Scientific Communication

Extended-height magnetic matrices to increase ultra – fine mineral particle recovery

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Abstract

In response to the challenge of recovering particles smaller than -0.45 microns in Mineral Processing, GAUSTEC® has significantly enhanced the Wet High Intensity Magnetic Separation (WHIMS) technology. By Extending the Height of the Magnetic Grooved Plate Matrix, a core component of Jones Magnetic Separator Technology, GAUSTEC® has raised the industry standards. For over fifty years, since the installation of the first Jones separator at VALE Cauê Mine in 1972, the standard matrix height has remained at 220 mm. The worldwide demand to reduce tailings prompted a team of researchers to look for new solutions to improve slimes recovery. After trying traditional methods and process variables it was decided to extend the matrices heights to increase the processing time inside the magnetic field. Evaluating four matrix heights, researchers found that doubling the standard height (2H) provided outstanding results. The 2H matrix recovered 2.5 times more mass from slimes compared to the standard 1H matrix height, in this study.

Keywords: magnetic separation, whims, slimes, tailings, tailing ponds, matrix height, NoBLOCK, BigFLUX, environment, ultra fines.

1. Introduction

This study focuses on improving the recovery of ultrafine iron ore particles, typically less than 45 microns to mitigate their disposal in tailings ponds. As a Scientific Communication it provides just a first approach to describe the influence of the magnetic Matrix Height to address the challenge to scavenge slimes. It must be considered just a starting point, and the readers are invited to contact the authors to get further information and developments on this issue.

After exploring the standard process variables without success, the research team decided to increase the time the slimes pass through the magnetic field in the separation process. Several test work were conducted using matrices of different heights, ranging from 220 mm to 880 mm, i.e., in the range 1H, 1.6 H, 2H, 3H and 4H. Figure 1 shows matrix plates 1H and 2H.

Figure 1 - Grooved Plates 1H (220mm) and 2H (440mm).

The findings highlighted that the height of 440 mm or 2H, offers the most cost-effective solution, providing a 2.5-fold increase in mass recovery and improving concentrate contents, when compared to standard 220 mm, 1H Matrix. Notably, this higher matrix can also be of use in existing magnetic separators with modifications, thus allowing the use of this solution in scavenging tailings WHIMS recovery projects. Slimes recovery has been a challenge for decades in the mineral processing sector due to its extremely small particle sizes. It is important to highlight that these ultrafine particles are currently being wasted because they are not fully recoverable by current methods. Typically, they have the adequate size (below 150 microns) and liberation to become pellet feed.

2. The JONES WHIMS magnetic separator and its general technical features

One of the most widely used equipment for concentrating iron ore fines is the JONES Wet High intensity Magnetic Separator (WHIMS).

The concentration of the slurry takes place inside the magnetic matrix by the competition between the vertical force of the water's hydraulic drag that acts on all the particles and the magnetic force of attraction that acts on the magnetizable particles.

The equation (Svoboda, 2004) that defines the force of magnetic attraction is given by:

$$F = K\,(d^3.\,Xm.\,B\,.\,\nabla B)$$

Where: K = Constant of proportionality; d = Particle diameter; Xm = Ore susceptibility; B = Magnetic field; ∇B = Magnetic field gradient.

The magnetic force of attraction is a key factor to recover the particles, since they need to displace within the slurry and reach the tips of the matrix to be collected. The time available for particle displacement depends on the height of the matrix.

3. Test work research procedures varying matrix height and parameters

The research was based on test work making use of two Lab scale Magnetic Separators, the first with the standard height magnetic matrix (220 mm) and the second with double height (440 mm).

