1916

Oils and flotation

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OILS AND FLOTATION.

BY

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AND

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A

THESIS

submitted to the faculty of the

SCHOOL OF MINES AND METALLURGY OF THE UNIVERSITY OF MISSOURI

in partial fulfillment of the work required for the

Degree of

METALLURGICAL ENGINEER

AND

BACHELOR OF SCIENCE IN METALLURGY

Rolla, Mo.

1916.

Approved by Horace T. Mann

Associate Professor of Metallurgy and Ore Dressing.

Thesis. Oils and Flotation. Clayton and Peterson. 1916

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INTRODUCTION. Flotation is today attracting the attention of the metallurgist, chemist, physicist, and intelligent technical man in general. The application of the process is making great strides, but the success of it is hindered by the lack of knowledge concerning the many variables that affect the operation. A mill may be running smoothly for weeks at a time when, without apparent reason, the froth dies and everything goes wrong. Sometimes a change in the ore does this, sometimes the water supply, sometimes lubricating oils get into the system, and sometimes the tube-mill is to blame. It is up to the flotation man to study these variables more carefully and get a better control of them.

We know that the sulphides, or minerals with a metallic lustre, can be floated either with or without oil and that the carbonates, silicates, etc., cannot be floated so readily. Why do certain oils have the power of selecting certain minerals? Why do certain oils produce a froth? Why do certain oils give a watery froth? Why do some give an ephemeral froth and others a tough one? Of the thousands of oils known, only a few classes have found successful application in this new process. Is it because others will not give results or is it because they have not been tried?

Among the oils used at the present time are the wood-oils, the coal-tars and their derivatives, water-gas tars and derivatives, the fixed oils and fatty acids, petroleum products, and occasionally an essential oil. By a study of these groups and the oils available in each group it will be seen that only a small percentage of the various oils is in use. Why is one oil better than another?

In buying oils for flotation it proves often that the same oil, supposedly, gives different results. The method of manufacture and the care of an oil before it is used play important parts in successful practice. The properties of an oil may vary by reason of oxidation, exposure to light, or slight differences in the method of manufacture, especially the distillation temperature in the common flotation-oils. In wood-oils the composition may vary with the species of wood from which it is obtained.

The trend of work today seems to be to study flotation from the standpoint of the ore, its electro-static charge (so-called), etc., and from the standpoint of colloidal chemistry. We believe that, in addition, a study of oils would give a better understanding of the process and of the variables concerned, while also aiding in the solution of certain theories not yet advanced.

This leads us to the question, what property or combination of properties make oils valuable as flotation agents? Thinking that a careful study of oils and their properties might lead us to the solution of this problem, we made the experiments herewith recorded.

From the scanty literature of the subject it would seem that the chief factors are:

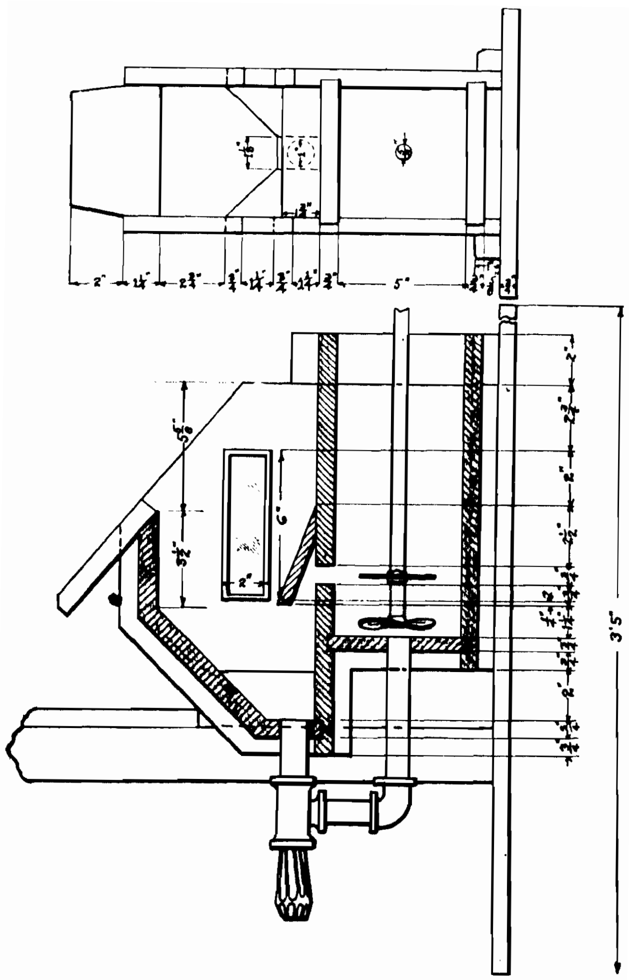
1. Di-electric strength.
2. Optical properties, the power to absorb certain rays.
3. Insulation value.
4. Viscosity.
5. Saponification value.
6. Water-soluble content.
7. Degree to which an oil (as a whole) is dissolved by water.
8. Facility to be emulsified.
9. Surface tension.
10. Specific gravity.
11. Chemical composition.

In attacking the problem the first step was to classify the available oils into groups. The oils so far tested cover a large field and can be divided as follows: Fixed oils, fatty acids, essential oils, wood-oils (including the resins), coal-tars and derivatives, water-gas tar and derivatives, petroleum and derivatives.

In making this classification we realize that some groups overlap, that is, contain like compounds, but the idea was to get a classification that would show the source and be easily understood. In addition to this general classification, oils were studied in detail and technical articles abstracted, giving a volume of matter too large for publication at this time.

The next step was to classify oils as to their flotation-value. This was accomplished in test-tube and machine tests. By shaking small quantities of oil, water, and ore in a test-tube and noting the action, we obtained a general classification of oils: frothing oils, selective oils, oils that froth and select, and oils that are seemingly inactive. The data were tabulated to aid the machine tests. The machine tests were made in a modified Hoover machine, as shown in the accompanying drawing. The capacity of this machine was 4000 cc. of water and 800 grams of ore, making a ratio 5:1. The agitator gave 1700 r.p.m. The time of each test was 20 minutes.

Since making these tests we have found that it is advantageous to replace the small circulation pipe, connecting the agitator-box and the spitz, with an air-lift. Throughout this work the only variable was the kind of oil.



FLOTATION MACHINE USED IN THE MISSOURI SCHOOL OF MINES.

OILS

Our Number	Name	Company
1	Castor	Eimer and Amend.
2	Linnseed (Raw)	" "
3	Linnseed (Boiled)	" "
4	Neatsfoot	" "
5	Olive	" "
6	Petroleum	" "
7	Rapeseed	" "
8	Sperm	" "
9	Turpentine	" "
10	Turpentine #1	" "
11	Turpentine #2	" "
12	Toluol	" "
12a	Xylol	Meyer Bros. Drug Co.
13	Almond	Meyer Bros. Drug Co.
14	Colza	" "
15	Lemon	Local Druggist
16	Peanut	Meyer Bros. Drug Co.
17	Sesame	" "
18	Amyl Acetate	Local Druggist
19	Pyroligineous Acid	" "
20	Cedar Wood	" "
21	Cedar Wood(crude)	" "
22	Oleic Acid	Eimer and Amend
23	Eucalyptus	
24	Orange Peel	Local Druggist
25	Cresylic Acid	Meyer Bros. Drug Co.
26	Creosote	" "

OILS (Continued)

Our Number	Name	Company
27	Corn Oil	Eimer and Amend
28	China Wood	" "
29	Menhaden (Tech)	" "
30	Rape seed	" "
31	Soya Bean	" "
32	Menhaden Pure	" "
33	Poppy seed	" "
34	Rosin	" "
35	Rosin	Meyer Bros. Drug Co.
36	Paraffin	Eimer and Amend
37	Cottonseed	" "
38	Cottonseed (crude)	Southern Cottonseed Oil Co.
39	" (refined)	" "
40	" (residue)	" "
41	Wine	Local Druggist
42	Male Fern	" "
43	Pennyroyal	" "
44	Cloves	" "
45	Citronella	" "
46	Codliver	" "
47	Sassafrass	" "
48	Origanum	" "
49	Amber	" "
50	Kerosene	" "
51	Commercial Tar Oil	Florida Wood Products Co.
52	Fuel Oil	Water's Pierce Co.

