	H = 1.		O = 16.		
	Clarke.	German.	Clarke.	Richards.	German.
Rubidium	84.75	84.76	85.4	85.44	85.4
Ruthenium	100.9	100.9	101.7	101.7	101.7
Samarium	149.2 ?	148.9	150.3 ?	150.	150.
Scandium	43.8	43.8	44.1	44.	44.1
Selenium	78.6	78.5	79.2	79.2	79.1
Silicon	28.2	28.2	28.4	28.4	28.4
Silver	107.11	107.12	107.92	107.93	107.93
Sodium	22.88	22.88	23.05	23.05	23.05
Strontium	86.95	86.94	87.60	87.68	87.6
Sulphur	31.83	31.83	32.07	32.065	32.06
Tantalum	181.5	181.6	182.8	183.	183.
Tellurium	126.1	126.	127.7	127.5 ?	127.
Terbium	158.8	....	160.	160.	....
Thallium	202.61	202.6	204.15	204.15	204.1
Thorium	230.8 ?	230.8	232.6 ?	233.	232.5
Thulium	169.4	170.	170.7	171. ?	171.
Tin	118.1	117.6	119.0	119.0	118.5
Titanium	47.8	47.7	48.15	48.17	48.1
Tungsten	182.6	182.6	184.	184.	184.
Uranium	237.8	237.7	239.6	238.5[1]	239.5
Vanadium	51.0	50.8	51.4	51.4	51.2
Xenon	127.	127.	128.0	128.	128.
Ytterbium	171.9	172.	173.2	173.	173.
Yttrium	88.3	88.3	89.0	89.0	89.
Zinc	64.9	64.9	65.4	65.40	65.4
Zirconium	89.7	90.0	90.4	90.6	90.7

METALLIC SOAPS FROM LINSEED OIL. AN INVESTIGATION OF THEIR SOLUBILITIES IN CERTAIN OF THE HYDROCARBONS.

By Hermann T. Vulté and Harriet Winfield Gibson.

Received October 19, 1901.

In the analysis of mixed paints, two of the most important points to be determined are the nature and the amount of the drying agent contained therein, since upon the quality of the drier present the value of the paint is largely conditioned. In modern practice, the driers used are almost invariably either the manganese or the lead soaps of linseed oil (so-called linoleates) or they are the resinates of the same metals, or they may be any mixture of these salts. The investigation of paint driers, therefore, resolves itself into a determination of the four salts mentioned. The method ordinarily pursued has been to separate the

[1] From unpublished determinations by Richards and Merigold.

base and the drier from the pigment by means of petroleum ether, the ethereal solution being then transferred to a tightly corked Erlenmeyer flask, and allowed to stand for from twelve to twenty-four hours. A somewhat gummy sediment, white to yellow in color and more or less adherent to the sides of the flask, is deposited. The sediment is then separated from the ethereal solution, and carefully washed by decantation with a further quantity of the petroleum ether. As, upon analysis, this sediment may be shown to consist mainly of the lead soap of linseed oil, together with some manganese soap, it has been assumed that a complete separation of the drier took place at this point and it was, therefore, believed that this method could be used in determining the character and amount of the drier. Upon further trial this method has proved far from satisfactory and various hydrocarbons, ranging from petroleum ether to benzine, have been suggested as a substitute for the solvent employed. None of these substitutes has been found to effect a perfect separation of the drier, although a distinct difference in solvent action has been observed. For example, the lead salts precipitate most quickly from petroleum ether and least from benzine, while the manganese salts are, in comparison, but slightly affected by either, except on long standing.

Since, then, a perfect separation of the drier from the base cannot be effected by any known solvent, it has been thought advisable to study the behavior of various metallic salts of linseed oil with different hydrocarbon solvents, and to determine the percentages of solubility at the end of stated and uniform periods. The work has been extended to cover the linseed oil soaps of most of the common metals, and the results of the investigation are given in the following paper.

The sodium soap of linseed oil was first prepared, great care being taken to effect complete saponification. The soap was curded out by excess lye, the use of salt being avoided. It was then washed free of impurities as far as possible, framed and allowed to stand until perfectly hard and dry. The soap thus formed was light brown in color, and had a pronounced odor of linseed. With water it formed a golden yellow solution and afforded an abundant lather.

