HOW THE DURATION OF MAGNETIC TREATMENT AFFECTS
THE DEPOSITION RATE OF MAGNETIZED MAGNETITE PULP

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The capacity of an assembly of fine ferromagnetic particles to form large aggregate-flocules under the effect of an external magnetic field or residual magnetization is used extensively in beneficiation of strongly magnetic iron ores to increase the productivity of the plant and improve the selectivity of a number of beneficiation processes.

About 90% of all the iron ore processed is subjected to magnetic beneficiation. However, theoretical and experimental research on magnetic flocculation is lagging behind practical requirements. The effect of the residence time of the pulp being magnetized in a magnetic field on the results of magnetic flocculation is largely an unknown factor.

Recommendations on the necessary duration of magnetization of magnetite pulps are often vague and even contradictory [1-3]. A common feature of most reports [1-6] is that the authors recommend a field intensity of 400 to 600 Oe (32-48 kA/m) and a magnetization period of less than one second; however, the absolute values of this period vary from 0.2 [1] to 1/15 sec [3].

In this paper we attempt to elucidate the role of the duration of magnetization during magnetic flocculation. Figure 1 shows the layout of the experimental apparatus for studying the effect of the duration of magnetization on the flocculation results.

A pulp of given consistency was prepared by mixing water and the product in a mixer 5; it was then fed by pump 6 to two successive separation stages 1. The 10-jet pulp separator 1 made it possible to feed to the magnetizing apparatus 4 any proportion of the current in the range from 1/100 to 99/100 of the total. The excess pulp was returned to mixer 5 via demagnetizing apparatus 3. Control of the duration of magnetization was effected by varying the volume of pulp handled. A constant pulp level was maintained in the receiver 7 of the apparatus by means of valve 8.

The duration of magnetization was determined by the formula

$$t = \frac{LS}{Q} \text{ sec,}$$

where $L$ is the path length of the pulp in the magnetization apparatus in meters, $S$ is the cross-sectional area of the magnetization apparatus in $\text{m}^2$, and $Q$ is the pulp current, $\text{m}^3/\text{sec}$.

The results of pulp flocculation were assessed from the settling rate in standard 500 ml measuring cylinders under constant conditions (pulp temperature 291°K and solids content 10 wt.%; the samples magnetized at higher solids contents (20, 40%) were therefore diluted.

The work was performed on magnetite concentrate of the Inguletsk beneficiation combine (see Table 1). In the first stage of the investigations we studied the significance of the magnetization parameters by means of experiments planned by the Box-Wilson method [7]. The experiments were planned on the basis of a two-factor experimental scheme based on the field intensity, $H$, and the exposure of the material in the field, $t$. The values
TABLE 1

<table>
<thead>
<tr>
<th>Iron content, %</th>
<th>Specific gravity, kg/m³</th>
<th>Yield of size classes, %</th>
<th>Magnetic properties</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>-0.1 + 0.1 mm</td>
<td>-0.074 + 0.074 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+ 0.1 mm</td>
<td>+ 0.074 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.6</td>
<td>1.8</td>
</tr>
<tr>
<td>64.6</td>
<td>4660</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

H = 48 kA/m and t = 0.8 sec corresponded to the base level [7]; the units of factor variation were 24 kA/m and 0.7 sec, respectively.

From the experimental results we calculated linear values for the linear regression coefficients

\[ b_j = \frac{1}{n} \sum_{i=1}^{n} x_{ij} y_i \]  \[ 7 \],

which were respectively as follows:

With concentration of the solids content of the deposit from 10 to 15% for a factor H 0.94 and for a factor t 0.14:

- the same from 10 to 25% 0.95 and 0.18;
- the same from 10 to 35% 0.96 and 0.20;
- the same from 10 to 55% 0.73 and 0.18.

Here \( b_j \) is the regression coefficient of the j-th factor, \( i \) is the number of the experiment, \( n \) is the number of experiments, \( x_{ij} \) is an arbitrary dimensional value, and \( y_i \) is the result of the i-th experiment.

The values of the regression coefficients characterize the degree of the effect of the corresponding factor on the function under investigation; therefore, by comparing the values of \( b_j \) for H and t we can infer that the field intensity influences the deposition rate \( v \) more markedly than the duration of magnetic processing of the pulp.

Planning of the experiments is effected in a reduced system of coordinates and the equation of the response function may be written as follows:

\[ y = b_0 + b_1 x_1 + b_2 x_2 + \ldots + b_j x_j \]  \[ 7 \],

where \( y \) is the response function (in our case the deposition rate of the magnetized pulp); \( b_0, b_1, b_2, \ldots, b_j \) are the regression coefficients, \( x_1, x_2, \ldots, x_j \) form a coded variable, related to the investigated factors by the equation

\[ x = \frac{x_j - x_0}{S_j} \]  \[ 7 \],

where \( x_j \) are the values of these factors in the experiments, \( x_0 \) are the values at the base level, and \( S_j \) is the unit of variation of the j-th factor.

Processing of the experimental data gave us the following linear regression equations showing the dependence of the pulp deposition rate on the field intensity and the duration of magnetization of the pulp: concentration from 10 to 15% solids

\[ v = 2.93 + 0.034 H - 0.172 t + 0.08 H t; \]  \[ 5 \]