OILS (Continued)

Our Number	Name	Company
53	Atlanta Red	Standard Oil
54	Diamond Refined	" "
55	Standard Heavy Engine	" "
56	No. 8 Flotation Oil	General Naval Stores
57	No. 17 " "	" " "
58	No. 18 " "	" " "
59	No. 28 " "	" " "
60	E-3	" " "
61	S. F. Cylinder Oil	Standard Oil Company
62	Cushing's Crude	Water's Pierce Oil Co.
63	Black Oil	" " "
64	Tar Oil	Standard Oil
65	No. 7 Sunny South CPT	General Naval Stores
66	Pine Oil #6	" " "
67	Refined Tar Oil	Fla. Wood Products Co.
68	Flotation Oil #200	Pensacola Tar and Turp. Co.
69	Fla. Oil No. 400	" " "
70	# 80 Crude Wood Turps.	" " "
71	# 15 Special Rosin	" " "
72	# 75 Crude Wood Turps.	" " "
73	# 1580 Special Pine Oil	" " "
74	# 350 Crude Wood Oil	" " "
75	Pure Pine Oil (Steam refined)	" " "
76	#20 Flotation Oil	General Naval Stores
77	# 1 Creosote	American Tar Products
78	# 2 Mixture Creosote and Refined Tar	" " "

Our Number	Name	Company
79	#3 Crude Gas House Tar	American Tar Products
80	#4 Crude Water Gas Tar	" " "
81	#5 Crude Coke Oven Tar	" " "
82	#6 Oil from Water Gas Tar	" " "
83	Coal Tar from Gas Oven	Laclede Gas Co., Sta. A.
84	Water Gas Tar	" " "
85	Coal Tar	Public Service Co. Illinois.
86	Linseed (Raw) 200 cc. Rosin 10 grams	Made as used.
87	Pyroligenous Acid 200cc. Rosin 10 grams	" "
88	Turpentine 200 cc. Rosin 10 grams	" "
89	Coal Tar Toluol	" "
90	Turpentine 2/3 Cresylic Acid 1/3	" "
91	Turpentine 1/4 Cresylic Acid 3/4	" "
92	Turpentine 2/3 Cresylic Acid 1/3 Rosin	" "
93	Turpentine 1/4 Cresylic Acid 3/4 Rosin	" "
94	Cresylic Acid 4/5 Cottonseed (Residue) 1/5	" "
95	Cresylic Acid 3/4 Cottonseed (Residue) 1/4	" "
96	Cresylic Acid 1/2 Castor 1/2	" "
97	Cresylic Acid 3/4 Tar (S-Black) 1/4	" "

OILS (Continued)

Our Number	Name	Company
98	Cresylic Acid 3/4 Turpentine #1 1/4	Local Druggist
99	Cresylic Acid 3/4 Turpentine #2 1/4	" "
100	No. 96 Mix. 2/3 No. 88 Mix. 1/3	" "
101	No. 89 Mix. 1/2 Cresylic Acid 1/2	" "
102	Creosote 1/3 Rosin 1/3 Commercial Tar 1/3	" "
103	Cresylic Acid 3/10 Cushing's Crude 7/10	" "
104	Cushing's Crude 7/10 Creosote 3/10	" "
105	Cushing's Crude 1/2 No. 100 Mix. 1/2	" "
106	Cushing's Crude 7/10 Cottonseed Residue 3/10	" "
107	Flotation Oil #1	B. M. Company
108	Flotation Oil #2	" "
109	Flotation Oil #3	" "
110	Bitter Almond	Local Druggist
111	Cumin-Oleum Cuminis	" "
112	Mustard-Oleum Sinapis Vol.	" "
113	Cubeb-Oleum Cubebae	" "
114	Cajuput	" "
115	Wormwood-Oleum Absinthum	" "
116	Croton-Oleum Tiglin	" "
117	Wormseed	" "
118	Bergamot -Oleum Bergamelon	" "
119	Cassia-Oleum Cinnamonium	" "

OILS (Continued)

Our Number	Name	Company
120	Balsam Copeiba	Local Druggist
121	Balsam of Peru	" "
122	Beechwood Creosote (Pure)	" "
123	Beechwood Creosote (Crude)	" "
124	Spearmint	" "
125	Rue	" "
126	Verbena	" "
127	Black Pepper	" "
128	Sandalwood	" "
129	Sweet Orange	" "
130	Pyroligneous Acid	Florida Wood Products Co.
131	Commercial Tar Oil	" " "
132	Tar	" " "
133	Wood Creosote Oil #xx	Cleveland Cliffs Iron Co.
134	Wood Creosote Oil #3	" " "
135	Special Flotation Oil	" " "
136	#7 Special Pine Tar Oil	General Naval Stores.
137	A 11	United Naval Stores.
138	A 12	" " "
139	B 12	" " "
140	C 15	" " "
141	B 14	" " "
142	Pine Oil H	" " "
143	Wood Creosote Oil #1	Cleveland Cliffs Iron Co.
145	Phenolic Acid(Wood Pulp by-products)	S. D. Warren Co. Boston.
146	#90 Tar Oil Refined	Pensacola Tar & Turp. Co.

OILS (continued)

Our Number	Name	Company
147	#750 Special Tar Oil	Pensacola Tar & Turp. Co.
148	#200 Refined Creosote Oil	" " "
149	Australole	Georgia Pine Turpentine Co.
150	Carolina Tar Oil	" " "
151	Pine Wood Spirits & Turp.	" " "
152	Calol A	Standard Oil Co.
153	Calol B	" "
154	Calol C	" "
155	Pineole Soluble	Georgia Pine Turpentine Co.
156	Carolina Ref. Pine Tar	" " "
157	Flotation Oil #2	" " "
158	Flotation Oil #B	" " "
159	Flotation Oil #1	" " "
160	Carolina Tar Oil Special	" " "
161	Creosote Oil	" " "
162	Cannel Coal Tar	" " "

ORE USED. In tests numbered D1 to D109 an ore composed of dolomite and galena was employed. It gave the following screen analysis:

	Through mesh	On mesh	Weight Lb.	%	Cumulative %	Lead %	Total lead %
1	65	80	16.25	3.25	3.25	5.34	4.30
2	80	100	33.50	6.70	9.95	4.49	7.35
3	100	115	17.70	3.54	13.49	3.35	2.90
4	115	150	54.53	10.91	24.40	3.69	9.65
5	150	170	34.40	6.88	31.28	3.47	5.55
6	170	200	64.50	12.90	44.18	3.17	9.75
7	200	220	2.00	4.40	44.58	3.43	0.34
8	220	240	11.92	2.38	46.96	3.065	1.83
9	240	260	57.70	11.54	58.50	3.47	9.65
10	260	...	207.50	41.50	100.00	4.63	48.60
			500.00	100.00			100.92

Standard screens were used.

In tests D110 to D155 we used similar ore. It gave the following screen analysis:

	Through mesh	On mesh	Weight Lb.	%	Cumulative %	Lead %	Total lead %
1	..	65	1.0	0.20	0.20	20.22	0.885
2	65	80	3.7	0.74	0.94	5.90	0.955
3	80	100	23.6	4.72	5.66	7.62	8.000
4	100	115	28.9	5.78	11.44	4.65	5.875
5	115	150	61.2	12.24	23.68	3.45	9.240
6	150	170	47.7	9.54	33.22	3.00	6.300
7	170	200	146.4	29.28	62.50	3.22	20.700
8	200	220	.....	......	62.50	....	......
9	220	240	4.2	0.84	63.34	3.61	0.663
10	240	260	59.0	11.80	75.14	4.25	10.960
11	260	...	124.3	24.86	100.00	6.72	36.550
			500.00	100.00			100.128

The results of the machine-tests are given in tabular form.

Machine

Experimenter

Missouri School of Mines and Metallurgy

FLOTATION LABORATORY.

OPERATING DATA.

ORE

Test No	OIL No.	OIL Amt.	OIL Kind.	REAGENTS Kind	REAGENTS Amt.	FROTH Kind	FROTH Amt.	REMARKS.	Concentrate Wt.	Concentrate Per Ct.	RESULTS Wt.	RESULTS Per Ct.	RESULTS Wt.	RESULTS Per Ct.	Oil Value ~~Per Ct. Ext.~~
D1	1	✓	Castor				No	Thick black skum	19.9	52.07					20 - 52
D2	2	✓	Linseed (Raw)				No	Fair skum; no froth	11.7	73.88					12 - 74
D3	3	✓	Linseed (Boiled)				No	Practically no froth	4.9	53.11					5 - 53
D4	4	✓	Neatsfoot				No	Thin oil film	3.3	25.09					3 - 25
D5	5	✓	Olive				No	Slight skum	3.2	53.67					3 - 54
D6	6	✓	Petroleum				No	oil film; good selector	4.1	76.27					4 - 76
D7	7	✓	Rapeseed				No	Oil	1.5	43.31					1.5 - 43
D8	8	✓	Sperm			Ephem		Froth forms at once; not lasting	3.8	54.90					4 - 55
D9	9	✓	Turpentine			Ephem		Thin ephemeral froth	9.48	49.91					9.5 - 50
D109	10	✓	Turpentine #1			Light	Small	Light ephemeral watery froth	4.19	25.6					4 - 26
D110	11	✓	Turpentine #2			Ditto	Ditto	Ditto	1.80	50.1					2 - 50
D10	12	✓	Toluol			Ditto	Ditto	Very thin froth	3.84	54.52					4 - 55
D11	13	✓	Almond			Ditto	Ditto	Small bubbles; not very dark	7.3	53.59					7 - 54
	14		Colza												
D13	15	✓	Lemon			Light	Fair	Thin ephemeral froth	24.63	68.36					25 - 68

Machine

Experimenter

Missouri School of Mines and Metallurgy

FLOTATION LABORATORY.

OPERATING DATA.