A table follows, giving the petroleum solvents used, together with their boiling-points and specific gravities :

	Boiling-point.	Sp. gr. at 15° C.
Petroleum ether	35°–55°	0.639
Benzine	55°–75°	0.702
Benzine	75°–85°	0.695
Naphtha	59°	0.741
Naphtha	62°	0.732
Benzine	71°	0.698
Gasolene	74°	0.699
Turpentine	...	0.855

In the preparation of the various metallic soaps whose solubility it was desired to test, a water solution of the sodium soap was first carefully cooled to 20° C. or below. This is essential, as many of the metallic soaps examined have a very low melting-point. A soluble salt of the metal in question, exhibiting its lower valency if possible, was then selected, and a solution of this salt slowly added to the soap solution until precipitation ceased. The metallic soap was then washed by decantation with distilled air-free water, carefully dried, an excess amount added to each solvent, and the solutions allowed to stand in the dark. At the expiration of one hour, twenty-four hours, and forty-eight hours, 10 cc. of the clear solution were carefully evaporated in a tared watch-glass over a water-bath and the gain in weight recorded as dissolved matter. From this, the actual percentages of solubility were calculated and the results obtained, together with any peculiarities of the different salts, will be found in the annexed tables. It was thought well to first classify the metals into groups according to the ordinary method pursued for qualitative analysis, and then to give a résumé of the properties developed by each salt. For purposes of comparison, their solubility in turpentine, under the same conditions, is also given in these tables:

TABLES GIVING THE AMOUNT OF DISSOLVED MATTER IN THE VARIOUS SOLVENTS.

GROUP ONE.

Lead.

		35°–55°.	55°–75°.	75°–85°.	59°.	62°.	71°.	74°.	Turps.
1 hr.	gms.	0.0385	0.0276	0.0477	0.0309	0.0276	0.0296	0.0405	0.2494
	p. ct.	0.602	0.393	0.686	0.417	0.377	0.424	0.579	2.917
24 hrs.	gms.	0.0381	0.0277	0.0479	0.0318	0.0278	0.0286	0.0413	0.2490
	p. ct.	0.598	0.394	0.689	0.428	0.379	0.409	0.591	2.912
48 hrs.	gms.	0.0376	0.0277	0.0471	0.0328	0.0273	0.0277	0.0420	0.2510
	p. ct.	0.590	0.394	0.678	0.443	0.373	0.398	0.601	2.935

Group Two.

Mercury.

		35°–55°.	55°–75°.	75°–85°.	59°.	62°.	71°.	74°.	Turps.
1 hr.	gms.	0.0138	0.0057	0.0085	0.0041	0.0067	0.0027	0.0093	0.1692
	p. ct.	0.216	0.081	0.122	0.055	0.091	0.039	0.133	1.979
24 hrs.	gms.	0.0376	0.0475	0.0356	0.0155	0.0359	0.0147	0.0542	0.2544
	p. ct.	0.588	0.677	0.512	0.209	0.490	0.211	0.776	2.975
48 hrs.	gms.	0.0500	0.0782	0.0672	0.0552	0.0435	0.0384	0.0899	0.4593
	p. ct.	0.782	1.114	0.967	0.745	0.594	0.550	1.286	5.372

Copper.

		35°–55°.	55°–75°.	75°–85°.	59°.	62°.	71°.	74°.	Turps.
1 hr.	gms.	0.0285	0.0257	0.0145	0.0087	0.0124	0.1135	0.0609	0.1238
	p. ct.	0.449	0.336	0.209	0.117	0.169	1.626	0.871	1.448
24 hrs.	gms.	0.2516	0.3652	0.0962	0.1151	0.1094	0.1213	0.1032	0.4847
	p. ct.	3.962	5.202	1.384	1.553	1.494	1.738	1.476	5.669
48 hrs.	gms.	0.2534	0.4173	0.0977	0.1822	0.1172	0.1414	0.1886	0.6625
	p. ct.	3.992	5.944	1.406	2.459	1.601	2.026	2.698	7.748

Group Three.

Tin.

