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THE DETERMINATION OF THE FERRO-SILICON CONTENT OF HEAVY MEDIA CONTAINING PYRRHOTITE FROM CLEVELAND TIN N.L.

Introduction

Cleveland Tin N.L. were experiencing contamination by pyrrhotite of the ferro-silicon in their heavy media plant. During a recent shut-down, the heavy media was subjected to flotation to remove the pyrrhotite. Samples of the flotation products were forwarded to the Department of Mines so that a reasonably quick method could be established to determine the quantity of pyrrhotite in the heavy media.

Sample

Four samples were submitted, each a few hundred grams in weight. They were labelled as follows:—

Flotation Feed
Cleaner Flotation Concentrate
Cleaner Flotation Tail
Rougher Tail

The Rougher Tail sample was khaki-coloured and the Cleaner Flotation Concentrate was black. The Cleaner Flotation Tail and Flotation Feed samples were intermediate in colour. They were all in powder form.

Later a sample of new clean Ferro-silicon and a sample of pyrrhotite from the mine were requested from Cleveland Tin N.L. A few hundred grams of ferro-silicon powder and two or three pounds of pyrrhotite in lump form were supplied.

Note: No responsibility will be accepted for the results shown in this report except insofar as they apply to the samples received.

Test Work

Initially, the Rougher Tail, Cleaner Flotation Concentrate, and Flotation Feed samples were treated in the Davis Tube magnetic concentrator to produce magnetic concentrates at varying field strengths. Twenty gram samples of each product were agitated in the Davis Tube for ten minutes. The results of these tests are shown in the following table:—

Sample	Magnetic Field Strength (Gauss)	Magnetic Concentrate % Weight
Rougher Tail (ferro-silicon)	5500	98.2
	3000	98.0
	1000	97.5
	750	97.0
	500	71.2
	250	1.5
Cleaner Flotation Concentrate (pyrrhotite)	750	66.0
	500	16.8
	250	0.5
Flotation Feed	750	90.0
	500	40.5
	250	0.5

These results show that the Cleaner Flotation Concentrate (essentially pyrrhotite) is not as strongly attracted magnetically as the Rougher Tail (essentially ferro-silicon). However, at 750 gauss 97.0% of the ferro-silicon is recovered and 66.0% of the pyrrhotite is recovered, and at this strength a satisfactory separation is not obtained. At 500 gauss recovery of pyrrhotite falls to 16.8% while recovery of ferro-silicon is 71.2%. A separation is achievable at this field strength, but a loss of 28.8% of ferro-silicon could not be tolerated.

A chemical method was then tried in order to separate the pyrrhotite from the ferro-silicon. Dilute acid attack with peroxide oxidation of the pyrrhotite appeared to work satisfactorily. However, it was shown that solution of iron from the ferro-silicon occurred when the method was tried on a sample of new clean ferro-silicon.

A sample of cleaner concentrate was concentrated by gravity means on the super-panner and some ferro-silicon was separated from the pyrrhotite. The pyrrhotite was taken from the super-panner and specific gravity determinations were made. Results obtained in duplicate tests were 4.95 and 4.88. This compared with the specific gravity range for pyrrhotite of 4.58-4.64 given by Dana. This indicated that all the ferro-silicon present in the sample had not been eliminated by super-panning. A silicon determination on the pyrrhotite product upon which the specific gravity determinations were made, gave a result of 4.0% Si which confirmed the presence of ferro-silicon.

The sample of rougher tail was similarly treated on the super-panner and a ferro-silicon concentrate was taken and duplicate specific gravity determinations gave results of 6.82 and 6.78.

A specific gravity determination was made on the new clean ferro-silicon with a result of 6.86.

The lump pyrrhotite from the Cleveland mine was crushed and screened and magnetically separated on the disc type dry magnetic separator. The magnetic concentrate was demagnetised and then passed over the magnetic separator again. This process was repeated three times. Examination of the final magnetic concentrate under the microscope showed the presence of a small amount of translucent material (possibly a silicate or carbonate) which had proved to be very magnetic and very difficult to separate from the pyrrhotite.

It is probable that this mineral also contaminated the heavy media at Cleveland Tin N.L. The magnetic concentrate was given duplicate specific gravity determination with results 4.53 and 4.49.

Duplicate specific gravity determinations on the flotation feed sample gave results of 5.25 and 5.30.

Conclusions

The pyrrhotite in the Cleveland ore is very nearly as magnetic as the ferro-silicon, and alteration of the field strength of the magnet in the heavy media circuit is not a solution to the problem, since if the field strength was reduced sufficiently to effect a separation of the pyrrhotite from the ferro-silicon, the loss of ferro-silicon would be too high.

The presence of ferro-silicon in the cleaner flotation concentrate shows that the ferro-silicon has a tendency to float, and flotation conditions may need to be altered in order to get more selective flotation.

Taking the pyrrhotite specific gravity as 4.50 and the ferro-silicon specific gravity as 6.86, the following formula is derived:—

$$X = 42.5D - 191.5$$

where X = per cent of ferro-silicon present, and D is the specific gravity of the dry heavy media.

This formula will determine the percentage of ferro-silicon present when the specific gravity of the dry heavy media is known.

From the formula, the amount of ferro-silicon in the flotation feed sample was 33%.