ORE

Test No	OIL No.	OIL Amt.	OIL Kind.	REAGENTS Kind	REAGENTS Amt.	FROTH Kind	FROTH Amt.	REMARKS.	Concentrate Wt.	Concentrate Per Ct.	RESULTS Wt.	RESULTS Per Ct.	Wt.	Per Ct.	Oil Value ~~Per Ct. Ext.~~
D57	16	✓	Peanut			Light	Small	Very little froth	5.61	70.55					6 - 71
D56	17	✓	Sesame			Do	Do	Do	4.77	67.17					5 - 67
D14	18	✓	Amyl Acetate			Do	Large	Good Ephemeral Froth	14.60	45.42					15 - 45
D15	19	✓	Pyroligenous Acid			Thin		Good Selector	6.40	56.97					6 - 57
D16	20	✓	Cedar Wood			Heavy	Large	Large, strong bubbles	28.07	47.80					28 - 48
D89	21	✓	Cedar Wood (Crude)				No	Oily skum; very little or no froth	9.48	72.40					9 - 72
D17	22	✓	Oleic Acid			Heavy	Large	Large, strong bubbles; picks gangue	76.70	13.29					77 - 13
D18	23	✓	Eucalyptus			Do	Do	Very Ephemeral	51.40	47.65					51 - 48
D26	24	✓	Orange Peel			Do	Do	Thick and Pulpy; rapid good selector	20.61	75.92					21 - 76
D27	25	✓	Cresylic Acid			Do	Do	Dark Ephemeral froth	31.90	71.28					32 - 71
D28	26	✓	Creosote			Do	Do	Dark froth	24.20	73.60					24 - 74
D78	27	✓	Corn Oil				Very Small	No froth at first; light color later	—	—					—
D79	28	✓	China Wood				No	Practically no froth or skum	—	—					—
D80	29	✓	Menhaden (Tech)				Very Small	Could not save froth	—	—					—
D111	30	✓	Rape Seed												

Missouri School of Mines and Metallurgy

FLOTATION LABORATORY.

Machine ____________

Experimenter ____________

ORE ____________

OPERATING DATA.

Test No	OIL No.	OIL Amt.	OIL Kind	REAGENTS Kind	REAGENTS Amt.	FROTH Kind	FROTH Amt.	REMARKS.	Concentrate Wt.	Concentrate Per Ct.	RESULTS Wt.	RESULTS Per Ct.	RESULTS Wt.	RESULTS Per Ct.	Oil Value ~~Per Ct. Ext.~~
D81	31	✓	Soya Bean				Very Small	Could not save froth	—	—					—
D82	32	✓	Menhaden (Pure)				Do	Do	—	—					—
D83	33	✓	Poppy Seed				Do	Do	—	—					—
D84	34	✓	Rosin			Fair	Small	Fair Froth	15.2	48.96					15 - 49
D112	35	✓	Rosin (M.B.D.Co)			Heavy	Large	Heavy stiff froth; picks gangue.	22.08	37.40					22 - 37
D85	36	✓	Paraffine				Very Small	Could not save froth	—	—					—
D23	37	✓	Cottonseed			Light	Small	Thick froth	7.25	63.76					7 - 64
D108	38	✓	Cottonseed (crude)			Poor	No	Poor froth; no selection	—	—					—
D24	39	✓	Cottonseed (refined)			Light	Small	Light bubbles	4.8	66.57					5 - 67
D21	40	✓	Cottonseed (residue)			Heavy	Large	Extra large heavy bubbles	16.4	23.25					16 - 23
D90	41	✓	Wine			Light		Very black froth	14.55	64.40					15 - 64
D91	42	✓	Male Fern			Heavy	Large	Heavy froth; much gangue	21.10	44.00					21 - 44
D92	43		Pennyroyal			Light	Do	Black froth; small bubbles	34.30	64.00					34 - 64
D93	44	✓	Cloves			Light	Do	Black froth	34.79	70.00					35 - 70
D94	45	✓	Citronella			Do	Do	Do ; Ephemeral	30.30	74.11					30 - 74

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Machine

Experimenter

ORE

OPERATING DATA.

Test No	OIL No.	OIL Amt.	OIL Kind.	REAGENTS Kind	REAGENTS Amt.	FROTH Kind	FROTH Amt.	REMARKS.	Concentrate Wt.	Concentrate Per Ct.	RESULTS Wt.	RESULTS Per Ct.	RESULTS Wt.	RESULTS Per Ct.	Oil Value ~~Per Ct. Ext.~~
D95	46	✓	Cod Liver				No	No Results	2.70	57.88					3 - 58
D96	47	✓	Sassafras			Small Bubbles	Large	Thin, small bubbles	10.60	53.96					11 - 54
D97	48	✓	Origanum			Ephem.	Do	Good selector	16.07	66.14					16 - 66
D98	49	✓	Amber			Large Bubbles	Do	Good frother	12.6	50.20					13 - 50
D87	50	✓	Kerosene				No	Thin, Oil film	—	—					—
D35	51	✓	Commercial Tar			Large Bubbles	Large	Heavy stiff froth	28.0	55.28					28 - 55
D36	52	✓	Fuel				No	Oil film	11.20	68.35					11 - 68
D37	53	✓	Atlantic Red				No	Thin film	1.40	46.90					1.5 - 47
D38	54	✓	Diamond Refined				No	Do	3.98	47.06					4 - 47
D39	55	✓	Stand Heavy Engine				No	Do	2.60	42.14					3 - 42
D40	56		#8 Flotation			Strong	Large	Heavy froth, big bubbles	31.50	60.86					32 - 61
D41	57		#17 Flotation			Large Bubbles	Do	Thin, large bubbles; black froth	31.90	75.21					32 - 75
D42	58		#18 Flotation			Do	Large	Do	34.80	70.92					35 - 71
D43	59		#22 Flotation			Ephem.	Fair	Medium sized ephem. bubbles	19.15	67.87					19 - 68
D45	60		K-3 (G.N.S.)			Light	Small	Very ephemeral froth	11.60	71.60					12 - 72

Machine	
Experimenter	
ORE	

Missouri School of Mines and Metallurgy

FLOTATION LABORATORY.

OPERATING DATA.

Test No	OIL No.	OIL Amt.	OIL Kind.	REAGENTS Kind	REAGENTS Amt.	FROTH Kind	FROTH Amt.	REMARKS.	Concentrate Wt.	Concentrate Per Ct.	RESULTS Wt.	RESULTS Per Ct.	Wt.	Per Ct.	Oil Value ~~Per Ct. Ext.~~
D46	61	✓	S.Y. Cylinder				No	Oil failed to emulsify	1.23	22.31					1 - 22
D47	62	✓	Cushing's Crude				No	Do	3.00	36.04					3 - 36
D48	63	✓	Black				No	Do	2.70	25.74					3 - 26
D49	64	✓	Tar (S-Black)				No	Do	4.10	40.04					4 - 40
D[illegible]	65	✓	#75 Sunny South C.P.T.			Large Bubbles	Large	Good frother; stiff froth	19.47	35.4					19 - 35
D50	66	✓	Pine Oil #6			Light	Fair	Fairly stiff froth	16.35	68.85					16 - 69
D58	67	✓	Refined Tar			Do	Large	Small frail bubbles	20.95	71.12					21 - 71
D59	68	✓	Flotation #200			Heavy	Do	Large stiff bubbles	23.35	63.57					23 - 64
D60	69	✓	Flotation #400			Do	Do	Fairly stiff froth	29.50	67.72					30 - 68
D61	70	✓	#80 Crude Wood Turps.			Small Bubbles	Do	Ephemeral froth	5.34	61.39					5 - 61
D62	71	✓	#15 Special Rosin			Do	Fair	Light, ephemeral froth	2.22	46.37					2 - 46
D63	72	✓	#75 Crude Wood Turps.			Light	Small	Small, ephemeral bubbles	4.40	54.53					4 - 55
D64	73	✓	#1580 Special Pine			Light	Fair	Do	4.65	56.97					5 - 57
D65	74	✓	#350 Crude Wood			Heavy	Large	Large, thick, stiff bubbles	17.75	52.10					18 - 52
D66	75	/	Pure Pine (Steam Refined)			Small Bubbles	Do	Ephemeral small bubbles	13.10	72.00					13 - 72

Missouri School of Mines and Metallurgy

FLOTATION LABORATORY.

Machine ____________

Experimenter ____________

ORE

OPERATING DATA.

Test No	OIL No.	OIL Amt.	OIL Kind	REAGENTS Kind	REAGENTS Amt.	FROTH Kind	FROTH Amt.	REMARKS.	Concentrate Wt.	Concentrate Per Ct.	RESULTS Wt.	RESULTS Per Ct.	Wt.	Per Ct.	Oil Value ~~Per Ct. Ext.~~
D67	76		#20 Flotation				No	No froth or skum	—	—					—
D68	77	✓	#1 Creosote				No	No froth; good selection	5.0	59.80					5 - 60
D69	78	✓	#2 Mixture Creosote & Refined Tar			Light	Large		37.12	69.16					37 - 69
D70	79	✓	#3 Crude Gas House Tar				No	Apparently good selector	—	—					—
D71	80	✓	#4 Crude Water Gas Tar				No	Ditto	—	—					—
D72	81	✓	#5 Crude Coke Oven Tar				No	Ditto	—	—					—
D75	82	✓	#6 Oil from Water Gas Tar				No	Skum formed	8.55	61.86					9 - 62
D76	83	✓	Coal Tar from Gas Oven				No	No results	—	—					—
D77	84	✓	Water Gas Tar				No	Ditto	—	—					—
D78	85	✓	Coal Tar				No	Difficult to emulsify	—	—					—
D19	86		Linseed (Raw)	Rosin	10 gms in 200 c.c.	Light	Very Small	Very light froth	14.2	54.93					14 - 55
D20	87		Pyroligenous Acid	Rosin	10 gms in 200 c.c.		No	No action at all	—	—					—
D22	88		Turpentine	Rosin	10 gms in 200 c.c.	Good	Large	Large amount of froth	18.3	54.58					18 - 55
D25	89		Coal Tar, Toluol			Light	Small	Ephemeral froth	8.24	52.34					8 - 52

Missouri School of Mines and Metallurgy

FLOTATION LABORATORY.

Machine ____________________

Experimenter ____________________

ORE

OPERATING DATA.