		35°–55°.	55°–75°.	75°–85°.	59°.	62°.	71°.	74°.	Turps.
1 hr.	gms.	0.0435	0.0776	0.0926	0.0600	0.0804	0.0928	0.1216	0.2401
	p. ct.	0.681	1.105	1.332	0.809	1.098	1.329	1.739	2.808
24 hrs.	gms.	0.0520	0.0780	0.0921	0.0626	0.0867	0.0935	0.1322	0.2408
	p. ct.	0.801	1.111	1.325	0.844	1.184	1.339	1.891	2.816
48 hrs.	gms.	0.0601	0.0787	0.0922	0.0661	0.0885	0.0933	0.1389	0.2352
	p. ct.	0.940	1.121	1.326	0.892	1.209	1.336	1.987	2.751

Antimony.

		35°–55°.	55°–75°.	75°–85°.	59°.	62°.	71°.	74°.	Turps.
1 hr.	gms.	0.0766	0.0877	0.0897	0.0703	0.1069	0.0785	0.0608	0.3496
	p. ct.	1.198	1.249	1.291	0.948	1.462	1.124	0.869	4.088
24 hrs.	gms.	0.1051	0.0965	0.0974	0.0702	0.1088	0.0814	0.0698	0.3446
	p. ct.	1.631	1.374	1.401	0.947	1.486	1.166	0.998	4.023
48 hrs.	gms.	0.1306	0.1155	0.1041	0.0742	0.1104	0.0903	0.0746	0.3432
	p. ct.	2.043	1.645	1.498	1.001	1.508	1.294	1.067	4.014

Group Four.

Iron.

		35°–55°.	55°–75°.	75°–85°.	59°.	62°.	71°.	74°.	Turps.
1 hr.	gms.	0.1887	0.2570	0.2589	0.2878	0.2635	0.2087	0.1873	0.6103
	p. ct.	2.953	3.661	3.725	3.884	3.599	2.989	2.679	7.138
24 hrs.	gms.	0.3105	0.2985	0.3139	0.3287	0.2840	0.1999	0.1897	0.6424
	p. ct.	4.859	4.252	4.516	4.436	3.878	2.864	2.711	7.513
48 hrs.	gms.	0.2484	0.2251	0.2483	0.2895	0.2130	0.1535	0.1511	0.6424
	p. ct.	3.887	3.206	3.572	3.907	2.909	2.199	2.161	7.513

Chromium.

		35°–55°.	55°–75°.	75°–85°.	59°.	62°.	71°.	74°.	Turps.
1 hr.	gms.	0.0455	0.0539	0.0645	0.0620	0.0579	0.0595	0.0592	0.2293
	p. ct.	0.712	0.768	0.928	0.837	0.791	0.852	0.847	2.682
24 hrs.	gms.	0.0473	0.0646	0.0598	0.0902	0.0729	0.0579	0.0597	0.3822
	p. ct.	0.740	0.920	0.860	1.217	0.992	0.829	0.854	4.470
48 hrs.	gms.	0.0520	0.0459	0.0501	0.0571	0.0551	0.0497	0.0485	0.3853
	p. ct.	0.814	0.654	0.721	0.772	0.753	0.712	0.694	4.506

Aluminum.

		35°–55°.	55°–75°.	75°–85°.	59°.	62°.	71°.	74°.	Turps.
1 hr.	gms.	0.0045	0.0033	0.0025	0.0022	0.0097	0.0067	0.0036	0.1796
	p. ct.	0.070	0.047	0.036	0.029	0.132	0.096	0.052	2.101
24 hrs.	gms.	0.0422	0.0610	0.0439	0.0199	0.0378	0.0514	0.0351	0.1898
	p. ct.	0.660	0.868	0.632	0.268	0.516	0.736	0.502	2.219
48 hrs.	gms.	0.0940	0.1038	0.0763	0.0457	0.0570	0.0718	0.0509	0.1941
	p. ct.	1.471	1.479	1.097	0.617	0.779	1.029	0.728	2.270

GROUP FIVE.

Nickel.

		35°–55°.	55°–75°.	75°–85°.	59°.	62°.	71°.	74°.	Turps.
1 hr.	gms.	0.1094	0.1255	0.1282	0.0785	0.0851	0.1048	0.1127	0.2306
	p. ct.	1.709	1.788	1.845	1.059	1.162	1.501	1.612	2.697
24 hrs.	gms.	0.1933	0.1751	0.1874	0.1584	0.1046	0.1277	0.1487	0.3769
	p. ct.	3.025	2.494	2.696	2.138	1.429	1.829	2.127	4.408
48 hrs.	gms.	0.1856	0.1703	0.1807	0.1583	0.0559	0.0632	0.0873	0.3345
	p. ct.	2.904	2.425	2.600	2.136	0.763	0.905	1.249	3.912

Cobalt.

