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EVALUATION OF DEPRESSANTS USED IN IRON ORE FLOTATION

by

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ORE FLOTATION

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SUMMARY OF RESULTS

Using a standardized procedure, several reagents classed as depressants were evaluated to determine their relative efficiency in depressing iron minerals while floating silica and silicate minerals with cationic reagents.

None of the reagents acted only as depressants. In all cases recoveries of iron were lower than in tests done without any depressants but grades of the non floats were increased considerably. Of the 17 reagents tested, the reagents which were found to be most valuable as flotation modifiers were Dextrine WW82, Morningstar-Paisley guar gum, Grain Products starches 927-1 and 927-7, and Lignosol SFX. Further work will be done to determine what function these chemicals have in iron ore flotation using cationic collectors.

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INTRODUCTION

Purpose of Investigation

The aim of these tests was to determine the depressing effects of certain products on the flotation of iron ores. The depressants tested were for iron minerals, and cationic reagents were used to float silica and silicates.

Depression is the converse of activation. It comprises steps taken to prevent flotation of a particular mineral or groups of minerals. The methods of depression can be classified* under certain headings which are: 1) prevention of activation resurfacing by soluble salts present in the small pulp; 2) closure of surfaces against collector reaction; 3) destruction or nullification of collector coatings; 4) dispersion; 5) resurfacing to produce water-avidity.

The reagents used in this series of tests are organic colloids which usually depress due to a hydrophilic coating on the particles involved, iron minerals in this case.

Materials

The ore used for these tests was a mixture of cobber concentrates from the "E" and "F" ores from Kukatush Mining Corporation (1960) Limited, Kukatush, Ontario.

Mineralogy reports of both these ores are contained in Mines Branch Investigation Reports IR 61-85 and IR 61-103. Magnetite is the principal ore mineral associated with chert and iron silicates, such as minnesotaite and stilpnomelane, as gangue minerals.

Previous flotation work has been done on the Kukatush ore and is reported in Investigation Report IR 62-82.

The first group of depressants to be tested was provided by Morningstar-Paisley of Canada Ltd., 207 Queens Quay West, Toronto, Ontario, and consisted of:

Guar Gum
Locust Bean Gum
Benefite M-8
Benefite M-11
Benefite 100

*Taggart, Handbook of Mineral Dressing.

Benefites are non-ionic, high molecular weight polyacrylamide flocculants; the gums consist largely of carbohydrates and are hydrophilic colloids.

The second group of depressants was furnished by Grain Products Inc., Dodge City, Kansas and are known as 927-1, 927-2, 927-4, 927-5, 927-7. These grain products are starches which include a mixture of saturated giant polymeric molecules, both straight and branch-chained, the constituents consisting of glucose units with hydroxyl radicals as active or polar groups.

The third group of depressants was provided by Lignosol Chemicals Limited, Quebec City, Quebec and included Lignosol SFX, BD, AXD, XD, FSD, SF. These lignosols are lignin sulphonates which are metallic sulfonate salts made from the lignin of sulfite pulp-mill liquors and give colloidal solutions on dispersion in water. Lignin is a major non-carbohydrate constituent of wood and woody plants.

Sample Analysis

All iron analyses, in conjunction with this investigation, were done by using the "Lerch" method for iron determination by the stannous chloride-potassium dichromate procedure and therefore are for soluble iron only.

OUTLINE OF INVESTIGATION

Based on previous work, as reported in Investigation Report IR 62-82, standard amounts of cationic collectors and frothers were used; and standardized flotation procedures were employed in each test, varying only the amounts and types of depressants.

Two froth products were floated in each test leaving the iron concentrate or non float in the cell. The weight floated and the iron content of these three products appeared sufficient to estimate the effects of the depressants. Only in the last test was the first froth product cleaned and the non float from the cleaning and the second froth portion reground and re-floated.

DETAILS OF INVESTIGATION

The ore was reduced to minus 20 mesh and ground in 1000 gram batches in a porcelain mill. Each batch was then split into two 500 gram portions which were floated in a Denver Sub-A Laboratory Flotation machine.

The procedures were as follows:

R. P. M.: 1000

Pulp density: 30% solids

Mixing time: 1 minute

Conditioning with depressants: 1 minute

Conditioning with collector and frother: 30 seconds

First froth flotation time: 5 minutes

Additional conditioning with collector and frother: 30 seconds

Second froth flotation time: 5 minutes

The collector, Rosin Amine D Acetate, and frother, POA*, additions were standardized for all floats and consisted of 0.4 lb of collector and 0.3 lb of frother per ton for the first froth float and 0.2 lb of each per ton for the second froth float.

Preliminary Work

Various levels of depressant additions were carried out with Dextrine WW82, a product of Industrial Grain Products Ltd., which had been used previously, to determine the most significant levels. Two grinds, one of 40 minutes and the other of 50 minutes, were tried. Tables 1 and 2 report the results.