Test No	OIL No.	OIL Amt.	OIL Kind.	REAGENTS Kind	REAGENTS Amt.	FROTH Kind	FROTH Amt.	REMARKS.	Concentrate Wt.	Concentrate Per Ct.	RESULTS Wt.	RESULTS Per Ct.	Wt.	Per Ct.	Oil Value ~~Per Ct. Ext.~~
D_{29}	90		$\frac{2}{3}$ Turpentine			Large Bubbles	fair	Stiff froth	17.13	62.43	—				17–62
			$\frac{1}{3}$ Cresylic Acid												
~~D_{32}~~	91		$\frac{1}{4}$ Turpentine			Large Bubbles	large	Large stiff bubbles	39.00	62.89					39–63
			$\frac{3}{4}$ Cresylic Acid												
D_{31}	92		$\frac{2}{3}$ Turpentine	Rosin		Thin	Fair	Thin large bubbles	15.10	71.79					15–72
			$\frac{1}{3}$ Cresylic Acid												
D_{30}	93		$\frac{1}{4}$ Turpentine	Rosin		Large Bubbles	large	Large stiff bubbles	34.90	59.76					35–60
			$\frac{3}{4}$ Cresylic Acid												
~~D_{33}~~	94		$\frac{4}{5}$ Cresylic Acid			Do	Do	Do	22.95	52.70					23–53
			$\frac{1}{5}$ Cottonseed (Residue)												
D_{34}	95		$\frac{3}{4}$ Cresylic Acid			Do	Do	Do	34.90	55.97					35–56
			$\frac{1}{4}$ Cottonseed (Residue)												
D_{51}	96		$\frac{1}{2}$ Cresylic Acid			Small Bubbles	Large	Heavy black froth	23.80	72.61					24–73
			$\frac{1}{2}$ Castor												

Machine

Experimenter

Missouri School of Mines and Metallurgy

FLOTATION LABORATORY.

OPERATING DATA.

ORE

Test No	OIL No.	OIL Amt.	OIL Kind.	REAGENTS Kind	REAGENTS Amt.	FROTH Kind	FROTH Amt.	REMARKS.	Concentrate Wt.	Concentrate Per Ct.	RESULTS Wt.	RESULTS Per Ct.	RESULTS Wt.	RESULTS Per Ct.	Oil Value ~~Per Ct. Ext.~~
D_{105}	97		3/4 Cresylic Acid; 1/4 Tar (S-Black)												
D_{106}	98		3/4 Cresylic Acid; 1/4 Turpentine #1			Ephem.	Large	Ephemeral froth: very black	27.05	71.30					27 – 71
D_{107}	99		3/4 Cresylic Acid; 1/4 Turpentine #2			Heavy	Large	Extra good tough froth	24.57	62.40					25 – 62
D_{52}	100		2/3 No. 96 Mix.; 1/3 No. 88 Mix.					Good frother	35.90	62.30					36 – 62
D_{54}	101		1/2 No. 89 Mix; 1/2 Cresylic Acid			Small Bubbles	Large		35.7						36 –
D_{53}	102		1/3 Creosote; 1/3 Rosin; 1/3 Commercial Tar				No	No results	—	—					
D_{99}	103		3/10 Cresylic Acid; 7/10 Cushing's Crude			Ephem.	Fair	Small frail watery bubbles							

Machine

Experimenter

Missouri School of Mines and Metallurgy

FLOTATION LABORATORY.

OPERATING DATA.

ORE

Test No	OIL			REAGENTS		FROTH		REMARKS.	Concentrate		RESULTS				Oil Value
	No.	Amt.	Kind.	Kind	Amt.	Kind	Amt.		Wt.	Per Ct.	Wt.	Per Ct.	Wt.	Per Ct.	~~Per Ct. Ext.~~
D_{100}	104		7/10 Cushing's Crude												
			3/10 Creosote												
D_{74}	105		1/2 Cushing's Crude						7.90	57.40					8 - 57
			1/2 No. 100 Mix												
D_{101}	106		7/10 Cushing's Crude				No	No results; no selection	—	—					—
			3/10 Cottonseed Residue												
D_{102}	107	✓	Flo. Oil #1 B.M.Co			Light	Fair	Light, watery, ephemeral froth	12.95	43.40					13 - 43
D_{103}	108	✓	Flo. Oil #2 B.M.Co.			Do	Do	Ditto	5.74						
D_{104}	109	✓	Flo. Oil #3 B.M.Co.			Do	Do	Ditto	5.52	49.82					6 - 50
	19		1/2 Pyro. acid												
D_{113}	84		1/2 Water Gas Tar					No action - good selector.							
			1/3 Water Gas Tar				large	Stiff - large bubbles	No	No					—
			1/3 Pancoline					Mostly gangue							
D_{114}			1/3 Pyrol. Acid												

Missouri School of Mines and Metallurgy

FLOTATION LABORATORY.

Machine ....

Experimenter ....

ORE

OPERATING DATA.

Test No	OIL No.	OIL Amt.	OIL Kind.	REAGENTS Kind	REAGENTS Amt.	FROTH Kind	FROTH Amt.	REMARKS.	Concentrate Wt.	Concentrate Per Ct.	RESULTS Wt.	RESULTS Per Ct.	Wt.	Per Ct.	Oil Value ~~Per Ct. Ext.~~
D115	119	✓ ✓	Cassia			Small Bubbles	Large	Large volume of froth	22.95	65.14					23-65
D116	111	✓	Cumin			Heavy	Large	Heavy black froth	15.95	49.30					16-49
D117	112	✓	Mustard				No	Nothing on surface of water	—	—					—
D118		✓	Mustard Lab. #1			Large Bubbles	Fair	Tough watery froth	20.70	32.90					21-33
D119	115	✓	Wormwood			Large Bubbles	Fair	Carries little mineral-ephemeral	4.00	48.64					4-49
D120	113	✓	Cubeb			Small Bubbles	Very little	Watery froth-with black skum surface	4.84	50.16					5-50
D121	118	✓	Bergamot			Heavy	Large	Heavy black froth		38.88					-39
D122	162	✓	Cannal Coal Tar				None	No results	—	—					—
D123															
D124															
D125	120	✓	Balsam Capaibla			Tough	Large	Med. bubbles; carries gangue	22.41	13.3					22-13
D126	122	✓ ✓	Beechwood Pure Creasote			Watery	Large	Black froth; large bubbles	4.16	32.2					4-32
D127	121	✓	Balsam of Peru			Light	Very little	No action at first; light froth more oil	5.56	26.2					6-26
D128		✓	Oil of Amber			Large Bubbles	Little	Watery light froth; carries gangue	3.97	41.5					4-42

Machine

Experimenter

ORE

Missouri School of Mines and Metallurgy

FLOTATION LABORATORY.

OPERATING DATA.

Test No	OIL			REAGENTS		FROTH		REMARKS.	Concentrate		RESULTS				Oil Value
	No.	Amt.	Kind.	Kind	Amt.	Kind	Amt.		Wt.	Per Ct.	Wt.	Per Ct.	Wt.	Per Ct.	~~Per Ct. Ext.~~
D129	123	✓	✓ Beechwood Crude Creosote					Same as ref. creos. but more gangue	10.43	42.0					10 - 42
D130	127	✓	Black Pepper			Small Bubbles	Little	Slow forming froth; poor selector	22.36	54.48					22 - 54
D131	124	✓	✓ Spearmint			Small Bubbles	Large	Tough, skumy froth; carries much min.	50.28	44.00					50 - 44
D132	125	✓	✓ Rue			Very Small Bubbles	Little	Skum-like froth; tough; much conc	6.72	64.44					7 - 64
D133	128	✓	Sandalwood			Very Small Bubbles	Little	Skum of good conc.; not very tough	11.67	59.20					12 - 59
D134	126	✓	Verbina			Med. Bubbles	Fair	Stiff froth; carries gangue	35.80	67.4					36 - 67
D135	129	✓	Sweet Orange			Fairly tough	Small	Light froth; carries little mineral	6.50	67.6					7 - 68
D136	152	✓	Flot "A" Calol "A"			Very Light	Small	Small bubbles; carries mostly gangue	0.99	19.8					1 - 20
D137	153	✓	Flot "B" Calol "B"			Do	Do	More mineral than "A"	0.85	24.4					1 - 24
D138	154	✓	Flot "C" Calol "C"			Do	Do	Very small bubbles; more mineral	0.46	24.9					0.5 - 25
D139	130	✓	Pyroligneous Acid				Very Little	No results; very slight froth	—	—					—
D140	135		Special Flot. Oil			Small Bubbles	Large	Small bubbles; stiff froth	3.60	52.6					4 - 53
D141	133	✓	Wood Creo. Oil #XX			Do	Do	Ditto	19.24	63.6					19 - 64
D142	134	✓	Wood Creo. Oil #3			Do	Do	Small bubbles; ephem.	13.81	64.2					14 - 64
D143	136	✓	#7 Special Pine Tar			Large Bubbles	Large	Extra good frother.	12.40	34.2					22 - 39

Missouri School of Mines and Metallurgy

FLOTATION LABORATORY.

Machine

Experimenter

ORE

OPERATING DATA.