		35°–55°.	55°–75°.	75°–85°.	59°.	62°.	71°.	74°.	Turps.
1 hr.	gms.	0.0172	0.0185	0.0201	0.0143	0.0176	0.0140	0.0082	0.3742
	p. ct.	0.269	0.263	0.289	0.193	0.243	0.200	0.116	4.376
24 hrs.	gms.	0.0204	0.0195	0.0209	0.0265	0.0270	0.0250	0.0157	0.2997
	p. ct.	0.319	0.278	0.301	0.358	0.369	0.358	0.225	3.505
48 hrs.	gms.	0.0262	0.0181	0.0210	0.0343	0.0386	0.0390	0.0271	0.3611
	p. ct.	0.410	0.257	0.302	0.463	0.527	0.558	0.388	4.223

Manganese.

		35°–55°.	55°–75°.	75°–85°.	59°.	62°.	71°.	74°.	Turps.
1 hr.	gms.	0.2280	0.0998	0.0896	0.0721	0.0702	0.0673	0.1077	0.1827
	p. ct.	3.568	1.421	1.289	0.973	0.959	0.964	1.541	2.137
24 hrs.	gms.	0.2425	0.0990	0.0840	0.0899	0.0816	0.0854	0.0945	0.2098
	p. ct.	3.795	1.410	1.208	1.213	1.115	1.223	1.352	2.454
48 hrs.	gms.	0.0480	0.0276	0.0461	0.0282	0.0281	0.0288	0.0403	0.2749
	p. ct.	0.751	0.393	0.663	0.381	0.384	0.414	0.576	3.215

Zinc.

		35°–55°.	55°–75°.	75°–85°.	59°.	62°.	71°.	74°.	Turps.
1 hr.	gms.	0.0254	0.0492	0.0420	0.0310	0.0187	0.0424	0.0360	0.1870
	p. ct.	0.397	0.701	0.604	0.418	0.255	0.607	0.515	2.187
24 hrs.	gms.	0.0536	0.0792	0.0865	0.0674	0.0640	0.0719	0.0706	0.2530
	p. ct.	0.838	1.128	1.245	0.909	0.874	1.031	1.010	2.959
48 hrs.	gms.	0.0606	0.0715	0.0903	0.0649	0.0663	0.0846	0.0853	0.2946
	p. ct.	0.948	1.018	1.299	0.876	0.905	1.212	1.220	3.445

GROUP SIX.

Barium.[1]

		35°–55°.	55°–75°.	75°–85°.	59°.	62°.	71°.	74°.	Turps.
1 hr.	gms.	0.0066	0.0022	0.0015	0.0031	0.0072	0.0017	0.0007	0.1228
	p. ct.	0.103	0.031	0.021	0.042	0.098	0.024	0.001	1.436
24 hrs.	gms.	0.0062	0.0040	0.0013	0.0024	0.0143	0.0031	0.0027	0.1301
	p. ct.	0.097	0.057	0.019	0.032	0.195	0.044	0.039	1.522

Calcium.[1]

		35°–55°.	55°–75°.	75°–85°.	59°.	62°.	71°.	74°.	Turps.
1 hr.	gms.	0.0154	0.0051	0.0053	0.0011	0.0109	0.0133	0.0045	0.1022
	p. ct.	0.241	0.072	0.076	0.015	0.149	0.191	0.064	1.195
24 hrs.	gms.	0.0120	0.0064	0.0049	0.0009	0.0098	0.0127	0.0042	0.1274
	p. ct.	0.188	0.091	0.070	0.012	0.134	0.182	0.064	1.490

CONCLUSION.

A comparison of the figures given in the foregoing tables discloses the fact that certain of these metallic soaps, namely, those made of lead, nickel, iron and manganese, show marked individuality, the characteristics of each not being repeated by any other soap.

