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Beneficiation of Elazığ-Kefdağ Chromite by Multi Gravity Separator

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Abstract

In this study, the possibility of beneficiation of chromite in the Elazığ-Kefdağ region by Multi-Gravity Separator was investigated. The results of beneficiation studies showed that commercial concentrate containing 52.14% Cr_2O_3 was obtainable with a 69.57% rate of recovery. The optimum operation parameters determined for the concentration of chromite ores are as follows; a washwater flowrate of 3 l/min, shake amplitude of 15mm, shake frequency of 4.8 cps, tilt angle of 4° and drum speed of 220 rpm.

Key Words: Multi-Gravity Separator, chromite

Elazığ-Kefdağ Kromitlerinin Multi Gravite Separatör ile Zenginleştirilmesi

Özet

Bu çalışmada, Elazığ-Kefdağ yöresi kromitlerinin Multi Gravite Separatör ile zenginleştirilebilme olanakları araştırılmıştır. Zenginleştirme çalışmalarının sonuçları % 52.14 Cr_2O_3 içeren satılabilir konsantrenin % 69.57 verimle elde edilebileceğini göstermektedir. Optimum deney koşulları; yıkama suyu: 3 l/dk, genlik: 15mm, çalkalama hızı: 4.8 cps, açı:4° ve tambur hızı: 220 rpm olarak belirlenmiştir.

Anahtar Sözcükler: Multi Gravite Separatör, kromit

Introduction

Chromite is an important mineral used in the metallurgy, chemistry and refractory industries. Chromite ores contain a variety of gangue minerals such as serpentine and olivine. Therefore, some kind of ore beneficiation is required. The most commonly used beneficiation methods for chromite ores are the gravity methods, such as the shaking table, jig, spiral and Reichert cone methods. Beneficiation with heavy medium is also utilised for preconcentration purposes. In addition, magnetic separation may be preferred, depending on the ore characteristics. Flotation is also used for the beneficiation of finely grained ores. With these conventional methods depending on the liberation particle size of the ore, significant amounts of fine chromite are lost to the tailings. For this reason, all of these methods are only partly successful in the fine particle size range (Kurşun et al. 1994; Boci et al.1996; Veglio' et al.1996; Çiçek et al.1998).

The Multi Gravity Separator (MGS) is able to separate two minerals from each other, provided that there is a reasonable difference between them in specific gravity. The MGS is suitable for the treatment of fines with a maximum particle size of approximately 0.5 mm. Typical applications include the scavenging of precious metals or valuable minerals from tailings, and pre-concentrating heavy mineral sands or industrial minerals such as chromite, barytes, anatase, coal, etc. (Özdağ et al.1993; Özdağ et al.1994).

In this study, the possibilities of beneficiation of Elazığ-Kefdağ chromite was investigated using a laboratory/pilot scale MGS.

1. Experimental

1.1. Sample, Equipment and Method

The chromite sample used for MGS studies was taken from the Elazığ-Kefdağ chromite plant. The sample was ground to minus 0.150 mm before MGS tests. The chemical analysis of the chromite ore sample is given in Table 1.

Table 1. Complete analysis of chromite ore sample

Content %					
Cr_2O_3	Fe_2O_3	SiO_2	Al_2O_3	CaO	MgO
38.33	18.00	12.83	9.38	0.40	21.06

A series of batch tests was run in order to determine the optimum operational parameters for the maximum concentrate grade and chromite recovery. The operational variables are the washwater flowrate, the rotational speed of the drum, the shake amplitude, the shake frequency and tilt angle of the drum.

A laboratory/pilot MGS of type C900 was used in the tests. The MGS consists of a slightly tapered open-ended drum that rotates in a clockwise direction and is shaken in a sinusoidal form in an axial direction. The parameters affecting the efficiency of separation of the MGS are the drum speed (100 to 300rpm), tilt angle (0° to 9°), shake amplitude (10/15/20mm), shake frequency (4.0/4.8/5.7cps), amount of washwater (0 to 10 liters per minute) and feed pulp density (10% to 50% solids by weight) (Chan and Mozley, 1987; Chan et al.1991; Belardi et al.1995; Çiçek et al.1998).

Feed slurry is introduced continuously midway onto the internal surface of the drum via a perforated ring. Washwater is added via a similar ring positioned near the open end of the drum.

The dense particles migrate through the slurry film to form a semisolid layer against the wall of the drum as a result of the high centrifugal forces and the added shearing effect of the shake. The scrapers towards the open end of the drum convey this dense layer where it discharges into the concentrate launder. The less dense particles are carried by the flow of washwater into the tailing launder at the rear end of the drum.

The shake amplitude and frequency drum speed, tilt angle and amount of washwater were adjusted, and the MGS was operated.

A sample bucket was placed under the tailing discharge pipe, another under the concentrate discharge pipe and another one was placed under the center spillage discharge pipe. 500 grams of dry sample was mixed with one liter of water, giving a feed density of 33% solids by weight. The solids were kept in suspension during the test by manual stirring. The feed pulp was poured into the MGS feed vessel at a steady rate of 1.2 liters/minute, giving a feed rate of 40kg/h of dry sample whilst stirring continuously.

In all the tests, the total feeding time was 45 seconds. At the end of the feed period, the separator was kept running until the material flow was finished and the washwater was allowed to run for a further 2 or 3 minutes. The washwater was turned off and the MGS was stopped.

Scraper or conveyed product, which collected via the front launder during the feed and the wash period, were referred to as concentrate. Another product, which collected during the feed period was referred to as Tailing 1, and another product, which collected during the wash period was slightly higher in grade and was referred to as Tailing 2.

These samples were dried at 105°C, weighed and analysed in order to determine the chromite grade and recovery rate. Throughout the tests, Middling and Tailing 2 were combined with concentrate and Tailing 1, respectively.

2. Results and Discussion

A series of batch tests was run in order to upgrade the ore to over 48.0% Cr_2O_3 with maximum chromite recovery. In order to determine the effects of operational parameters in the equipment, several variables were tested.

3. Conclusions

1. A concentration of fine sized chromite ores by Multi Gravity Separator is possible.
2. The optimum operation parameters determined for concentration of chromite ores are as follows:

Washwater flowrate	:3 l/min	Drum speed	:220 rpm
Shake amplitude	:15 mm	Feed density	:33% w/w
Shake frequency	:4.8 cps	Feed rate	:40 kg/h
Tilt angle	:4°		

Increasing the washwater flowrate, shake amplitude, shake frequency and tilt angle lead to higher concentrate grades but lower recovery. The rotational speed of the drum is the most important operational parameter. In the experiments, the drum speed was varied between 180 rpm and 240 rpm with the other conditions kept constant. The results given in Table 2 show that a drum speed of 220 rpm produced the best results. A significant increase in the recovery rate of concentrate and a decrease in grade were obtained by increasing the rotational speed of the drum.

3. In optimum working conditions, a concentrate with 52.14 % Cr_2O_3 was obtained with 69.57 % recovery (Table 2).

Table 2. The results after middling was apportioned to concentrate and tailing

Drum speed (rpm)	PRODUCT	WEIGHT %	ASSAY Cr_2O_3%	RECOVERY Cr_2O_3%
180	Concentrate	21.27	53.84	29.88
	Tailing	78.73	34.14	70.12
200	Concentrate	41.73	54.99	59.87
	Tailing	58.27	26.40	40.13
220	Concentrate	51.14	52.14	69.57
	Tailing	48.86	23.87	30.43
240	Concentrate	42.09	46.27	50.81
	Tailing	57.91	32.56	49.19
	TOTAL	100.00	38.33	100.00

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