Test No	OIL No.	OIL Amt.	OIL Kind.	REAGENTS Kind	REAGENTS Amt.	FROTH Kind	FROTH Amt.	REMARKS.	Concentrate Wt.	Concentrate Per Ct.	RESULTS Wt.	RESULTS Per Ct.	RESULTS Wt.	RESULTS Per Ct.	Oil Value. ~~Per Ct. Ext.~~
D144	131	✓	Comm. Tar Oil			Large Bubbles	Large	Good frother, stiff, large bubbles	16.96	38.6					17-39
D145	137	✓	A-11 U.N.S.Co.			Do	Do	Ditto	13.33	33.8					13-34
D146	142	✓	H. Pine Oil U.N.S.Co			Ephem.	Fair	Small Ephem. bubbles	4.92	60.4					5-60
D147	140	✓	C15 U.N.S.Co.			—	None	No froth; apparently good selector	—	—					—
D148	139	✓	B-12 U.N.S.Co.			Ephem	Little	Slight froth; small bubbles.	0.92	41.0					1-41
D149	141	✓	B-14 U.N.S.Co.			Medium	Fair	Medium size bubbles -	9.17	60.4					9-60
D150	143	✓	Wood Creo. Oil *1			Large Bubbles	Fair	Stiff froth; large bubbles							
D151	145		"Phenolic Acid"			Do	Do	Ditto							
D152	146	✓	Tar Oil Ref.			—	None	No results; very slight froth	—	—					—
D153	147	✓	Special Tar Oil			—	Do	Ditto	—	—					—
D154	148	✓	Ref. Wood Creos.			Medium Bubbles	Fair	Fair froth; stiff							
D155	138	✓	A-12 U.N.S.Co			Large Bubbles	Large	Copious froth	14.90	17.8					15-18
Rep.		✓	Crude Beech Creos.						18.31	39.8					18-40
Rep.		✓	Pure " "						18.90	62.2					19-62
Rep.		✓	Oil of Amber						11.36	44.4					11-44

CONCLUSIONS. The results are interesting and show the possibility of using a great variety of oils if they were purchasable at a low price. The results also in dicate our inability to give to oils flotative values in numerical terms and the impossibility of getting the true values of oils that give no scum or froth, such as the coal-tars and crude petroleums. It is known that these are good selectors. The tabulations show further that oils vastly different in consistence have similar flotative values. They also bring out the fact that a great deal of work must be done before those properties of oils which give them flotative value are understood, for instance, why do oleic acid, cottonseed residue, and others froth and lift dolomite, while citronella, wood-creosote, pine-oil, and others froth and float galena?

The following experiments suggest themselves and are being attempted:

1. To determine whether there is any relation between an oil's selective power and its di-electric constant, or an oil's frothing power and its di-electric constant.

2. The relation, if any, between an oil's selective power and its viscosity or an oil's frothing power and its viscosity.

3. Whether the oil's surface tension or film strength plays any part in an oil's frothing power or in an oil's selective power.

4. Whether the saponification value bears any relation to the flotative value of an oil, either frothing value or selective

value.

5. The facility with which oils can be emulsified, and their flotative value.

6. The oil's water soluble content and the value of it to flotation.

7. The degree to which oil is soluble in water, soluble as a whole, and the value of it to flotation.

8. The quantitative effect of the use of frothing oils and of the use of selective oils.

9. The relation between a mineral's di-electric constant and its tendency to be floated. The sulphides have di-electric constants approaching infinity.

10. The grouping of oils as made by the chemist and the flotation-values of these various groups and to ascertain if the members of each group have similar value as selectors or frothers.

11. The effect of various salts and amounts of salts on the flotative value of an oil or combination of oils. Do these salts affect the surface of the mineral, do they combine with the oil, etc?

12. To show by micro-photographs how oils and bubbles attach themselves to minerals.

13. Whether classification is an aid to flotation.

EXPERIMENT NO. 1

TO DETERMINE WHETHER THERE IS ANY RELATION BETWEEN AN OIL'S SELECTIVE POWER AND ITS DIELECTRIC CONSTANT , OR AN OIL'S FROTHING POWER AND ITS DIELECTRIC CONSTANT.

Dielectric Constants of Some Flotation Oils. Preliminary.

by Dr. Herman Schlundt

University of Missouri.

Number	Name	D.C. Max.	D.C. Min.	
1	Oleic Acid	2.7	2.35	temp. 16-20°
2	Citronella	4.83	4.38	
3	Black Grease	3.12	2.78	
4	Cotton Seed	3.0	2.71	
5	Orange Peel	2.35	2.00	
6	Cresylic Acod	-----	9.80	(Approximate)
7	Corn Oil	3.00	2.6	
8	Lubricatin Oil	2.60	2.15	
9	½ Cresylic ½ Castor	-----	4.33	Conducts or contains hyd-
10	Water Gas Tar	-----	2.78	roxyl.
11	Lemon	-----	2.95	
12	General Naval #8	-----	4.36	Hydroxyl
13	General Naval #17	-----	12.	Approx. Hydrox
14	General Naval #18	-----	9.8	ditto
15	General Naval #22	-----	3.05	
16	Olive Oil	-----	2.76	L.B.&M Tabelle 2.9
17	Cylinder Oil	-----	2.47	ditto 2.3
18	Crude Wood Turpentine	-----	4.15	ditto pure 2.27
19	Rosin Oil	-----	2.95	

Dielectric Constants of Some Flotation Oils

by Dr. Herman Schlundt,

University of Missouri.

Number	Name	D. C.	Temperature
20	Peach kernel	2.86	24°C
21	Soy Bean	2.96	24
22	Coal Tar	3.49	24
23	Pine Oil	4.42	24
24	Sperm	2.90	23
25	Cod Liver	2.85	23
26	Crude	2.28	23
27	Castor	3.40	23
*28	Pyroligneous acid	----	--
29	Mixture	3.70	23

* Pyroligneous acid conducts current so well that its dielectric capacity cannot be determined.

DIELECTRIC CONSTANTS OF LIQUIDS.

Smithsonian Physical Tables. Fifth Ed.

Table 288-289.

Substance *	Temp °C	Wave length cm.	Dielectric Constant	Author.
Amyl Acetate	16	∞	4.81	10
Castor Oil	11	"	4.67	19
Linnseed	13	"	3.35	21
Sperm	20	"	3.17	20
Olive	20	"	3.11	23
Cottonseed	14	"	3.10	21
Peanut	11.4	"	3.03	21
Sesame	13.4	"	3.02	21
Neatsfoot	----	"	3.02	20
Rapeseed	16	"	2.85	21
Almond	20	"	2.83	18
Toluol	16	"	2.33	5
Meta Xylol	18	"	2.37	11
Lemon	21	"	2.25	22
Turpentine	20	"	2.23	20
Vaseline	----	"	2.17	25
Petroleum	----	2000	2.13	24

Dielektrizitatskonstanten und Quadrate elektrischer Brechungsindices (D)

Lit. Tab. 240, S. 774.

Flussige Isolationsmittel (Ole)

Material	t°		D	Autor
Petroleum			2,07	Hopkinson
			2,14	Winkelmann
		600	1,96	Arons und Rubens (1)
		1300 -3000	$2,12_6$	Marx (2)
Petrolather			1,778	Werner
Paraffinol	20	"	2,1179	Hasenohrl (2)
20 • • • •	20	"	$0,0_3738$	"
20 • • • •	- 50	"	$0,0_572$	"
Dichte 0,905		82	2,38	Hormell
Ruboll	16,2		2,85	Salvioni
Leinol	13	"	3,35	"
Baumwoll-samenol	13,7	"	3,10	"
		"	3,09	Ferry
		1000	3,00	"
Olivenol			3,02	Hopkinson
	12,4	"	2,99	Salvioni
	20	"	3,108	Heinke
Olivenol 20 • •			0,00364	"
		"	3,08	Arons u Rubens (1)
		600	2,92	
Sesamol	13,4		3,02	Salvioni
Mandelol		"	3,01	"
	20	"	2,8330	Hasenohrl (2)
20° • • •	20 - 40	"	0,001628	"
20 • • •	"	"	$0,0_4259$	"
Arachisol	11,4	"	3,03	Salvioni
Kamiol		"	2,55	v. Pirani
Ricinusol	10,9	"	4.62	Salvioni
		"	0,01067	Heinke
20 • • • •		"	4,67	Arons u Rubens (1)
		600	4,20	
		9	$4,00_0$	Kossonogoff
		6,4	3,968	"
		2	2,019	"
Atherische Ole,	Terpentin s. S. 771.			
Amylacetat	19,		4,81	Lowe
20° • • •		"	0,0024	"
Toluol		"	2,42	Hopkinson
	14,4	"	2,375	Landolt u. Jahn
	- 83	"	2,51	Abegg
	+16,5	"	2,33	"
	19	73	2,31	Drude (3)
15 • • •	0 - 30		$0,0_3921$	Ratz
0 • • •	20 -	"	$0,0_3977$	Tangl
0 • • •	181	"	$0,0_6463$	"
Cymol	17	"	2,249	Nernst
Phenol	48	73	9,68	Drude (3)
Kreosol	17		10,3	Lowe

Data for Conclusions to Experiment No.1.

The Oil	Flotation Value grams.	%Pb.	Dielectric Constants.
Oleis acid	77	13	2.35 - 2.79
Citronella	30	74	4.38 - 4.83
Paneoline	16	23	2.78 - 3.12
Cottonseed	7	64	2.71 - 3.00
Orange Peel	21	76	2.00 - 2.35
Cresylic Acid	32	71	9.8 ±
Corn	---------		2.60 - 3.00
S.F.Cylinder	1	22	2.15 - 2.60
Mixture ½Castor ½Cresylic	24	73	4.33
Oil from Water Gas Tar	9	62	2.78
Lemon	25	68	2.95
Olive	3	54	2.76
Diamond Ref.	4	47	2.47
Crude Wood Turps	5	61	4.15
Special Rosin	2	46	2.95
Peach Kernel	7	54	2.86
Soya Bean	-	-	2.96
Coal Tar	-	-	3.49
Pure Pine Oil.	16	69	4.42
Sperm.	4	55	2.90

A study of the flotation results and the dielectric constants of the various oils shows that with the data so far obtained no relation can be shown to exist between them. This does not necessarily mean that the dielectric constant does not affect an oils value to flotation.

