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OILS AND FLOTATION.

BY

CHARLES YANCEY CLAYTON⁵⁹⁶⁹

AND

CLARENCE EUGENE PETERSON.

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



Associate Professor of Metallurgy and Ore Dressing.

19720

*Thesis. Oil's 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.

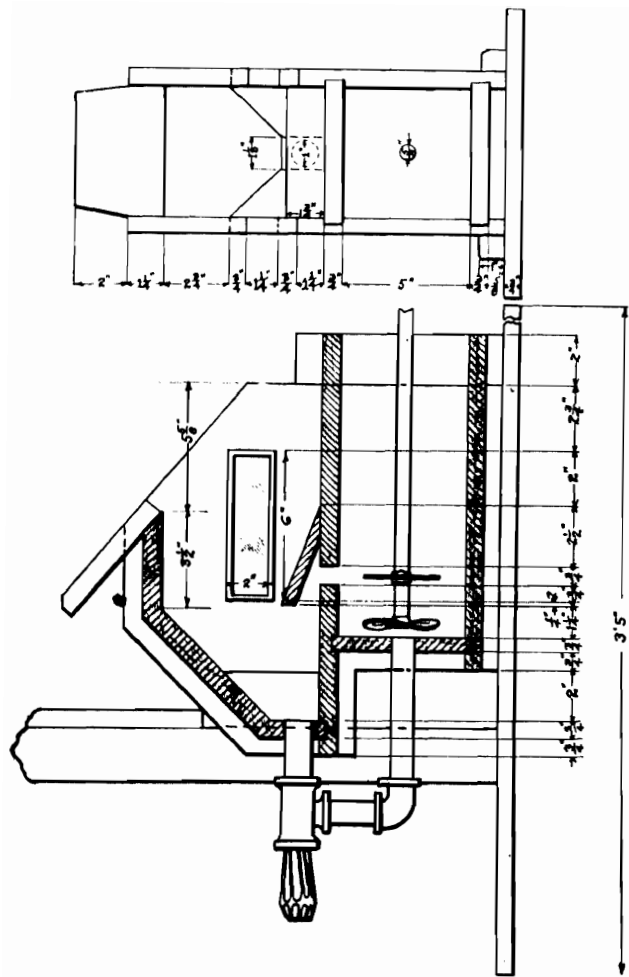
In attacking the problem the first step was to classify the available oils into groups. The oils so far tested cover a large field and can be divided as follows: Fixed oils, fatty acids, essential oils, wood-oils (including the resins), coal-tars and derivatives, water-gas tar and derivatives, petroleum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

OILS (Continued)

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 $\frac{3}{4}$ Turpentine #1 $\frac{1}{4}$	Local Druggist
99	Cresylic Acid $\frac{3}{4}$ Turpentine #2 $\frac{1}{4}$	" "
100	No. 96 Mix. $\frac{2}{3}$ No. 88 Mix. $\frac{1}{3}$	" "
101	No. 89 Mix. $\frac{1}{2}$ Cresylic Acid $\frac{1}{2}$	" "
102	Creosote $\frac{1}{3}$ Rosin $\frac{1}{3}$ Commercial Tar $\frac{1}{3}$	" "
103	Cresylic Acid $\frac{3}{10}$ Cushing's Crude $\frac{7}{10}$	" "
104	Cushing's Crude $\frac{7}{10}$ Creosote $\frac{3}{10}$	" "
105	Cushing's Crude $\frac{1}{2}$ No. 100 Mix. $\frac{1}{2}$	" "
106	Cushing's Crude $\frac{7}{10}$ Cottonseed Residue $\frac{3}{10}$	" "
107	Flotation Oil #1	B. M. Company
108	Flotation Oil #2	" "
109	Flotation Oil #3	" "
110	Bitter Almond	Local Druggist
111	Cumin-Oleum Guminis	" "
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	On	Weight		Cumu-	Lead	Total
	mesh	mesh	Lb.	%	lative	%	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
			<u>500.00</u>	<u>100.00</u>			<u>100.92</u>

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.	%	Cumu- lative %	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	...	<u>124.3</u>	<u>24.86</u>	100.00	6.72	<u>36.550</u>
			500.00	100.00			100.128

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

Machine _____

Experimenter _____

ORE _____

Missouri School of Mines and Metallurgy

FLOTATION LABORATORY.

