RECOVERYOF CHROMITE FINES UTILIZING SLON HIGH GRADIENT MAGNETIC SEPARATOR

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Abstract: A majority of mined chromite ore is in form of fine particles (-200 µm) which are difficult to be concentrated using gravity separation methods. On the other hand, these particles are required to be recovered in order to ensure process profitability and reduce environmental impacts. Slon high gradient magnetic separator is capable of processing paramagnetic particles. In this paper, the possibility of recovering chromite fine particles using a laboratory scale Slon high gradient magnetic separator is investigated. The effect of variables including magnetic field intensity, particle size, matrix size, and pulsating frequency was studied using the design of experiments. Results indicated that grade of concentrate part decreased when using a higher intensity magnetic field. Furthermore, with a rise in pulsating frequency and a reduction in the matrix size, the grade of concentrate part was increased. It was found that a concentrate grade of more than 40%, with a recovery of 65-90% is achievable using Slon magnetic separator.. Thus, it was concluded that the processing of fine chromite ore particles is technically viable using this method.

Keywords: Chromite, Slon, Recovery, Magnetic field intensity, Particle size.

INTRODUCTION

Chromite is the most important chromium bearing mineral. Gravity separation methods including shaking table, and spiral separator are the most common methods of processing chromite, which are sensitive to the presence of fine particles, and their performance considerably reduce when particle size decreases. Consequently, valuable particles are found in the tailings. Furthermore, the capacity of gravity separation methods is much lower than that of other methods. For instance, the capacity of a shaking table is about 1 t/h that is considered low in industry. Loss of fine chromite particles is essential, not only from economical but also from environmental perspectives.

Feng and Aldrich mentioned that column flotation could be used to recover fine chromite particles. In this work, various reagents were utilized, and the recovery of 30-40% was achieved with a grade of 43-45%. Tripathy et al. used a combination of flotation, gravity and magnetic separation methods to process fine chromite particles and achieved a recovery of 17-23 %, which is relatively a low recovery.

As shown by Xiong et al. in 1998, Slon high gradient magnetic separation equipment could be used in the processing of fine paramagnetic particles. In this equipment, magnetic field beside a matrix (high gradient magnetic field) and pulsating system is utilized to enhance the recovery of paramagnetic particles. Thus, not only the entrapment of gangue (non-magnetic) particles between valuable particles is reduced, but also the possibility of recovering more valuable fines

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is viable. This is the advantage of Slon equipment over other magnetic separators, which makes it possible to achieve higher performance separation.

The desired grade of chromite concentrate for the market is Cr2O3>42%, however, Cr2O3>44 % is a considered a high-quality product. In current study, fine chromite particles of Aria Dad Faravar processing plant was investigated for further processing with a high gradient magnetic separator, Since the grade of studied chromite particles is not appropriate for the market. The chromite fine particles are enriched using a Slon magnetic separator.

METHODS

Samples were collected from Aria Dad Faravar processing plant, Orzueeyeh, Kerman province, Iran. After sample preparation, size analysis was carried out and the assays were found. Thed$_{80}$ was found to be 163 µm and the Cr_2O_3 content was 35% (further processing required). Afterwards, samples were divided into three different size fractions, including +150, +106-150, -106 µm. It is notable that the grades of the fractions were almost similar. Tests were carried out with 100 g sample using a laboratory Slon magnetic separator located in Danesh Faravar Kansar Company, Kerman, Iran. Then, the concentrate and the tailing of the tests were prepared for analysis.

The experiments of screening step were performed varying the magnetic intensity, particle size, pulsating frequency, and matrix size. Experiments were designed and analyzed using DX7 software. Table 1 shows the variables and levels of the designed experiments.