1. The lead soap goes almost completely out of solution from all the petroleum solvents in less than one hour.

2. The nickel soap, while eventually affording a nearly complete separation, remains in solution for several days.

3. The iron soap, while giving a permanent solution of steadily increasing weight (due to oxidation), is an excellent drier on the application of slight heat.

4. The manganese soap is unique in its drying properties.

As thus far conducted, the foregoing investigation discloses the following facts:

1. The percentage of separation of the metallic soaps of linseed oil from their solutions in the hydrocarbon solvents is vari-

[1] The percentage of dissolved matter was so small in the cases of barium and calcium that the investigation was dropped at the expiration of twenty-four hours.

RÉSUMÉ OF ACTION OF PETROLEUM SOLVENTS ON METALLIC SOAPS OF LINSEED OIL.

		Character of soap.	Residue from evaporation.	Boiling-point of most active solvent.	Permanence of solution.
I	Lead	White; granular; oxidizes to yellow.	Colorless; hard lacquer.	35°–55°.	Nearly complete separation in 1 hour.
II	Mercury	White; curdy.	Soft; colorless.	74°.	Gain in weight all solvents.
	Copper	Pale green; curdy; oxidizes to deep green.	Bright green lacquer; rather soft.	55°–75°.	Gain in weight all solvents; nearly constant after 24 hours.
III	Tin.....	Yellow-white; scanty; granular to slimy.	Oily smear.	74°.	Nearly constant weight.
	Antimony ...	Yellow-white; plentiful; soft; granular.	Oily smear.	62°.	Nearly constant weight.
IV	Iron.....	Gray-green; oxidizes to red-brown very quickly.	Mahogany lacquer; rather soft.	35°–55°.	Maximum at 24 hours; loss slight.
	Chromium ..	Purplish gray; oxidizes to purplish green.	Bright green lacquer; quite hard.	59°.	Slight loss after 24 hours.
	Aluminum ..	White; granular; oxidizes to yellow.	Hard colorless lacquer.	55°–75°.	Gain in weight all solvents.
V	Nickel	Apple-green; granular.	Pale green lacquer.	35°–55°.	Permanent several days; then nearly complete separation.
	Cobalt.....	Purplish red; granular.	Soft; reddish.	62° (sol'n slight.)	Sol'n and sep'n slight.
	Manganese ..	Brownish; curdy; rapidly oxidizes to dark brown.	Brown lacquer; hard.	35°–55°.	Maximum at 24 hours; partial sep'n at 48 hours.
	Zinc.....	White; curdy.	Oily smear.	75°–85°.	Uniform after 24 hours.
VI	Barium	White; curdy.	Oily smear.	Very slight solubility.	
	Calcium	White; curdy.	Oily smear.	Very slight solubility.	

able, differing with the nature of the solvent and the character of the linoleate.

2. Each metallic soap affords a maximum percentage of solubility in some special hydrocarbon and, therefore, no one hydrocarbon solvent can be commended for all metals.

3. The time at which the maximum separation takes place is also variable, differing with the metal employed.

It is, therefore, evident that a knowledge of the behavior of each soap with the different solvents is essential to the general analysis of driers and it is with the hope of contributing to this knowledge that the present paper is submitted.

ON THE DECOMPOSITION OF SODIUM NITRATE BY SULPHURIC ACID. PART III.

BY C. W. VOLNEY.

Received November 11, 1901.

FROM results of previously reported work, the author concluded[1] that the action of sulphuric acid on sodium nitrate takes place in two distinct phases, expressed by :

$$2NaNO_3 + 2H_2SO_4 = NaNO_3 + NaH_32SO_4 + HNO_3 \cdots\cdots I$$
$$NaH_32SO_4 + NaNO_3 = 2NaHSO_4 + HNO_3 \cdots\cdots\cdots\cdots II$$

and that these two phases of the process are marked by distinctly different temperatures.

To obtain direct evidence for these conclusions, I have extended the experimental part of the investigation by producing in the retorts for distillation the exact condition for each phase, by using the materials, as represented therein.

For the first phase, 85 grams of dry sodium nitrate with 200 grams of concentrated sulphuric acid were subjected to distillation, according to I. The distillation was carried out in the manner and apparatus already described, which gave observations for the temperatures of applied heat, the retort contents and distilling acid.

In the following are given the results of this distillation, as they were observed :

[1] This Journal, **23**, 490.