OPERATING DATA.

Test No	OIL			REAGENTS		FROTH		REMARKS.	Concentrate		RESULTS		Oil Value Per Ct. Ext.
	No.	Amt.	Kind.	Kind	Amt.	Kind	Amt.		Wt.	Per Ct.	Wt.	Per Ct.	
D ₁	1	✓	Castor			No		Thick black skum.	19.9	52.07			20-52
D ₂	2	✓	Linseed (Raw)			No		Fair skum; no froth.	11.7	73.88			12-74
D ₃	3	✓	Linseed (Boiled)			No		Practically no froth.	4.9	53.11			5-53
D ₄	4	✓	Neatsfoot			No		Thin oil film.	3.3	25.09			3-25
D ₅	5	✓	Olive			No		Slight skum.	3.2	53.67			3-54
D ₆	6	✓	Petroleum			No		oil film; good selector.	4.1	76.77			4-76
D ₇	7	✓	Rapeseed			No		oil	1.5	43.31			1.5-43
D ₈	8	✓	Sperm.			Ephem.		Froth forms at once; not lasting.	3.8	54.90			4-55
D ₉	9	✓	Turpentine			Ephem.		Thin ephemeral froth.	9.48	49.91			9.5-50
D ₁₀₉	10	✓	Turpentine*1			Light	Small	Light ephemeral watery froth.	4.19	25.6			4-26
D ₁₁₀	11	✓	Turpentine*2			Ditto	Ditto	Ditto.	1.80	50.1			2-50
D ₁₀	12	✓	Toluol			Ditto	Ditto	Very thin froth.	3.84	54.52			4-55
D ₁₁	13	✓	Almond			Ditto	Ditto	Small bubbles; not very dark.	7.3	57.59			7-54
	14		Solza										
D ₁₃	15	✓	Lemon			Light	Fair	Thin ephemeral froth.	24.63	60.36			25-68

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.	Est.
D81	31	✓	✓	Soya Bean			Very Small	Could not save froth	—	—					—	
D82	32	✓		Menhaden (Pans)			Do	Do	—	—					—	
D83	33	✓		Pappy Seed			Do	Do	—	—					—	
D84	34	✓		Rosin			Fair Small	Fair Froth	15.2	48.96					15-49	
D11c	35	✓	✓	Rosin (M.B.D.Cs)			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	7.35	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	

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.	Per Ct.
D95	46	✓	Sad Liver			Small	No	No Results	2.70	57.88					3-58	
D96	47	✓	Sassafras			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	Do	Good frother	12.6	58.20					13-50	
D99	50	✓	Kerosene				No	Thin, Oil film	—	—					—	
D35	51	✓	Commercial Tar			Large	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	Do	Thin, large bubbles; black froth	31.90	75.21					32-75	
D42	58		#18 Flotation			Do	large	Do	34.80	70.97					35-71	
D43	59		#22 Flotation			Ephem.	fair	Medium sized ephem. bubbles	19.15	67.87					19-68	
D45	60		L-3 (G.N.S.)			Fight	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			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.
D46	61	✓	S. 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
D50	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 Resin			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

