSIONS

Results of magnetic separation of red mud after leaching bauxite from the FRIA deposit (Guinea) shows that it is possible to obtain magnetic and non–magnetic products that can be further treated and utilised. It is clear that an important factor affecting the efficiency of magnetic separation is particle size distribution of the feed. The non–magnetic product could be a suitable raw material for the alumina production.

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