In light of the theory advanced by Prof.V.H.Gottschalk (This theory has never been published),it is reasonable to believe that the dielectric constant which is a measure of the free electrons existing in a body would influence the adsorption of oils by certain minerals,even though it cannot be shown to be true at this writing.

One conclusion can be made at this time;that of the oils which give a recoverable froth those with high dielectric constants give the best flotation results.This holds true with the exception of Oil of Lemon Oil of Orange Peel which give good flotation results and have low constants.

Further experimentation should show that the dielectric constant at least plays an important part in flotation of minerals by flotation.

EXPERIMENT NO. 8.

THE QUANTITATIVE EFFECT OF FROTHING OILS AND OF SELECTIVE OILS.

Machine Hoover Type

Experimenter { Slayton / Peterson

Missouri School of Mines and Metallurgy

FLOTATION LABORATORY.

OPERATING DATA.

ORE: Dolomite & Galena

R.P.M. 1700

TIME 20 min.

PULP RATIO { WATER 5 / ORE 1

EXPERIMENTS SHOWING EFFECT OF INCREASING QUANTITY OF OIL.

Test No	OIL No.	OIL Amt.	OIL Kind.	REAGENTS Kind	REAGENTS Amt.	FROTH Kind	FROTH Amt.	REMARKS.	Concentrate Wt.	Concentrate Per Ct.	RESULTS Wt.	RESULTS Per Ct.	Wt.	Per Ct.	Per Ct. Ext.
T_1		1	1/4 Castor Oil						2.0	57.40					
T_2		2	1/4 #20 Flotation Oil						3.4	58.80					
T_3		3	1/4 Creosote						10.1	71.20					
T_4		4	1/8 Cottonseed (Ref.)						10.3	76.40					
T_5		5	1/8 Cresylic Acid						13.9	69.20					
T_{10}		10	↓						19.2	69.66					
T_{15}		15	↓						21.5	69.80					
T_{20}		20	↓						26.3	65.98					
T_{25}		25	↓						48.2	63.60					
T_{30}		30	↓						40.4	58.50					
T_{40}		40	↓						36.4	62.12					

Machine Hoover Type

Experimenter {Slayton / Peterson

Missouri School of Mines and Metallurgy

FLOTATION LABORATORY.

ORE: Dolomite & Galena

EXPERIMENTS SHOWING EFFECT OF INCREASING QUANTITY OF OIL

OPERATING DATA.

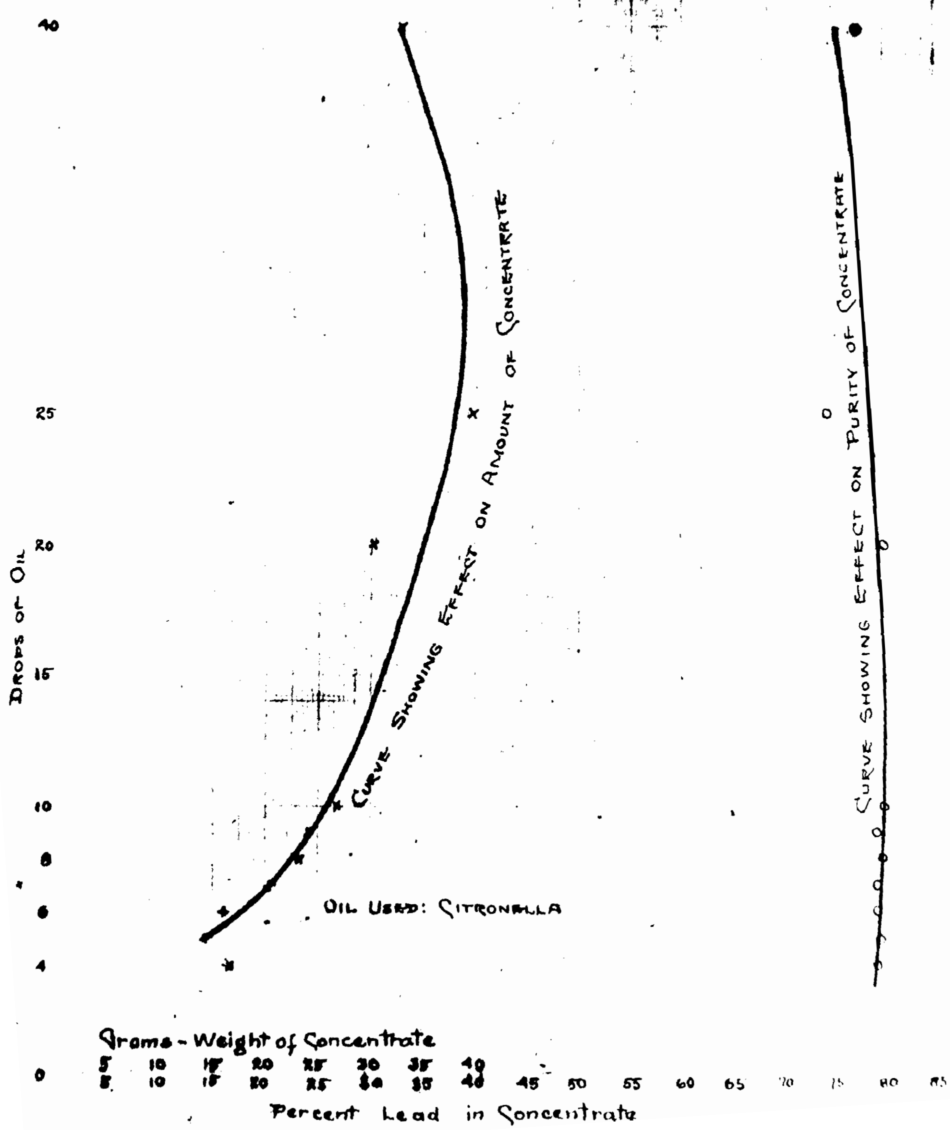
R.P.M.-1700

TIME 20 MIN.

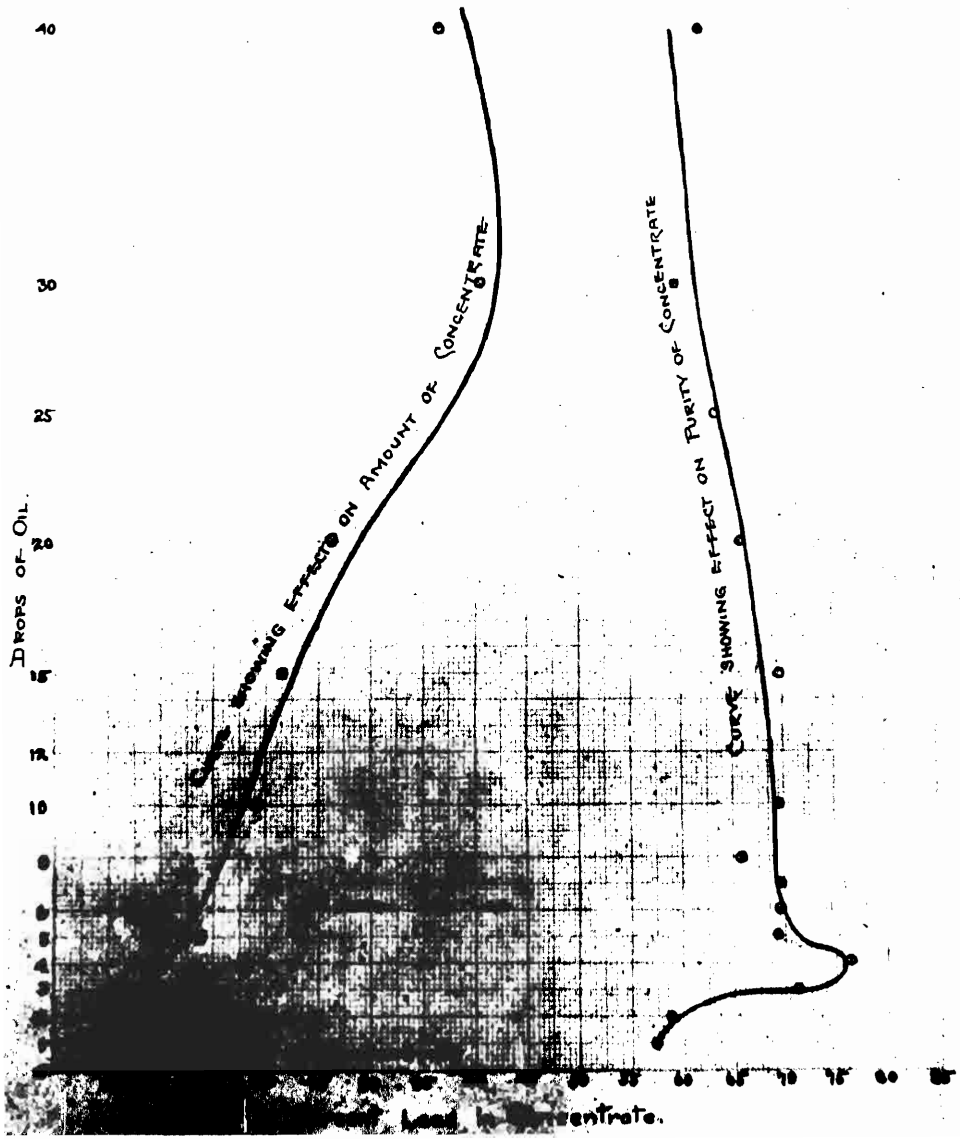
PULP RATIO {WATER 5 / ORE 1

Test No	OIL No.	OIL Amt.	OIL Kind.	REAGENTS Kind	REAGENTS Amt.	FROTH Kind	FROTH Amt.	REMARKS.	Concentrate Wt.	Concentrate Per Ct.	RESULTS Wt.	RESULTS Per Ct.	Wt.	Per Ct.	Per Ct. Ext.
C_4		4	Citronella						16.7	79.1					
C_5		5							14.4	79.3					
C_6		6							16.11	79.2					
C_7		7							20.5	79.3					
C_8		8							23.3	79.8					
C_9		9							24.2	79.3					
C_{10}		10							26.7	80.0					
C_{15}		15													
C_{20}		20							30.1	80.0					
C_{25}		25							39.7	74.24					
C_{40}		40							32.7	77.4					

CURVES SHOWING EFFECT OF VARYING QUANTITY OF OIL.