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. Est.	
D ₆₇	76		* 20 Flotation					No	No froth or skum	—	—					—
D ₆₈	77	✓	* 1 Creosote * 2 Mixture					No	No froth, good selection	5.0	59.80					5-60
D ₆₉	78	✓	Creosote & Refined Tar * 3 Crude Gas			light	large			37.12	69.16					37-69
D ₇₀	79	✓	House Tar * 4 Crude Water					No	Apparently good selector	—	—					—
D ₇₁	80	✓	Gas Tar * 5 Crude Coke					No	Ditto	—	—					—
D ₇₂	81	✓	Oven Tar					No	Ditto	—	—					—
D ₇₅	82	✓	* 6 Oil from Water Gas Tar					No	Skum formed	8.55	61.86					9-62
D ₇₆	83	✓	Coal Tar from Gas Oven					No	No results	—	—					—
D ₇₇	84	✓	Water Gas Tar					No	Ditto	—	—					—
D ₇₈	85	✓	Coal Tar					No	Difficult to emulsify	—	—					—
D ₁₉	86		linseed (Raw)	Resin	10 gms in 200 c.c.	light	Very Small		Very light froth	14.2	54.93					14-55
D ₂₀	87		Pyroligneous Acid	Resin	10 gms in 200 c.c.			No	No action at all	—	—					—
D ₂₂	88		Turpentine	Resin	10 gms in 200 c.c.	Good	large		large amount of froth	18.3	54.58					18-55
D ₂₅	89		Coal Tar Toluol			light	Small		Ephemeral froth	8.24	52.34					8-52

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. Int.
D ₁₀₅	97		$\frac{3}{4}$ Cresylic Acid $\frac{1}{4}$ Tar (S-Black)												
D ₁₀₆	98		$\frac{3}{4}$ Cresylic Acid $\frac{1}{4}$ Turpentine #1			Ephem. large		Ephemeral froth: very black	27.05	71.30					27-71
D ₁₀₇	99		$\frac{3}{4}$ Cresylic Acid $\frac{1}{4}$ Turpentine #2			Heavy large		Extra good tough froth	24.57	62.40					25-62
D ₅₂	100		$\frac{2}{3}$ No. 96 Mix. $\frac{1}{3}$ No. 88 Mix.					Good frother	35.90	62.30					36-62
D ₅₄	101		$\frac{1}{2}$ No. 89 Mix. $\frac{1}{2}$ Cresylic Acid			Small Bubbles large			35.7						36--
D ₅₃	102		$\frac{1}{3}$ Creosote $\frac{1}{3}$ Rosin $\frac{1}{3}$ Commercial Tar				No	No results	—	—					
D ₉₉	103		$\frac{3}{10}$ Cresylic Acid $\frac{7}{10}$ Cushing's Crude			Ephem. fair		Small frail watery bubbles							

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.	
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	112	✓	✓	Bergamot			Heavy	large	Heavy black froth		38.88					-39
D122	162	✓	✓	Santal Coal Tar				None	No results	—	—					—
D123																
D124																
D125	120	✓	✓	Balsam Capaiba Beechwood			Tough	large	Med bubbles; carries gangue	22.41	13.3					22-13
D126	122	✓	✓	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 _____

Missouri School of Mines and Metallurgy

FLOTATION LABORATORY.

OPERATING DATA.

Experimenter _____

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 ₁₂₉	123	✓	✓ Beechwood Crude Creosote					Same as ref. creos. but more gangue	10.43	42.0					10-42	
D ₁₃₀	127	✓	Black Pepper			Small Bubbles	little	Slow forming froth; poor selector	22.36	57.40					22-54	
D ₁₃₁	124	✓	Spearmint			Small Bubbles	large	Tough, skummy froth; carries much min.	50.28	44.00					50-44	
D ₁₃₂	125	✓	True			Very Small Bubbles	little	Skum-like froth; tough; much conc.	6.72	64.44					7-64	
D ₁₃₃	128	✓	Sandalwood			Very Small Bubbles	little	Skum of good conc.; not very tough	11.67	59.20					12-59	
D ₁₃₄	126	✓	Verbina			Med. Bubbles	Fair	Stiff froth; carries gangue	35.80	67.4					36-67	
D ₁₃₅	129	✓	Sweet Orange			Fairly Tough	Small	light froth; carries little mineral	6.50	67.6					7-68	
D ₁₃₆	152	✓	Flot "A" Calol "A"			Very Light	Small	Small bubbles; carries mostly gangue	0.99	19.8					1-20	
D ₁₃₇	153	✓	Flot "B" Calol "B"			Do	Do	More mineral than "A"	0.85	24.4					1-24	
D ₁₃₈	154	✓	Flot "C" Calol "C"			Do	Do	Very small bubbles; more mineral	0.46	24.9					0.5-25	
D ₁₃₉	130	✓	Pyroligneous Acid			Very Little	little	No results; very slight froth.	—	—					—	
D ₁₄₀	135	✓	Special Flot. Oil			Small Bubbles	large	Small bubbles; stiff froth	3.60	52.6					4-53	
D ₁₄₁	133	✓	Wood Creos. Oil #XX			Do	Do	Ditto	19.24	63.6					19-64	
D ₁₄₂	134	✓	Wood Creos. Oil #3			Do	Do	Small bubbles; ephem.	13.81	64.2					14-64	
D ₁₄₃	136	✓	#7 Special Pine Tar			Large Bubbles	large	Extra good frother.	12.40	39.3					21-39	