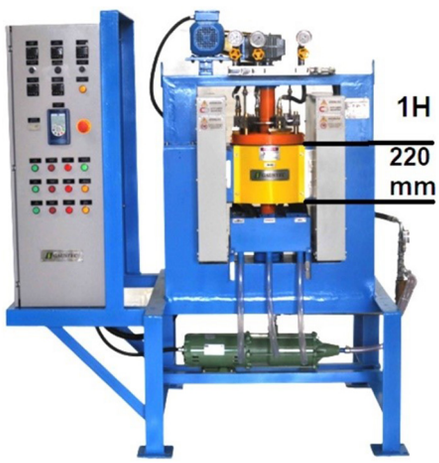

Figure 2 - Minimag® for 220mm height 1H Matrix

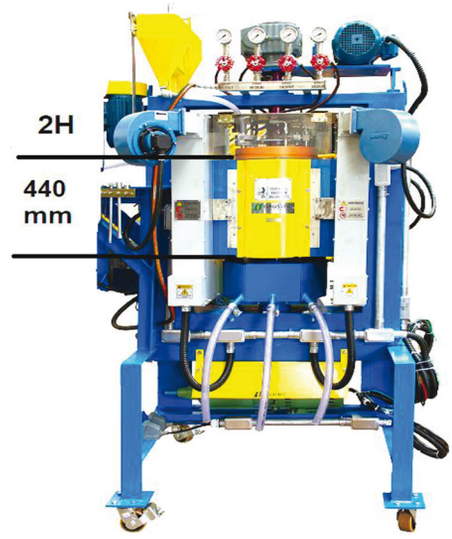

Figure 3 - Minimag® for 440mm height 2H Matrix.

The Feed were slimes samples supplied by VALE with P40 = 10 microns and 41% iron content.

The research evaluated matrix heights 1 H and 2 H, and the % solids of the samples were set to 20 %, 30 % and 40 %. Parameters such as Matrix type, GAP, magnetic field, middlings and concentrate water spray pressures remained constant.

4. Minimag results comparing matrix height 1 H and matrix height 2 H and mass % solids

The results confirmed that increasing the height of the matrix enables the recovery of ultrafine iron particles that were previously wasted in the tailings. That is, particles that have not been subjected to the magnetic field for a long enough time to be captured.

It is also noteworthy that the combination of the matrix height and high magnetic field factors is of paramount importance for the recovery of these materials, because even with an extended matrix, the magnetic field needs to be raised to the point where it can overcome the competing forces, i.e., the hydrodynamic force of the slurry.

For the test @ 40 % solids in the feed it yielded a Mass Recovery of 48.33% of magnetic product with the 2 H matrix Height and it was approximately 2.5 times the Mass Recovery of 20 % of the 1 H. The Fe contents in the tailings were higher for the standard size matrices 1H, than in the 2 H matrices. These facts were confirmed by setting the slurry to three different

% solids concentration: 20%, 30% and 40 %, and all the tests indicated the higher efficiency of the extended matrix 2 H. Another important conclusion to be observed is that with the greater dilution of the pulp, it is achieved greater selectivity in the concentrate generated. Also noteworthy the fact that the % Fe content of the tailings from the 2 H matrix was consistently lower than that of the 1H matrix. Additional tests were carried out with other samples also proving the effectiveness of this new extended Height Magnetic Matrix Technology. As mentioned, all test work procedures as well as the mass yields chemical qualities and feed characteristics are available to be shared with the readers upon request.

5. Economics of the extended height magnetic matrix

Investment cost reduction: A positive result of this research is the cost reduction that this technology can provide to the mining industry. One Magnetic Separator with the 2 H Height matrix can outperform two machines using the 1 H Height matrix in the scavenging process.

Electrical Energy: the additional energy demanded to increase the height of the matrices is around 20 % and relatively low compared with the benefits of higher mass recovery. The increase in the matrix height requires to increase only the sides of the coils while its wider dimension, the width, is kept unchanged. This way there is not noticeable increase of conductor length and of the energy demanded by the coils.

6. Conclusion

Ultrafine iron ore particles have been the subject of many studies to find a friendly way for processing iron ore. The magnetic matrix, which was usually 220mm high or 1 H, were changed to a height of 440mm or 2 H. This change made it possible to increase mass recovery by up to 2.5 times, without harming the iron content in the concentrate, at low solid content. In other words, it was possible with the 2 H matrix to capture particles that were previously wasted to the tailings, as they were not exposed for a long enough time under the magnetic field. This can be seen when observing that the extended height matrix consistently lowered the Fe content in the tailings, independently of the solid content on the feed. Additional tests performed with other samples maintained the same results pattern observed in this study and, therefore, prove the efficiency of this technology.

And finally, the huge economic savings provided by the double Height matrices will for sure be a source of motivation for the mining market to introduce, due to its comparative lower investment costs, further processing plants to spare scarcer raw materials.

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