Curves showing Effect of Varying Quantity of Oil.



Effect of Varying Quantity of Oil.

Not only is the kind of oil a big factor in the flotation process, but the amount of oil used influences the results considerably. From the tables of results on two series of tests one with Citronella and one with a mixture of Castor Oil, #20 Flotation Oil, Creosote Oil, Refined Cottonseed and Cresylic Acid, and the curves plotted from these results it will be seen that there is a critical quantity of oil which may be used. Below and above this amount inferior results will be obtained.

From the curves showing the effect of varying the amount of oil used it appears that equal selection can be had by using an amount of oil less than the critical amount, but the recovery will be less, so that in order to get the added recovery it will be necessary to add more oil.

EXPERIMENT NO.10

A STUDY OF THE GROUPING OF OILS AS MADE BY THE OIL CHEMIST TOGETHER WITH THE FLOATATION VALUES OF THE VARIOUS OILS IN ORDER TO DETERMINE IF THE OILS OF THE VARIOUS GROUPS HAVE SIMILIAR VALUE IN FLOTATION.

Machine

Experimenter

Missouri School of Mines and Metallurgy

FLOTATION LABORATORY.

OPERATING DATA.

ORE: FIXED OILS.

Test No	OIL No.	OIL Amt.	OIL Kind.	REAGENTS Kind	REAGENTS Amt.	FROTH Kind	FROTH Amt.	REMARKS.	Concentrate Wt.	Concentrate Per Ct.	RESULTS Wt.	RESULTS Per Ct.	Wt.	Per Ct.	Oil Value ~~Per Ct. Ext.~~
D5	5	I	Olive						3.2	53.67					3-54
D57	16	I	Peanut						5.61	70.55					6-71
D7	7	II	Rapeseed						1.5	43.31					1.5-43
D56	17	III	Sesame						4.77	67.17					5-67
D78	27	III	Corn Oil						—	—					—
D81	31	III	Soya Bean						—	—					—
D23	37	III	Cottonseed						7.25	63.76					7-64
D2	2	IV	Linseed (Raw)												
D3	3	IV	Linseed (Boiled)						4.90	53.11					5-53
D79	28	IV	China Wood						—	—					—
D83	33	IV	Poppy seed						—	—					—
D1	1	V	Castor						19.90	52.07					20-52
		V	Croton						—	—					—
D4	4	VIII	Neatsfoot						3.30	25.09					3-25
D82	32	X	Menhaden (Pure)						—	—					—
D80	29	X	Menhaden (Tech)						—	—					—

Machine

Experimenter

Missouri School of Mines and Metallurgy

FLOTATION LABORATORY.

OPERATING DATA.

ORE

FIXED OILS

Test No	OIL No.	OIL Amt.	OIL Kind.	REAGENTS Kind	REAGENTS Amt.	FROTH Kind	FROTH Amt.	REMARKS.	Concentrate Wt.	Concentrate Per Ct.	RESULTS Wt.	RESULTS Per Ct.	Wt.	Per Ct.	Oil-Value ~~Per Ct. Ext.~~
D95	46	X	Cod Liver						2.70	57.88					3-58
D8	8	XI	Sperm						3.80	54.90					4-55

Missouri School of Mines and Metallurgy

FLOTATION LABORATORY.

Machine

Experimenter

ORE

Coal Tar Oils & Creosotes

OPERATING DATA.

Test No	OIL No.	OIL Amt.	OIL Kind.	REAGENTS Kind	REAGENTS Amt.	FROTH Kind	FROTH Amt.	REMARKS.	Concentrate Wt.	Concentrate Per Ct.	RESULTS Wt.	RESULTS Per Ct.	Wt.	Per Ct.	Oil Value ~~Per Ct. Ext.~~
D68	77		#1 Creosote						5.0	59.80					5-60
D69	78		#2 Mixture Creos. & Ref. Tar						37.12	69.16					37-69
D75	82		#6 Oil from Water Gas Tar						8.55	61.86					9-62
D27	25		Cresylic Acid						31.90	71.28					32-71
D10	12		Toluol						3.84	54.52					4-55
D102	107		#1 B.M.Co.						12.95	43.40					13-43
D104	109		#3 B.M.Co.						5.52	49.82					5-50

Missouri School of Mines and Metallurgy

FLOTATION LABORATORY.

Machine

Experimenter

ORE

PETROLEUM PRODUCTS

OPERATING DATA.

Test No	OIL No.	OIL Amt.	OIL Kind.	REAGENTS Kind	REAGENTS Amt.	FROTH Kind	FROTH Amt.	REMARKS.	Concentrate Wt.	Concentrate Per Ct.	RESULTS Wt.	RESULTS Per Ct.	Wt.	Per Ct.	Oil-Value ~~Per Ct. Ext.~~
D6	6		Petroleum						4.1	76.27					4-76
D85	36		Paraffine						—	—					—
D87	50		Kerosene						—	—					—
D46	61		S.F. Cylinder						1.23	22.31					1-22
D47	62		Cushing's Crude						3.00	36.04					3-36
D48	63		Black						2.70	25.74					3-26
D49	64		Tar (S-Black)						4.10	40.04					4-40
D36	52		Fuel						11.20	68.35					11-68
D37	53		Atlanta Red						1.40	46.90					1.5-47
D38	54		Diamond Ref.						3.98	47.06					4-47
D39	55		Stand Heavy Eng.						2.60	42.14					3-42
D136	152		Calol "A"						0.99	19.80					1-20
D137	153		Calol "B"						0.85	24.40					1-24
D138	154		Calol "C"						0.46	24.90					0.5-25

Machine

Experimenter

Missouri School of Mines and Metallurgy

FLOTATION LABORATORY.

OPERATING DATA.

ORE

ESSENTIAL OILS.

Test No	OIL			REAGENTS		FROTH		REMARKS.	Concentrate		RESULTS				Oil Value
	No.	Amt.	Kind.	Kind	Amt.	Kind	Amt.		Wt.	Per Ct.	Wt.	Per Ct.	Wt.	Per Ct.	~~Per Ct. Ext.~~
D11	13		Almond						7.3	53.59					7-54
D13	15		Lemon						24.63	68.36					25-68
D9	9		Turpentine						9.48	49.91					9.5-50
D109	10		Turpentine *1						4.19	25.60					4-26
D110	11		Turpentine *2						1.80	50.10					2-50
D98	49		Amber						12.60	50.20					13-50
D97	48		Origanum						16.07	66.14					16-66
D96	47		Sassafras						10.60	53.96					11-54
D50	66		Pine Oil *6						16.35	68.85					16-69
D66	75		Pure Pine (Ref.)						13.10	72.00					13-72
D16	20		Cedar Wood						28.07	47.80					28-48
D89	21		Cedar Wood (Crude)						9.42	72.40					9-72
D18	23		Eucalyptus						51.40	47.65					51-48
D26	24		Orange Peel						20.61	75.92					21-76
D117	112		Mustard						—	—					—

Machine

Experimenter

Missouri School of Mines and Metallurgy

FLOTATION LABORATORY.

OPERATING DATA.

ORE

ESSENTIAL OILS

Test No	OIL No.	OIL Amt.	OIL Kind.	REAGENTS Kind	REAGENTS Amt.	FROTH Kind	FROTH Amt.	REMARKS.	RESULTS Wt.	RESULTS Per Ct.	RESULTS Wt.	RESULTS Per Ct.	RESULTS Wt.	RESULTS Per Ct.	Per Ct. Ext.
D120	113		Cubeb						4.84	50.16					5-50
D121	118		Bergamot							38.88					- 39
D90	41		Wine						14.55	64.40					15-64
D91	42		Male Fern						21.10	44.00					21-44
D92	43		Pennyroyal						34.30	64.00					34-64
D93	44		Cloves						34.79	70.00					35-70
D94	45		Citronella						30.30	74.11					30-74
D130	127		Black Pepper						22.36	54.88					22-54
D131	124		Spearmint						50.28	44.00					50-44
D132	125		Rue						6.72	64.44					7-64
D133	128		Sandalwood						11.67	59.20					12-59
D134	126		Verbena						35.80	67.40					36-67
D135	129		Sweet Orange						22.95	65.14					23-65
D115	119		Cassia						15.95	49.30					16-49
D116	111		Cumin						4.00	48.64					4-49

Missouri School of Mines and Metallurgy

FLOTATION LABORATORY.

