IRON ORES ARE FLATATED BY TWO SYSTEMS, BASED ON ALIPHATIC ACID-TYPE COLLECTORS: DIRECT FLATATION WITH WATER GLASS AND SULFURIC ACID AND REVERSE FLATATION WITH CAUSTIC SODA AND VINAASE. BOTH PROCEDURES HAVE CERTAIN CHARACTERISTICS WHICH MAY BE ELUCIDATED BY ANALYZING THE FLATATION EFFICIENCY OF DIFFERENT SIZE CLASSES OF THE CRUSHED ORE.

The initial information processed consisted of screen analyses of the products of direct and reverse flatation of iron ores from different sectors of the Krivbass and the Kursk Magnetic Anomaly, performed under commercial and pilot-plant conditions. The flatation efficiency of the individual size classes of polydispersed pulp was assessed by the formula:

\[ E = \frac{\gamma - \alpha_{\text{min}}}{1 - \alpha_{\text{min}}} \times 100\% , \]

where \( \gamma \) is the yield of the concentrate in a given class as a percentage, \( \varepsilon \) is the extraction of iron into the concentrate in a given class as a percentage, and \( \alpha_{\text{min}} \) is the mineral content of the feedstock in a given class as a percentage.

The statistical data were also analyzed graphically by means of correlation equations derived on a Ural-2 computer.

Figure 1 is a plot of the flatation efficiency versus the procedure used. Curve 1 shows the results of direct flatation by an emulsion of tall oil and diesel fuel with water glass and sulfuric acid, curve 2 relates to the same procedure but with tall oil, curve 3 shows the results of reverse flatation with calcium chloride and alcoholic sulfate waste, and curve 4 the results of flatation by pyrolysate in a medium of sodium carbonate with water glass and aluminum sulfate. For all the ores investigated, direct flatation with tall oil or an emulsion of the latter and petroleum products gave poor beneficiation of the \(-0.02 \text{ mm fraction (efficiency 30–35\%). Analysis of the behavior of slimes revealed that they are flocculated into unselective conglomerates, which are transferred predominantly to the froth product and impair the quality of the concentrate. It is therefore necessary to deslime the crushed ore before direct flatation [1]. With reverse flatation, the pulp was dispersed by doses of caustic soda and vinaase, which provide better conditions for slime separation [2]. This is indicated by the high beneficiation efficiency (70–75\%) for the \(0.02 + 0.01 \text{ mm size class. In the case of the \(-0.01 \text{ mm fraction the efficiency fell to 50–60\% but remained better than in direct flatation (see Fig. 1, curve 3).}

Direct flatation of the coarse size classes with tall oil gave poor results. A high flatation efficiency with this collector is observed only for the \(-0.05 + 0.02 \text{ mm fraction (E = 70\%). With addition of petroleum products (diesel fuel or Emulsol) the beneficiation efficiency of the \(-0.08 + 0.05 \text{ mm class rises from 50 to 65–70\%, and that of the \(-0.1 + 0.08 \text{ mm class from 30 to 50\%. The flatation efficiency of the coarser material is lower. Screen analysis of the waste product reveals a higher iron content in the coarse size classes even with higher consumptions (2–4 kg/ton) of collector (Fig. 2). It may be inferred that the ore grains and rich concritions larger than 0.1 mm are not retained in the air bubbles and remain in the cell product.

The beneficiation efficiencies of the coarse size classes can give us indirect assessments of the collector flatation activity. Analysis of the experimental data reveals that with addition of diesel fuel to tall oil the upper size limit is increased from 0.07 to 0.1 mm.

In addition to our own data, we used the results of screen analyses quoted by E. F. Vetrova.
The relative beneficitation efficiencies of the coarse size classes are the same for reverse flotation (in fresh water) as for direct flotation with petroleum products (see Fig. 1, curves 1 and 2). The experimental data do not reveal advantages of direct flotation in beneficitation of the coarse classes. It is more correct to state that under these conditions it might be more advantageous to utilize differences in the crushabilities of the iron mineral and quartz. Owing to the greater hardness of quartz and the higher specific gravity of hematite, in the crushing of iron ores in a closed cycle with hydraulic sizing apparatus we observe depletion of the coarse ore classes, which may be lost in the tailings without appreciable reduction of extraction. American beneficitation plants have been constructed on this principle [4, 5].

A number of reports [3] on direct flotation of iron ores recommend the heavy fraction of the pyrolysate of wood resin as a new type of collector. Tests on oxidized quartzites of the Mikhailov deposits of the Kursk Magnetic Anomaly revealed* that this collector gives somewhat better separation of slimes than tall oil. However, the effectiveness of the pyrolysate is manifested for very finely crushed ore—up to 98% of the −0.05 + 0 mm class. Coarser hematite grains are not extracted into the froth product and even the beneficitation efficiency of the −0.05 + 0.04 mm class is unsatisfactory (see Fig. 1, curve 4).

To determine the dependence of the over-all flotation efficiency on the beneficitation efficiencies of the individual size classes, the experimental data were processed with a Ural-2 computer. The equations derived were characterized by a high correlation ratio (\( \eta^2 > 0.85 \)), but are not really satisfactory because for most of the size classes the partial correlation coefficients \( r \) were less than 0.4. Higher values \( (r > 0.98) \) were obtained when the over-all process efficiency was considered as a function of the beneficitation efficiencies of the individual size

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*In these tests we were assisted by colleagues of the Scientific Research Institute of the Kursk Magnetic Anomaly, E. P. Krylova, and M. I. Shevlyakov.