Table 1

40 Minute Grind - Dextrine WW82

WW82 lb/ton	Products	% Wt	% Sol Fe	% Fe Dist'n
0.0	1st Froth	24.5	19.9	10.3
	2nd Froth	18.9	39.0	15.5
	Non Float	56.6	62.6	74.2
0.5	1st Froth	24.6	14.8	7.8
	2nd Froth	18.5	36.9	14.8
	Non Float	56.9	62.6	77.4
1.0	1st Froth	26.4	14.7	8.4
	2nd Froth	17.6	40.7	15.5
	Non Float	56.0	63.3	76.1
1.5	1st Froth	27.5	15.9	9.4
	2nd Froth	16.7	41.0	14.6
	Non Float	55.8	63.6	76.0
2.0	1st Froth	26.4	13.0	7.3
	2nd Froth	14.4	37.4	11.7
	Non Float	59.2	63.1	81.0

*POA is a mixture of Pine Oil, Aerosol OT 100 and water in the proportions of 50%, 2.5% and 47.5% respectively, by weight.

Table 2

50 Minute Grind - Dextrine WW82

WW82 lb/ton	Products	% Wt	% Sol Fe	% Fe Dist'n
0.0	1st Froth	16.8	13.6	4.9
	2nd Froth	11.9	24.7	6.4
	Non Float	71.3	58.5	88.7
0.5	1st Froth	20.7	15.6	6.8
	2nd Froth	12.4	26.6	7.0
	Non Float	66.9	60.7	86.2
1.0	1st Froth	25.2	15.4	8.3
	2nd Froth	12.5	31.0	8.3
	Non Float	62.3	62.7	83.4
1.5	1st Froth	27.9	16.8	10.0
	2nd Froth	20.2	43.2	18.4
	Non Float	51.9	65.1	71.6
2.0	1st Froth	27.9	14.6	8.7
	2nd Froth	17.0	44.0	16.0
	Non Float	55.1	64.4	75.3

It was decided to grind all ore samples for a 50 minute period as at this grind larger difference in grade and recovery for the different depressant levels were obtained. It was also decided to use the 0.5 lb/ton and 2.0 lb/ton levels as standard additions for all successive depressants.

Screen Test on 50 Minute Grind

Screen tests on the 50 minute grinds used for all subsequent flotation tests gave these typical results:

+ 200 mesh: 0.5%
+ 325 mesh: 3.4%
- 325 mesh: 96.1%

Morningstar-Paisley Depressants

The Morningstar-Paisley depressants were the first group of reagents to be tested and the results are given in Table 3.

Table 3

Flotation Results with Morningstar-Paisley Depressants

Depressants*	Products	0.5 lb/ton			2.0 lb/ton		
		% Wt	% Fe	% Fe Dist'n	% Wt	% Fe	% Fe Dist'n
Guar Gum	1st Froth	27.7	17.0	10.0	29.4	20.5	9.2
	2nd Froth	18.8	40.0	16.0	16.7	39.7	14.1
	Non Float	53.5	64.9	74.0	53.9	65.0	76.7
Bean Gum	1st Froth	37.1	25.0	19.6	25.4	21.1	11.6
	2nd Froth	22.4	56.6	26.4	18.2	49.1	19.4
	Non Float	40.5	63.3	54.0	56.4	56.7	69.0
Benefite M-8	1st Froth	16.4	13.6	4.8	36.5	20.1	16.0
	2nd Froth	7.9	29.8	5.2	21.4	52.8	24.3
	Non Float	75.7	54.8	90.0	42.1	65.3	59.7
Benefite 100	1st Froth	54.3	34.3	40.1	50.9	36.1	39.7
	2nd Froth	32.6	58.9	41.4	24.9	49.7	26.9
	Non Float	13.1	65.8	18.5	24.2	63.6	33.4
Benefite M-11	1st Froth	80.6	42.6	73.8	75.9	41.2	67.4
	2nd Froth	14.0	59.4	17.8	13.7	59.6	17.7
	Non Float	5.4	64.4	8.3	10.4	66.1	14.9

*These were added as 0.5% and 1% solutions.

Grain Products Depressants

The second group of depressants to be tested was furnished by Grain Products Inc.

Sample 927-7 was prepared in two ways. The first was simply mixed and dispersed in water while the second sample was dispersed in a 10% NaOH solution which was later acidified to neutrality with H_2SO_4 .