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. Exp.
D144	131	✓	Comm. Tar Oil			Large Bubbles	Large	Good froth; 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 feed 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 Large Bubbles	Fair	Medium size bubbles	9.17	60.4					9-60
D150	143	✓	Wood Spec. Oil #1			Large Bubbles	Fair	Stiff froth; large bubbles							
D151	145		"Phenolic Acid"			Do	Do	Ditto							
D152	146	✓	Tar Oil Ref.			—	None	No result; 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	So. pious froth	14.90	17.8					15-18
Rep.		✓	Crude Beech Spec.						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 indicate 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 FROTH-
ING 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 Acid	-----	9.80 (Approximate)
7	•Corn Oil	3.00	2.6
8	Lubricatin Oil	2.60	2.15
9	• $\frac{1}{2}$ Cresylic $\frac{1}{2}$ 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. Hydroxyl
14	•General Naval #18	-----	9.8 ditto
15	•General Naval #22	-----	3.05
16	•Olive Oil	-----	2.76 I.B.&M Tabelle 2.92
17	•Cylinder Oil	-----	2.47 ditto 2.38
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
Linseed	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

Dielektrizitätskonstanten und Quadrate elektrischer Brechungsindices (D)

Lit. Tab. 240, S. 774.

Flussige Isolationsmittel (Ole)

Material	t ^o	D	Autor
Petroleum		2,07	Hopkinson
		2,14	Winkelmann
	600	1,96	Arons und Rubens (1)
	1300	2,126	Marx (2)
	-3000		
Petrolather		1,778	Werner
Paraffinol	20	"	Hasenohrl (2)
20	20	"	"
20	- 50	"	"
Dichte 0,905	82	"	"
Ruboll	16,2	"	Hormell
Leinol	13	"	Salvioni
Baumwoll-			"
samenol	13,7	"	"
	"	3,10	"
	"	3,09	Ferry
	1000	3,00	"
Olivenol		3,02	Hopkinson
	12,4	"	Salvioni
	20	"	Heinke
Olivenol 20 . .	"	3,108	"
	"	0,00364	"
	600	3,08	Arons u
		2,92	Rubens (1)
Sesamol	13,4	3,02	Salvioni
Mandelol		3,01	"
	20	"	Hasenohrl (2)
20	20 - 40	"	"
20	"	"	"
Arachisol	11,4	"	Salviani
Kamiol		"	v. Pirani
Ricinusol	10,9	"	Salvioni
20	"	"	Heinke
	"	0,01067	"
	"	4,67	Arons u
	600	4,20	Rubens (1)
	9	4,000	Kossonogoff
	6,4	3,968	"
	2	2,019	"
Atherische Ole,	Terpentin s. S. 771.		
Amylacetat	19,	"	Lowe
	"	0,0024	"
Toluol	20	"	Hopkinson
	14,4	"	Landolt u. Jahn
	- 83	"	Abegg
	16,5	"	"
	19	73	Drude (3)
	0 - 30	"	Ratz
15	20 -	"	Tangl
0	181	"	"
0	17	"	Nernst
Cymol		2,249	"
Phenol	48	73	Drude (3)
Kreosol	17		Lowe
		10,3	

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
Pansoline	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		
½ Castor	24 - 73	4.33
½ Cresylic		
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 oil's 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 Lemons and 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
 { Clayton
 Experimenter { Peterson

Missouri School of Mines and Metallurgy
FLOTATION LABORATORY.

