



Research article

Enrichment of low-grade Hematite sample by gravity and magnetic methods (Case study: Red soil of Sahel mine)

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English Extended Abstract

Summary

In this research, concentration of red soil ore located in Bandar Abbas west was investigated. Mineralogical studies showed that iron minerals in sample contain Hematite and Goethite, Calcite and Quartz are main part of gangue minerals. According to chemical assaying, the average iron grade of ore was 44.71% Hematite (31.3% Fe) and our aim is achieve to grade above 55% Hematite. Gravity (Shaking Table), Wet High-Intensity Magnetic Separation, and Dry High-Gradient Magnetic Separation tests were carried out on sample for concentration and reducing gangue minerals. The tests of Shaking Table were designed by use of full factorial method and effect of dip, cleaning water and feed water flow rates were investigated. For Shaking Table tests in size fraction +150 microns with feed water flow rate 8 l/min, dip 8° and wash water flow rate 11.5 l/min –regarding as best performance condition- concentration assay and recovery were 55.87% Hematite and 63.25% respectively and it can be used for pre-concentration. According to assay distribution after feed disliming, Dry High-Gradient Magnetic Separation for two-size fraction -2380+1000 and -1000+150 microns was used. For size fraction of -2380+1000 microns concentration assay and relative recovery were 57.6% Hematite and 95.11% respectively and for size fraction -1000+150 microns concentration assay and relative recovery were 64.34% Fe₂O₃ and 75.14% respectively. For Wet High-Intensity Magnetic Separation, concentration assay and relative recovery were 57.53% Hematite and 64.9% respectively. Also after using more tests related to Wet High-Intensity Magnetic Separation and applying two cleaner stages, concentration grade reach to 80.17% Hematite.

Introduction

Today, the extensive applications and needs of various industries for red soil have led humans to exploit new reserves of red soil and even to produce artificial red soil due to the low quality and quantity of natural red soil [1-3].

The sample studied in this research belongs to the Sahel mine in Hormozgan province, which is located 20 km west of Bandar Abbas. This mine is an example of the numerous and low reserves in the region that are not economically exploited. The present study aims to increase productivity and benefit for mines whose extracted products are currently sold without processing and only in the form of granules to cement production units in the region and the southern Persian Gulf countries.

Since the difference in specific gravity is significant for iron-bearing and waste minerals, most physical enrichment methods can be applied to iron ores [4]. The common method of concentrating iron ores,

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especially deposits such as red soil that contain iron oxide particles in the form of Hematite that have weak magnetic properties, is magnetic concentration, which is the cheapest and most efficient method of concentrating and removing iron impurities [5].

Methodology and Approaches

All materials were crushed to a size smaller than 2.35 mm. After crushing the sample using a roller crusher, the sample was mixed and homogenized. The d80 of the final product is approximately 1110 μm .

The results of XRD analysis showed that the main minerals in the sample were Hematite, calcite, and quartz. The Titration analysis showed that the amount of iron in the sample was 31.3 percent (44.71% Hematite).

The Bond work index and the optimal grinding time of the sample were determined.

Processing tests include shaking table, dry and wet magnetic tests performed to enrich the red soil sample. Design Expert 7 software was used to design the experiments.

Results and Conclusions

As the slope of Shaking Table increases, the grade increases, and as the feed water flow rate increases, the grade decreases. To achieve high grade, the slope factor should be selected at a high level, the feed water at a low level, and the wash water factor (due to the interaction) at the opposite level of the slope.

By increasing the feed water parameter, the retention time of the particles in the magnetic separator is reduced, so completely valuable particles enter the concentrate and increase the grade.

Considering the initial sample dimensions, which were smaller than 5 mm, the Bond work index of the sample was 8.29 kWh/short ton, which indicates low energy consumption for achieving dimensions smaller than 150 microns.

In 4 minutes, 90% of the material passes through the 150 μm screen, and therefore the optimal grinding time can be considered to be 4 minutes.

In the experiments with the table separator, the parameters of table slope, feed water and interaction of slope and wash water were the most effective parameters on Fe_2O_3 grade and slope was the most effective parameter on Fe_2O_3 recovery, respectively, and finally a concentrate with a grade of 55.87% Fe_2O_3 and a relative recovery of 63.25% was obtained.

The best results were obtained using high wet intensity magnetic separators. With an enrichment step, a product with a grade of 57.53% Fe_2O_3 and a recovery of 64.9% was obtained. Also, in the continuation of the supplementary high intensity wet magnetic separation experiments, a product with a grade of 80.17% Fe_2O_3 and a recovery of 36.5% was obtained after two cleaning stages.

High gradient dry magnetic separation was performed for two dimensional ranges of -2380+1000 microns and -1000+150 microns, where the dimensional range of -2380+1000 microns had a product with a grade of 57.6% Fe_2O_3 and a relative recovery of 95.11%, and the dimensional range of -1000+150 microns had a product with a grade of 64.34% Fe_2O_3 and a relative recovery of 75.14%.

Considering the fineness of part of the sample, it is recommended to conduct flocculation experiments costs.

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