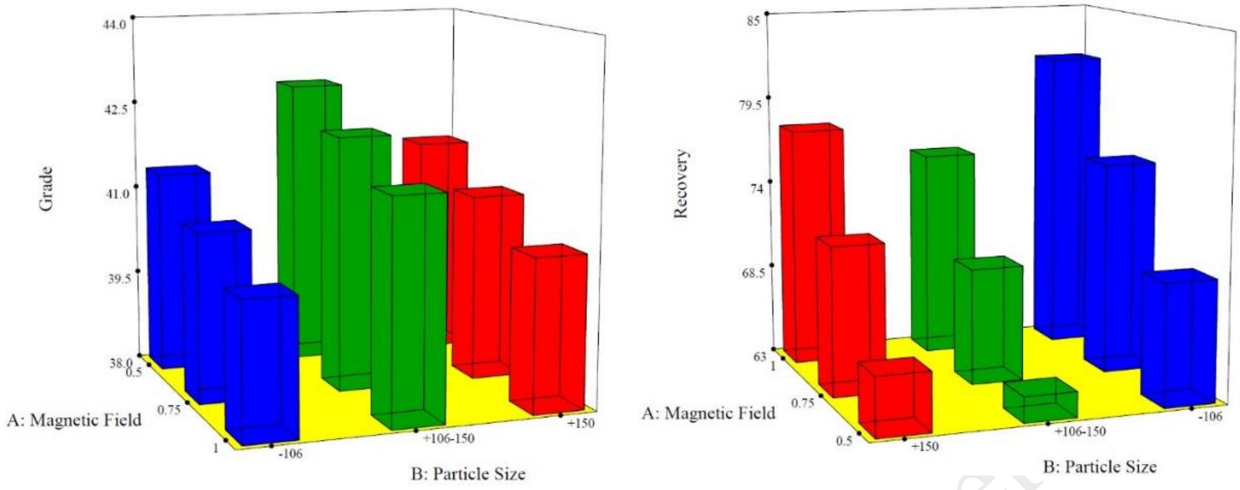
Table 1. Variables and levels in the designed experiments

Variables	Level 1	Level 2	Level 3
Magnetic intensity (T)	0.5	0.75	1
Particle size fraction (µm)	-106	+106-150	+150
Pulsating frequency (rpm)	100	200	300
Matrix size (mm)	1	2	3

FINDINGS AND ARGUMENT

1.The effect of particle size and magnetic intensity

In this section, the effect of the magnetic field and particle size on the grade and recovery of the magnetic separator was investigated (Fig 1).



A **B**

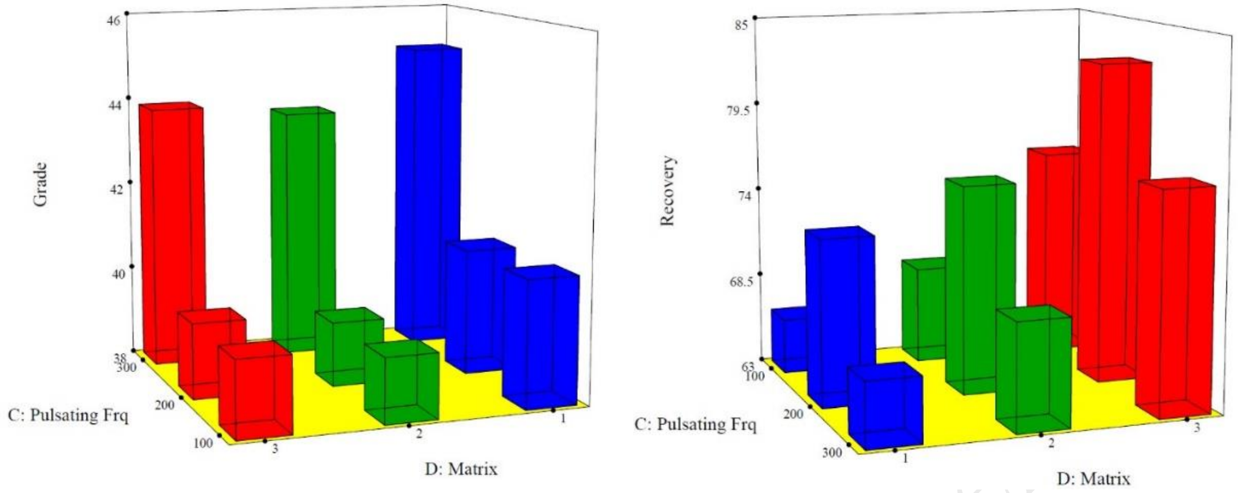
Figure 1. The effect of magnetic field and particle size on the Grade (A) and Recovery (B)

As it is shown, increasing magnetic intensity from 0.5 to 1 T reduced the concentrate grade while raised the recovery. Because with a higher magnetic intensity, particles with less magnetic properties will be recovered along with magnetic particles. As a result, the grade of concentrate was reduced, while the recovery increased. This result was observed in all size fractions. It could be concluded that the magnetic intensity required for magnetic separators depend on their role in the circuit. As an example, if Slon magnetic separator was employed as a scavenger, a higher magnetic intensity is required with the purpose of achieving better recovery.