OPERATING DATA.

ORE Dolomite & Galena

R.P.M. 1700
 TIME 20min
 PULP RATIO { WATER 5
 ORE 1

EXPERIMENTS SHOWING EFFECT OF INCREASING QUANTITY OF OIL.

Test No	OIL			REAGENTS		FROTH		REMARKS.	Concentrate		RESULTS			
	No.	Amt.	Kind.	Kind	Amt.	Kind	Amt.		Wt.	Per Ct.	Wt.	Per Ct.	Wt.	Per Ct.
T ₁	1	$\frac{1}{4}$	Saster Oil						2.0	57.40				
T ₂	2	$\frac{1}{2}$	#20 Flotation Oil						3.4	58.80				
T ₃	3	$\frac{3}{4}$	Cresote						10.1	71.20				
T ₄	4	$\frac{1}{2}$	Sottoseed (Ref)						10.3	76.40				
T ₅	5	$\frac{1}{2}$	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
 { Slayton
 Experimenter Peterson

Missouri School of Mines and Metallurgy
FLOTATION LABORATORY.

OPERATING DATA.

ORE Dolomite & Galena

R.P.M.-1700

TIME 20 MIN.

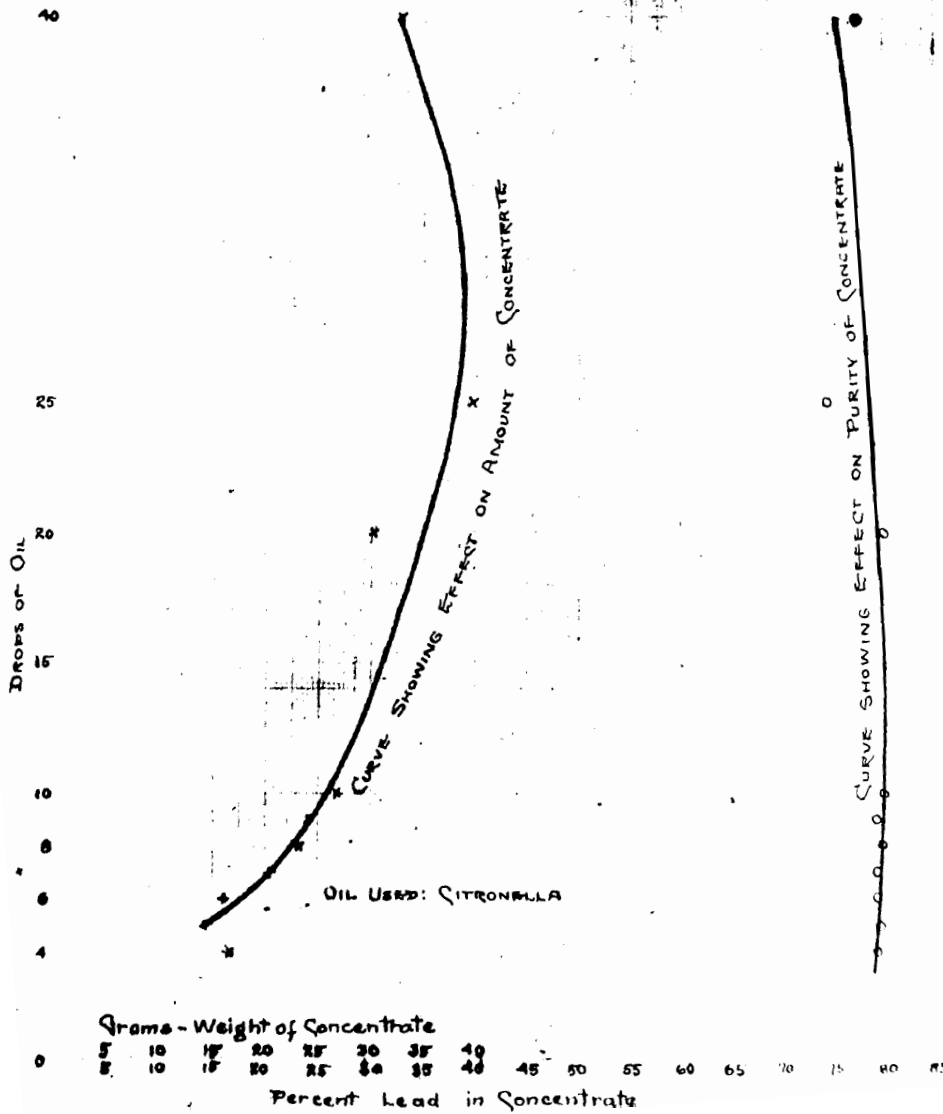
PULP RATIO { WATER 5
 ORE 1

EXPERIMENTS SHOWING EFFECT OF INCREASING QUANTITY OF OIL

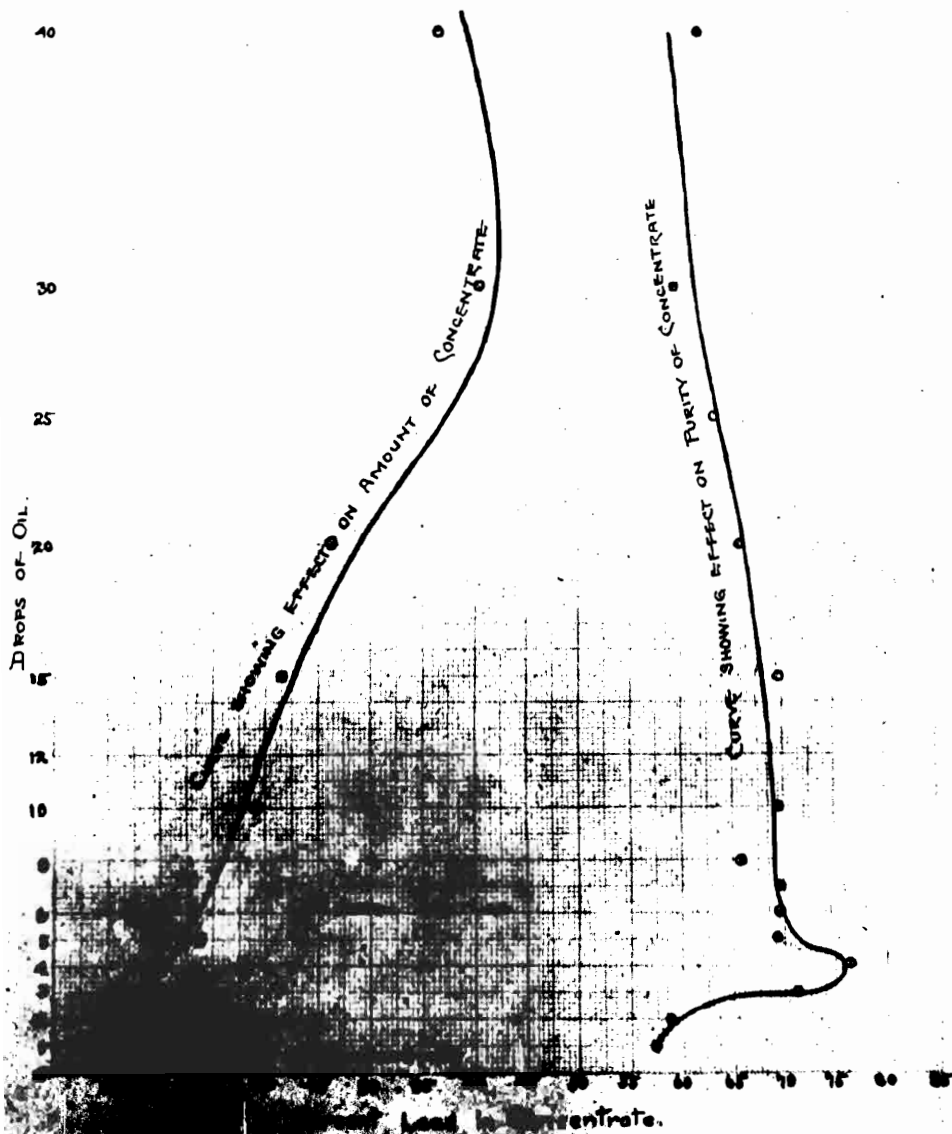
Test No	OIL			REAGENTS		FROTH		REMARKS.	Concentration		RESULTS				
	No.	Amt.	Kind.	Kind	Amt.	Kind	Amt.		Wt.	Per Ct.	Wt.	Per Ct.	Wt.	Per Ct.	Per Ct. Ext.
C ₄		4	Citronella						16.7	79.1					
C ₅		5							14.4	79.3					
C ₆		6							16.11	79.2					
C ₇		7							20.5	79.3					
C ₈		8							23.3	79.8					
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					