Machine ____________

Experimenter ____________

ORE

Essential Oils

OPERATING DATA.

Test No	OIL			REAGENTS		FROTH		REMARKS.	Concentrate		RESULTS				Oil Value
	No.	Amt.	Kind.	Kind	Amt.	Kind	Amt.		Wt.	Per Ct.	Wt.	Per Ct.	Wt.	Per Ct.	
D119	115		Wormwood						4.00	48.64					4-49
D146	142		H-Pine Oil U.N.S.Co.						4.92	60.40					5-60

Missouri School of Mines and Metallurgy

FLOTATION LABORATORY.

Machine ____________

Experimenter ____________

ORE ____________

Pine Oils.

OPERATING DATA.

Test No	OIL No.	OIL Amt.	OIL Kind.	REAGENTS Kind	REAGENTS Amt.	FROTH Kind	FROTH Amt.	REMARKS.	Concentrates Wt.	Concentrates Per Ct.	RESULTS Wt.	RESULTS Per Ct.	Wt.	Per Ct.	Oil Value ~~Per Ct. Ext.~~
D9	9		Turpentine						9.48	49.91					9.5 - 50
D109	10		Turpentine #1						4.19	25.60					4 - 26
D110	11		Turpentine #2						1.80	50.10					2 - 50
D61	70		#80 Crude Wood Turps.						5.34	61.39					5 - 61
D63	72		#75 " " "						4.40	54.53					4 - 55
D64	73		#1580 Special Pine Oil						4.65	56.97					5 - 57
D65	74		#350 Crude Wood Oil						17.75	52.10					18 - 52
D50	66		Pine Oil #6						16.35	68.85					16 - 69
D66	75		Pure Pine						13.10	72.00					13 - 72
D146	142		H-Pine Oil						4.92	60.40					5 - 60

Machine

Experimenter

Missouri School of Mines and Metallurgy

FLOTATION LABORATORY.

OPERATING DATA.

ORE

COAL TARS

Test No	OIL No.	OIL Amt.	OIL Kind.	REAGENTS Kind	REAGENTS Amt.	FROTH Kind	FROTH Amt.	REMARKS.	Concentrate Wt.	Concentrate Per Ct.	RESULTS Wt.	RESULTS Per Ct.	Wt.	Per Ct.	Oil Value ~~Per Ct. Ext.~~
D70	79		#3 Crude Gas House Tar						—	—					—
D71	80		#4 Crude Water Gas Tar						—	—					—
D72	81		#5 Crude Coke Oven Tar						—	—					—
D76	83		Coal Tar from Gas Oven						—	—					—
D77	84		Water Gas Tar						—	—					—
D78	85		Coal Tar						—	—					—
D147	140		C15 Oil						—	—					—
D122	162		Cannal Coal Tar						—	—					—

Machine

Experimenter

Missouri School of Mines and Metallurgy

FLOTATION LABORATORY.

OPERATING DATA.

ORE

WOOD TAR OILS.

Test No	OIL No.	OIL Amt.	OIL Kind.	REAGENTS Kind	REAGENTS Amt.	FROTH Kind	FROTH Amt.	REMARKS.	Concentrate Wt.	Concentrate Per Ct.	RESULTS Wt.	RESULTS Per Ct.	Wt.	Per Ct.	Oil Value ~~Per Ct. Ext.~~
D143	136		#7 Special Pine Tar						22.40	39.40					22 - 39
D156	65		#7 Sunny South C.P.T. Oil						19.47	35.40					19 - 35
D144	131		Commercial Tar Oil						16.96	38.60					17 - 39
D152	146		#90 Tar Oil Refined												
D153	147		#750 Special Tar Oil												
D58	67		Ref. Tar Oil						20.95	71.12					21 - 71
D35	51		Commercial Tar Oil						28.00	55.28					28 - 55

Machine

Experimenter

ORE

Missouri School of Mines and Metallurgy

FLOTATION LABORATORY.

OPERATING DATA.

WOOD CREOSOTES.

Test No	OIL No.	OIL Amt.	OIL Kind.	REAGENTS Kind	REAGENTS Amt.	FROTH Kind	FROTH Amt.	REMARKS.	Concentrate Wt.	Concentrate Per Ct.	RESULTS Wt.	RESULTS Per Ct.	Wt.	Per Ct.	Oil Value ~~Per Ct. Ext.~~
D120	123		Beechwood Crude Creosote						18.31	39.80					18 - 40
			Beechwood Pure Creosote						18.90	62.20					19 - 62
D141	133		Wood Creosote Oil # XX						19.24	63.60					19 - 64
D142	134		Wood Creosote Oil # 3						13.81	64.20					14 - 64
D150	143		Wood Creosote Oil # 1												
D154	148		#200 Refined Creosote Oil												
D59	68		Ref. Wood Creas. Flotation Oil #200						23.35	63.57					23 - 64
D60	69		Crude Wood Creos. Flotation Oil #400						29.50	67.72					30 - 68

Machine

Experimenter

ORE

Missouri School of Mines and Metallurgy

FLOTATION LABORATORY.

Rosin Oils and Wood Resins

OPERATING DATA.

Test No	OIL No.	OIL Amt.	OIL Kind.	REAGENTS Kind	REAGENTS Amt.	FROTH Kind	FROTH Amt.	REMARKS.	Concentrate Wt.	Concentrate Per Ct.	RESULTS Wt.	RESULTS Per Ct.	Wt.	Per Ct.	Oil-Value ~~Per Ct. Ext.~~
D84	34		Rosin Oil						15.20	48.96					15-49
D112	35		Rosin Oil (Myer Bros.)						22.08	37.40					22-37
D62	71		#15 Special Rosin Oil						2.22	46.37					2-46
D125	120		Balsam Copaiba						22.41	13.30					22-13
D127	121		Balsam of Peru						5.56	26.20					6-26

Machine

Experimenter

Missouri School of Mines and Metallurgy

FLOTATION LABORATORY.

OPERATING DATA.

ORE

MISCELLANEOUS OILS

Test No	OIL No.	OIL Amt.	OIL Kind.	REAGENTS Kind	REAGENTS Amt.	FROTH Kind	FROTH Amt.	REMARKS.	Concentrate Wt.	Concentrate Per Ct.	RESULTS Wt.	RESULTS Per Ct.	Wt.	Per Ct.	Oil-Value ~~Per Ct. Ext.~~
D14	18		Amyl Acetate						14.60	45.42					15-45
D17	22		Oleic Acid						76.70	13.29					77-13
D15	19		Pyroligneous Acid						6.40	56.97					6-57
D151	145		"Phenolic Acid"												
D139	130		Pyroligneous Acid						—	—					—

The Fixed Oils.

The Fixed Oils may be classified as "inactive" oils as far as frothing ability is concerned. They all form a slight skum on the surface of the water and, where large enough to handle, shows fair selection on the part of the oil. The Fixed Oils are all of a "greasy" or lubricating nature as distinguished from the solvent types of oils such as turpentines and pine oils and all have the stiffness or "body" which seems to prevent their emulsifying or mixing with the water.

Petroleum Oils.

The Petroleum Oils give practically no froth and as a class show poor selection. These oils are not miscible with the water but form a slight skum on the surface which is difficult to separate from the water.

The Essential Oils.

The Essential Oils give a good froth and show good selective properties. The froth is ephemeral and usually consists of small bubbles. An ephemeral froth with small bubbles will give a clean concentrate because the possibility of contamination by suspended slimes in the water is lessened in proportion to the thinness of the bubble film and this is probably one reason that the Essential Oils give such clean concentrates. These oils are miscible with the water to a large extent and this tendency undoubtedly aids their frothing ability, as contrasted with the oils of the fixed oil group which separate in a clear line from the water.

The Pine Oils.

The Pine Oils are practically the same as Essential Oils or a mixture of Essential Oils and act as good frothers and good selectors.

The Coal Tars.

The Coal Tars are not miscible with water and usually have a gravity greater than1, so no results are obtainable when used alone, altho they undoubtedly are good selectors.

The Wood Tar Oils.

The Wood Tar Oils are the heavy oils other than the creosotes occuring in the destructive distillation of wood. They all give a stiff froth, with large bubbles, and select less well than the average. The poorness of selection is probably due to a large extent to the mechanical contamination of the froth by the "dirty" slime water which with the oil makes the thick bubble films.

The Wood Creósotes.

The Wood Creosotes give a heavy stiff froth with large bubbles and good selection. They give a slightly less amount of froth than Wood Tar Oils, and the total weight of concentrate made is less, showing a thinner oil film and therefore one that will give a cleaner concentrate.

Rosin Oils and Wood Resins.

The Rosin Oils and Wood Resins seem to act as good frothers and poor selectors. They are more or less miscible with the water, accounting for their frothing ability.

The Fatty Acids.

Oleic Acid was the only Fatty Acid tested and it gave a very large amount of froth, but very poor selection.

In general, it seems that the oils which are miscible with the water are the frothing oils and theoretically, at least, the oil which will give the ephemeral, small bubble, froth will give the cleaner concentrate when compared with an oil which forms a thick stiff froth, but the recovery may be greater in the second case. To get a clean concentrate, therefore, it may be necessary to sacrifice recovery, and vice versa, when using only one oil. With more than one oil a new problem comes in. From a small amount of preliminary work done, it was found that when mixing two oils in varying amounts, the frothing and selecting properties of the mixture did not always lie between the values found for the separate oils, tending to show the possibility of the formation of a chemical compound rather than a simple physical mixture, or at any rate this would show that the physical properties of each were considerably modified by the presence of the other.