Table 4

Results of Flotation with Grain Products Depressants

Depressants*	Products	0.5 lb/ton			2.0 lb/ton		
		% Wt	% Fe	% Fe Dist'n	% Wt	% Fe	% Fe Dist'n
927-1	1st Froth	33.1	19.0	13.7	33.0	22.9	16.4
	2nd Froth	23.9	47.9	24.8	26.3	50.0	27.8
	Non Float	43.0	65.7	61.5	40.7	65.0	56.1
927-2	1st Froth	27.1	21.9	12.4	23.6	20.1	10.0
	2nd Froth	17.6	39.6	14.8	18.7	37.3	14.6
	Non Float	55.3	62.4	72.8	57.7	62.5	75.4
927-4	1st Froth	50.4	32.2	34.2	45.7	32.5	30.5
	2nd Froth	36.8	61.8	47.9	33.9	59.7	41.6
	Non Float	12.8	66.6	17.9	20.4	66.7	27.9
927-5	1st Froth	46.8	31.4	31.0	51.0	30.9	34.4
	2nd Froth	30.2	58.3	36.9	22.2	56.9	27.2
	Non Float	23.0	66.2	32.1	26.8	66.3	38.4
927-7 (water)	1st Froth	33.5	22.9	16.3	27.4	21.9	12.8
	2nd Froth	21.8	47.8	22.1	25.0	40.5	21.6
	Non Float	44.7	65.9	61.6	47.6	64.3	65.6
927-7 (NaOH sol'n)	1st Froth	30.8	25.6	16.6	46.8	34.9	34.3
	2nd Froth	20.5	43.8	18.7	16.3	51.8	17.6
	Non Float	48.7	63.3	64.7	36.9	62.0	48.1

*The depressants were added as 0.5% or 1% solutions.

Lignosol Chemicals Depressants

The third group of depressants was provided by Lignosol Chemicals Limited and the results obtained with them are given in Table 5.

Table 5

Results of Flotation with Lignosol Chemicals Depressants

Depressants*	Products	0.5 lb/ton			2.0 lb/ton		
		% Wt	% Fe	% Fe Dist'n	% Wt	% Fe	% Fe Dist'n
Lignosol SFX	1st Froth	52.7	30.9	35.4	22.2	21.9	10.2
	2nd Froth	27.3	60.2	35.7	21.4	31.2	13.9
	Non Float	20.0	66.6	28.9	56.4	65.1	75.9
Lignosol BD	1st Froth	46.1	29.3	29.5	20.0	21.2	9.1
	2nd Froth	25.6	52.1	29.1	33.4	36.6	26.5
	Non Float	28.3	66.7	41.4	46.6	63.8	64.4
Lignosol AXD	1st Froth	46.2	28.2	28.4	35.5	25.3	19.5
	2nd Froth	24.1	55.9	29.2	27.4	48.6	28.7
	Non Float	29.7	66.0	42.4	37.1	64.8	51.8
Lignosol XD	1st Froth	41.4	31.0	27.4	23.4	25.0	12.4
	2nd Froth	22.2	43.8	20.7	25.4	35.1	18.9
	Non Float	36.4	66.7	51.9	51.2	62.9	68.7
Lignosol FSD	1st Froth	37.4	26.0	20.5	16.4	21.9	7.5
	2nd Froth	21.8	50.3	23.1	25.9	32.4	17.6
	Non Float	40.8	65.4	56.4	57.7	62.0	74.9
Lignosol SF	1st Froth	39.8	27.0	22.2	14.6	18.6	5.7
	2nd Froth	16.0	53.6	17.8	27.6	31.1	18.2
	Non Float	44.2	65.4	60.0	57.8	62.2	76.1

*Added as 1% solutions.

A flotation test, using 2.0 lb/ton of Lignosol SF was repeated to include cleaning of the first and second froth. In this test, the first froth was refloat and the non float was added to the second froth. This mixture was reground for ten minutes and refloat with 0.4 lb/ton of Lignosol SF, 0.1 lb/ton of RADA, 0.1 lb/ton of POA for a five minute period. Results of this test are seen in Table 6.

Table 6

Final Flotation Results Using Lignosol SF

Products	% Wt	% Sol Fe	% Fe Dist'n
Cleaned 1st Froth	16.2	13.1	4.0
Cleaned 2nd Froth	6.2	32.3	3.8
Non Float	77.6	62.8	92.2

RESULTS

The following table compares the reagents which were most effective in producing an iron concentrate near the required grade (66% Sol Fe) and with a reasonable recovery. The other reagents failed to produce either a good grade or a reasonable recovery.

Table 7

Comparison of Most Effective Reagents

Products	Addition lb/ton	Wt of Iron Conc %	Assay Sol Fe %	Distribution of Iron %
Dextrine WW82	1.5	51.9	65.1	71.6
"	2.0	55.1	64.4	75.3
Guar gum	0.5	53.5	64.9	74.0
"	2.0	53.9	65.0	76.7
GrainProducts 927-1	0.5	43.0	65.7	61.5
" 927-7	0.5	44.7	65.9	61.6
Lignosol SFX	2.0	56.4	65.1	75.9

CONCLUSIONS

A study of the flotation results indicates that none of the reagents acted solely as iron depressants. All recoveries of iron in the tests done with these reagents were lower than the recovery in the test done without any depressant. On the other hand, the grades of the non floats were all higher when the reagents were used than when they were not.

No reasons can be given at this time to explain this behaviour, but it would seem to indicate that the reagents have some activating effects. This activating effect could be concentrated on the iron silicates contained in the ore and on locked particles of silica and iron.

More work is underway to clarify the behaviour of the chemicals tested, which, considering the results of this investigation, are better described as modifiers, than depressants.

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