F OF MINES

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 FLOTATION VALUES OF THE VARIOUS OILS IN ORDER TO DETERMINE IF THE OILS OF THE VARIOUS GROUPS HAVE SIMILAR VALUE IN FLOTATION.

Machine _____

Missouri School of Mines and Metallurgy

OPERATING DATA.

Experimenter _____

FLOTATION LABORATORY.

FIXED OILS.

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.
D ₅	5	I	Olive					3.2	53.67				3-54
D ₅₇	16	I	Peanut					5.61	70.55				6-71
D ₇	7	II	Rapeseed					1.5	43.31				1.5-43
D ₅₆	17	III	Sesame					4.77	67.17				5-67
D ₇₈	27	III	Corn Oil					—	—				—
D ₈₁	31	III	Soya Bean					—	—				—
D ₂₃	37	III	Sottonseed					7.25	63.76				7-64
D ₂	2	IV	Linseed(Raw)										
D ₃	3	IV	Linseed(Boiled)					4.90	53.11				5-53
D ₇₉	28	IV	China Wood					—	—				—
D ₈₃	33	IV	Poppy seed					—	—				—
D ₁	1	V	Sastor					19.90	52.07				20-52
		V	Crator					—	—				—
D ₄	4	VIII	Neatsfoot					3.30	25.09				3-25
D ₈₂	32	X	Menhaden(Pure)					—	—				—
D ₈₀	29	X	Menhaden(Tech)					—	—				—

Machine _____

Experimenter _____

ORE _____

Missouri School of Mines and Metallurgy

FLOTATION LABORATORY.

OPERATING DATA.