Furthermore, Figure 1 reveals that the maximum grade of concentrate obtained was for +106-150 µm size fraction. Thus, this is considered as the optimum size fraction for this separator providing the maximum grade of concentrate. Moreover, during the experiments, the recovery was in the range of 64-82% that is much higher than the recovery of gravity separation process. It is worth noting that the capacity of Slon magnetic separator is significantly higher than gravity separators. A better separation efficiency and a higher capacity are the advantages of Slon magnetic separators over conventional gravity separators.

2.The effect of pulsating frequency and matrix size

In this section, the effect of pulsating frequency and matrix size on the results is discussed using the charts presented by DX7.



A B

Figure 2. The effect of pulsating frequency and matrix on the Grade (A) and Recovery (B)

Figure 2 confirms that a higher grade of concentrate was achieved using a matrix size of 1 mm. Because when matrix size is reduced, the effective matrix area decreases and non-magnetic and middling particles could not reach the concentrate. In other words, the effect of magnetic gradient increases with reducing matrix size. Consequently, reducing matrix size is a practical solution to improve the grade of chromite in Slon separators.

Also, it was found that the grade of chromite in the concentrate increased with the pulsating frequency. Because with a higher pulsating frequency, entrapment of gangue particles in the concentrate is reduced providing a higher grade. Hence, selecting a higher pulsating frequency and a lower matrix size is the practical solution to enhance chromite grade of about 45% using Slon separator.

3.Optimum economic conditions based on magnetic intensity

As previously mentioned, the aim of this paper is to process fine particles of chromite using Slon separator which was confirmed in previous sections. In this section, the particles in -106 and +106-150 µm size fractions were studied varying magnetic intensity to find the grade and the recovery in which the profitability is maximized, varying magnetic intensity. Therefore, the Net Smelter Return (NSR) was calculated as an economic indicator using the economic data collected in 2017(Figure 3). Results indicated that for -106 and +106-150 µm size fractions, maximum NSR were obtained in 0.6, and 0.7 T respectively.

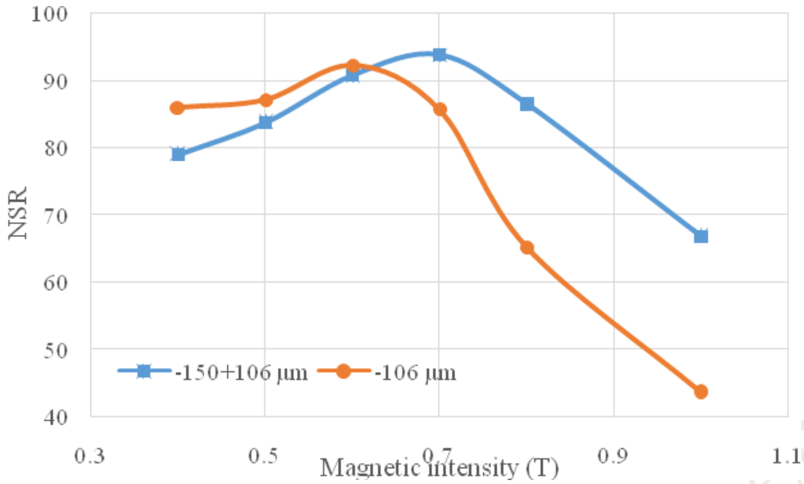


Figure 3. The effect of magnetic field intensity on NSR varying particle size fraction

CONCLUSIONS

In this work, the application of a laboratory scale high gradient magnetic separator was investigated for processing fine chromite particles. Using designed experiments, the effect of magnetic intensity, particle size, pulsating frequency and matrix size was studied on the performance of Slon separator. Results indicated that +106-150 µm fraction provided the best separation performance between different size fractions. Also it was proved that a higher pulsating frequency and a lower matrix size could produce higher grade chromite concentrates. It was found that a concentrate grade higher more than 40 % with a recovery of 65-90% percent is achievable using Slon magnetic separator.. Finally, the optimum magnetic intensity was 0.6, and 0.7 T, respectively for -106 and +106-150 µm size fractions.

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