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DEPARTMENT OF MINES

DIVISION OF ORE DRESSING AND METALLURGY



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MINES BRANCH

REPORT OF HYDRO-METALLURGICAL TEST ON LOW-GRADE PYRRHOTITE FROM HORNE MINE, ROUYN TOWNSHIP, QUEBEC

W. R. McClelland

The following test was carried out on a sample of low-grade pyrrhotite from the Rouyn district, with the object of concentrating the low gold values, and effecting a recovery of the iron, copper, and sulphur.

The ore was given a preliminary roast in order to drive off one atom of sulphur from the pyrite, thus converting it to a mono-sulphide or artificial pyrrhotite. This product was then subjected to leaching with ferric chloride liquor by which iron and copper are brought into solution and sulphur is precipitated. This product was again roasted and leached, resulting in a further concentration of the low gold values which are found in the residues along with the precipitated sulphur.

Iron was obtained by electrolysis of the leach liquors; sulphur was recovered by distillation of the residues; the copper was recovered as a mixed cement copper and sulphide residue from the purification tanks. The final residues were treated by cyanidation by Mr. Godard to determine the possible gold recovery. The results of the test are as follows:

A 30-pound sample (13065 gms) ore was ground to pass 10 mesh. The analysis was:

Total iron	50.3 %	Ferrous iron	33.18 %
Copper	1.2	Zinc	0 .37
Sulphur	34.52	Gold	0.10 oz/ton

This was roasted (primary roast) in a rotary furnace. The product weighed 12242 gms, and had the following analysis

Total iron	52.42 %	Ferrous iron	48.96 %
Copper	1.28		

Primary leaching

The roasted product was leached in three lots, each leach having a volume of 50-litres.

Leach X-11: Conditions: Charge 2853 gms (25% excess)
 Conc. of leach liquor Fe⁺⁺ 94.12 g/l
 Fe⁺⁺⁺ 47.84
 Temperature 96°C.
 Time of agitation 15 1/2 hrs.

Results: Wt. of residue 1880 gms
 Analysis: Total Fe 32.76 %
 Ferrous Fe 29.64
 Copper 0.58

% extraction of ferrous Fe 62.75
 " " copper 71.9

The copper was cemented from the leached liquor by means of sponge iron and calcium sulphide. Analysis of the purified liquor was:

Ferrous Fe	169.52 g/l	Ferric Fe	nil
Copper	nil	Zinc	0.385 g/l

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The residue was roasted in a pipe retort to distil off the sulphur. The residue weighed 1146 gms, analyzing Ferrous Fe 41.18% The sulphur recovered weighed 496 gms.

Test X-12: Conditions: Charge 5254 grams (40% excess)
 Conc. of leach liquor Fe^{II} 70.72 g/l
 Fe^{III} 73.36
 Hcl 2.0 cc/l
 Temperature 96°C.
 Time of agitation 15½ hours
 Results: Wt. of residue 3428 gms.
 Analysis: Total Fe 31.9% Ferrous Fe 28.3%
 Cu 0.69%

Cementation carried out as before:

% extraction of Fe 62.3
 " " Cu 64.8

The residue was roasted in two lots as in the previous test, giving a total product of 2264 grams, analyzing 45.6% ferrous iron. The sulphur recovered weighed 761 grams.

Test X-13: Residue of primary roasted ore.
 Conditions: Charge 3935 gms. (25% excess)
 Conc. of leach liquor Fe^{II} 71.76 g/l
 Fe^{III} 54.08
 Temperature 96°C.
 Time of agitation 12½ hours
 Results: Weight of residue 2587 grams
 Analysis: Total Fe 36.6% Ferrous Fe 34.2%
 Copper 0.83%
 % Extraction of Fe. 53.6
 " " " Cu 57.4

Residue from distillation of sulphur 1855 gms.
 Weight of sulphur recovered 542 "

Summary of Weight of leached product 7895 grms
Primary leaching: Weight of distilled product 5265 "
 Weight of sulphur recovered 1791 "
 Total extraction of total Fe. 59.7 %
 " " " Cu. 64.4 %

The distilled residues from the primary leach were again roasted (secondary roast). Roasting was carried out in the pipe retort at temperature of 750-800°C. The secondary roasted product weighed 4779 gms and analyzed 54.6% total Fe, 53.8% Fe^{II} and 1.13% copper. 151.6 grams of sulphur was recovered.

Secondary Leaching: (Tests 34, 35, and X-14). The secondary leaching was carried out in two 4-litre and on 3 50-litre leaches. The residues from the four-litre leaches were re-leached along with the 50-litre test. Weight of leached residue - 2743 gms.

This precipitated sulphur from this residue was distilled off in the pipe retort. Owing to the wearing away of the threads on the cover, little of the sulphur from this roast was recovered. The residue from this distillation constituted the final product. Weight of final product 1599 grams. Analysis:

Total Fe 43.2 % Ferrous Fe 38.1 %
 Copper 1.14 Sulphur 28.55
 Gold 0.76 oz/ton

Concentration by weight - 8.17 : 1

Sulphur recovery: Total sulphur actually recovered was 2664 gms, which was 60.4% of the sulphur in the original ore. Considering the somewhat crude retort, this may be taken as a very fair recovery.

Gold in head sample .0015 oz.
 Gold in concentrated residue .0013 oz.

% extraction of	total iron	89.5
"	copper	88.6
"	sulphur	60.4

Electro-deposition of iron from leach liquor

The test was carried out in the rotating cathode diaphragm cell. The electrolyte was leach liquor from the secondary leach.

Conc. of electrolyte	Fe ^{II}	145 g/l
"	Cu	nil

A rolled polished mandrel was used. The electrolyte was fed to the cell cold and maintained at the working temperature, over 80°C. by an electrical immersion heater. The data relative to the test are as follows:

Average current density	96 amp./sq.ft.
" voltage	3.7
" temperature	86° C.
Time of deposition	5 hours
Rate of feed of electrolyte	3-4/5 litres per hr.
Speed of cathode	274 r.p.m.
Approximate weight of deposit	490 gms.
Thickness of deposit	1/32 inch
Analysis anode overflow	Fe ^{II} 76 g/l
	Fe ^{III} 60 "

The deposit was silver white in colour, of uniform thickness and coherent. A number of small nodules formed on the surface.

On annealing and rolling these were flattened out, and a smooth cylinder was removed from the cathode.

Cyanidation of Residues

J. S. Godard

Results:

Residue gms.	Solution cc.	KCN %	Assay Heads Tailg.		Extraction %	KCN used lb/ton	Time hrs.
606	2360	0.2	0.76	0.185	75.6	32.7	50

Grinding: Residues ground wet in a ball mill using grey iron balls. Intermittent screening through 200 mesh. Oversize returned to the mill.

Remarks: Cyanidation in a more dense pulp, 1:2.5, using .075% KCN and increasing the time might increase the extraction, with a considerable decrease in KCN consumption.

The residue contained 1.13% copper. With a more complete removal of the copper, the gold extraction should be better, and the consumption of cyanide much lower.