PETROLEUM PRODUCTS

Test No.	OIL		REAGENTS		FROTH		REMARKS.	Concentrate		RESULTS		Oil-Value
	No.	Amt.	Kind.	Kind	Amt.	Kind		Amt.	Wt.	Per Ct.	Wt.	Per Ct.
D ₆	6		Petroleum					4.1	76.27			4-76
D ₈₅	36		Paraffine					—	—			—
D ₈₇	50		Kerosene					—	—			—
D ₄₆	61		S.F. Cylinder					1.23	22.21			1-22
D ₄₇	62		Cushings Crude					3.00	36.04			3-36
D ₄₈	63		Black					2.70	25.74			3-26
D ₄₉	64		Tar (S-Black)					4.10	40.04			4-40
D ₃₆	52		Fuel					11.20	68.35			11-68
D ₃₇	53		Atlanta Red					1.40	46.90			1.5-47
D ₃₈	54		Diamond Ref.					3.98	47.06			4-47
D ₃₉	55		Stand Heavy Ing.					2.60	42.14			3-42
D ₁₃₆	152		Solol "A"					0.99	19.80			1-20
D ₁₃₇	153		Solol "B"					0.85	24.40			1-24
D ₁₃₈	154		Solol "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 Per Ct. Flt.
	No.	Amt.	Kind.	Kind	Amt.	Kind	Amt.		Wt.	Per Ct.	Wt.	Per Ct.	Wt.	Per Ct.	
D ₁₁	13		Almond						7.3	53.59					7-54
D ₁₃	15		Lemon						24.63	68.36					25-68
D ₉	9		Turpentine						9.48	49.91					9-50
D ₁₀₉	10		Turpentine *1						4.19	25.60					4-26
D ₁₁₀	11		Turpentine *2						1.80	50.10					2-50
D ₉₈	49		Amber						12.60	50.20					13-50
D ₉₇	48		Origanum						16.07	66.14					16-66
D ₉₆	47		Sassafras						10.60	53.96					11-54
D ₅₀	66		Pine Oil *6						16.35	68.85					16-69
D ₆₆	75		Pure Pine (Ref.)						13.10	72.00					13-72
D ₁₆	20		Sedar Wood						28.07	47.80					28-48
D ₈₉	21		Sedar Wood (Crude)						9.42	72.40					9-72
D ₁₈	23		Eucalyptus						51.40	47.65					51-48
D ₂₆	24		Orange Peel						20.61	75.92					21-76
D ₁₁₇	112		Mustard						—	—					—

Machine.....

Missouri School of Mines and Metallurgy

OPERATING DATA.

Experimenter.....

FLOTATION LABORATORY.

ORE

ESSENTIAL OILS

Test No.	OIL			REAGENTS		FROTH		REMARKS.	RESULTS						
	No.	Amt.	Kind.	Kind	Amt.	Kind	Amt.		Wt.	Per Ct.	Wt.	Per Ct.	Wt.	Per Ct.	Per Ct. Ext.
D ₁₂₀	113		Subeb						4.84	50.16					5-50
D ₁₂₁	118		Bergamot							38.88					- 39
D ₉₀	41		Wine						14.55	64.40					15-64
D ₉₁	42		Male Fern						21.10	44.00					21-44
D ₉₂	43		Pennyroyal						34.30	64.00					34-64
D ₉₃	44		Sloves						34.79	70.00					35-70
D ₉₄	45		Citronella						30.30	74.11					30-74
D ₁₃₀	127		Black Pepper						22.36	57.88					22-54
D ₁₃₁	124		Spearmint						50.28	44.00					50-44
D ₁₃₂	125		Rue						6.72	64.44					7-64
D ₁₃₃	128		Sandalwood						11.67	59.20					12-59
D ₁₃₄	126		Verbena						35.80	67.40					36-67
D ₁₃₅	129		Sweet Orange						22.95	65.14					23-65
D ₁₁₅	119		Cassia						15.95	49.30					16-49
D ₁₁₆	111		Cumin						4.00	48.64					4-49

Machine _____

Missouri School of Mines and Metallurgy

OPERATING DATA.

Experimenter. _____

FLOTATION LABORATORY.

ORE

PINE 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.
D ₉	9		Turpentine						9.48	49.91						9.5-50
D ₁₀₉	10		Turpentine #1						4.19	25.60						4-26
D ₁₁₀	11		Turpentine #2						1.80	50.10						2-50
D ₆₁	70		*80 Crude Wood Turps.						5.34	61.39						5-61
D ₆₃	72		*75 " " "						4.40	54.53						4-55
D ₆₄	73		*1580 Special Pine Oil						4.65	56.97						5-57
D ₆₅	74		*350 Crude Wood Oil						7.75	52.10						18-52
D ₅₀	66		Pine Oil #6						16.35	68.85						16-69
D ₆₆	75		Pure Pine						13.10	72.00						13-72
D ₁₄₆	142		H-Pine Oil						4.92	60.40						5-60

Machine _____

Experimenter _____

ORE _____

Missouri School of Mines and Metallurgy FLOTATION LABORATORY.

OPERATING DATA.

COAL TARS

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. Est.
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		Small Coal Tar						—	—					—

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 than 1, 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 occurring 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 Creosotes.

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.