IMPROVING THE EFFICIENCY OF IRON ORE PROCESSING: DEMAGNETIZATION

Oleksandr Berezniak, Assoc. Prof. PhD-Tech.
Dnipro University of Technology, Ukraine

Introduction. The article presents an analysis of modern methods for improving the process of magnetic enrichment of iron-containing raw materials. The technical path of development of our civilization requires the ever-growing use of iron. For its production, iron ores are used, which are processed to increase the iron content.

The mineral of magnetite has a strong magnetic susceptibility, therefore it is easily enriched using magnetic separation. Before enrichment, it have to be grinded to a particle size of less than 50 microns in order to separate magnetite and rock (silica) particles from each other. Grinding is carried out in three stages in ball mills. After the mill, the material is classified by size and particles larger than the specified size are returned to the mill. This is called the circulating load, which can exceed 200 per cent in the case of magnetite enrichment.

Presentation of the main research. After each stage of grinding, magnetic separation is applied to remove rock (silica particles) and increase the quality of the concentrate. However, magnetite has not only magnetic susceptibility, but also great residual magnetization. This means that after magnetic separation, the magnetite particles themselves become magnets and are attracted to each other, forming floccules.

During hydraulic classification, large floccules return to the mill – see Figure 1, a). This increases the circulating load and reduces the efficiency of the mill.

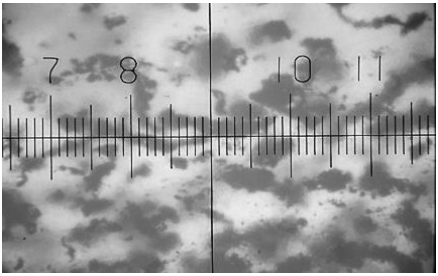
In addition, silica particles are trapped inside the floccule, which reduces the quality of the concentrate. To solve the problem, magnetite particles have to be demagnetized.

To demagnetize a large ferromagnetic body, it should be placed in an external alternating magnetic field, for example, in a solenoid, where maximum magnetic field induction exceeds residual magnetization, and then the field strength should be gradually decreased to zero (see Figure 2, b).

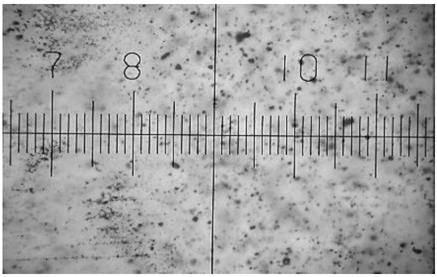
Figure 1

a) Optical testing of the magnetized slurry
b) Optical testing of the slurry, demagnetized at 50 kHz

a)



b)



You can reduce the field strength, either by slowly removing the body from the solenoid, or by reducing the current through the solenoid. Now solenoids operating at an industrial frequency of 50 Hz are used to demagnetize magnetite. The efficiency of such demagnetization is low. The reason for this is that the magnetized magnetite particles in the suspension have time to rotate following the external magnetic field, and are not completely demagnetized.

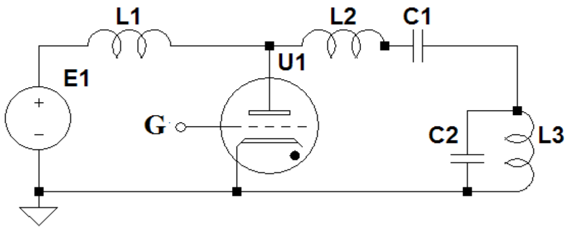
In this case, the field should change so quickly that the smallest particles do not rotate due to the forces of inertia and friction. Calculations show that the frequency of changes in the external magnetic field should exceed 50 kHz ($50 \cdot 10^3$ Hz). In this case, magnetite is completely demagnetized, which is confirmed by practice (Berezniak et al., 2015).

Figure 2

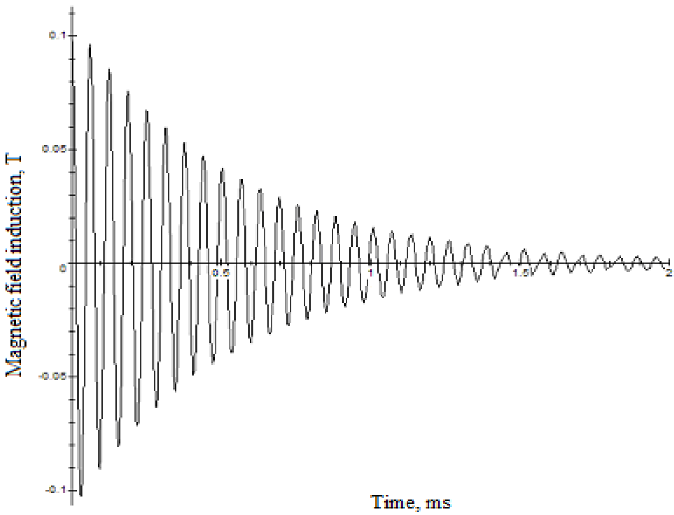
a) Schematic diagram of the pulsed generator of damped oscillations with the thyratron, L3 – solenoid

b) Dependence of the magnetic field induction in the center of the coil in time

a)



b)



It is energetically more advantageous to demagnetize magnetite in a pulsed mode. For this, damped oscillations of the required frequency are excited in an oscillatory circuit formed of a solenoid and a capacitor. In this case, all particles inside the solenoid are demagnetized. What is more, the pulse repetition interval should be less than the period, when the suspension is in the solenoid (see Figure 2, a).

The size of particles can be indirectly estimated from the rate of their sedimentation (precipitation, settling), which in the case of demagnetized magnetite is more than seven times less than that of magnetized – see Figure 1, b).

At the same time, the classification efficiency of demagnetized magnetite in a hydrocyclone increases from 76 to 84 in terms of percent (Mladetskyi et al. 2018).

Hydrosizer is a more efficient hydraulic classification device. In laboratory conditions, the classification efficiency for a size of 40 microns is 96.8 per cent. This is higher than with a Derrick fine screen at the same specific capacity. In addition, large particles in the overflow of the hydrosizer are mainly represented by quartz and intergrowths of quartz with magnetite.

Conclusion. Complete demagnetization of magnetite during its enrichment can reduce the circulating load on the mills and improve the quality of the concentrate. It increases the efficiency of magnetite ore processing in general, and reduces the cost of magnetite concentrate.

References

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