The Drying Rates of Raw Paint Oils: A Comparison

by Frank Peterson Brock

1913

Submitted to the Graduate School of the University of Kansas in partial fulfillment of the requirements for the Degree of Master of Science

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F. P. BROCK

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PREFACE.

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The investigations, which were made in order to prepare this article, were suggested by and carried out under the direction of Dr. L. V. Redman.

The author wishes to acknowledge his indebtedness to Dr. Redman and to Mr. A. J. Weith for suggestions and assistance, and to the companies who so geneously furnished samples of oils.

Frank P. Brock

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THE DRYING RATES OF RAW PAINT OILS - A COMPARISON.

OBJECT OF RESEARCH

The object of this research is to compare the relative drying qualities of a series of oils used in the paint and varnish industry. Some of these oils, such as soya bean and fish oil, have been introduced in large quantities to the trade comparatively recently.

The oils used in this research are linseed, fish, soya, bean and chinawood. Considerable work has been done upon the drying of linseed oil, and very recently investigations have been made upon suitable driers for fish, soya bean and chinawood oil, but not to the knowledge of the author has any comparison been made of the drying phenomena of these oils in the raw state, i. e. without driers.

The results of some of the more important investigations upon the drying phenomena of linseed and chinawood oils are given below.

HISTORICAL

Lippert[1] has found that raw linseed oil, when spread in thin films upon sheet iron, " increases in weight slowly for three

1. Jour. Franklin Institute, 1899, August, 156.

days, more quickly on the fourth and becomes dry on the seventh. The total gain in weight is found to agree with that of Mulder, namely 12.4%. " The note fails to state whether driers were added, but from what follows it is probable that no drier had been added, since the abstract states, " Linseed oil, strongly boiled without driers, dries more slowly than raw oil, and is more difficult to manipulate owing to its great viscosity, but eventually it absorbs within 2% of the oxygen taken up by the raw product. "

Olsen and Ratner[2] found that linseed oil increased in weight 18.05% when exposed in a thin film upon glass wool, in a stream of purified air passing at the rate of 15 liters a day for seventy-four days. They also collected the water and carbon dioxide and volatile organic matter given up by the oil, and found that 14.55% of water and 5.21% of carbon dioxide was given off. This makes the total oxygen absorbed by the oil amount to 37.80%. This was probably raw linseed oil without driers, but the article does not state.

Sabin[3] found that raw linseed oil without driers increased in weight to a maximum (16-18%) in seven days, which according to Lippert is when his linseed oil became dry, showing that setting up begins at or after

2. Jour. Soc. Chem. Ind., 1912, 31, 937.
3. Jour. Ind. & Eng. Chem., 1911, 3, 84-86.

the maximum increase in weight is reached. Sabin states the oil did not set up until after this point was reached.

Orloff[4] found that linseed oil increases in weight 15-16 percent with initial setting up at 12% when the oil is spread out into films, weighing 0.1 to 0.15 grams over an area of 108 square centimeters.

Geuther[5] finds that linseed oil will absorb 23% oxygen at room temperature in the dark, 34.7% at 95° in light of Uviol-lamp and that the volatile products formed run as high as 15%. According to the results of other investigators, this is too high unless we subtract the percentage of volatile products given, which would make the gain in weight 8% in the dark and 19.7% in the Uviol light.

We may conclude from these investigations that linseed oil increases in weight from 8% to 18% in the absorption of oxygen; that the maximum increase is reached about the seventh day; that setting up takes place at about the time the maximum increase in weight is reached and that the volatile products given off, consisting mostly of water and carbon dioxide, amount to about 15 to 20 percent. Our linseed oil No. 1 falls readily into this class (See curves).

Meister[6] finds that chinawood oil is slower than linseed oil in absorbing oxygen and " although a skin

4. Chem. Soc. Abstr., 1912, i, 158.
5. Chem. Abstr., 1907, 1, 912.
6. Jour. Soc. Chem. Ind. 1911, 30, 95

Plate I.

Plate II.

Oil-Drying Machine.

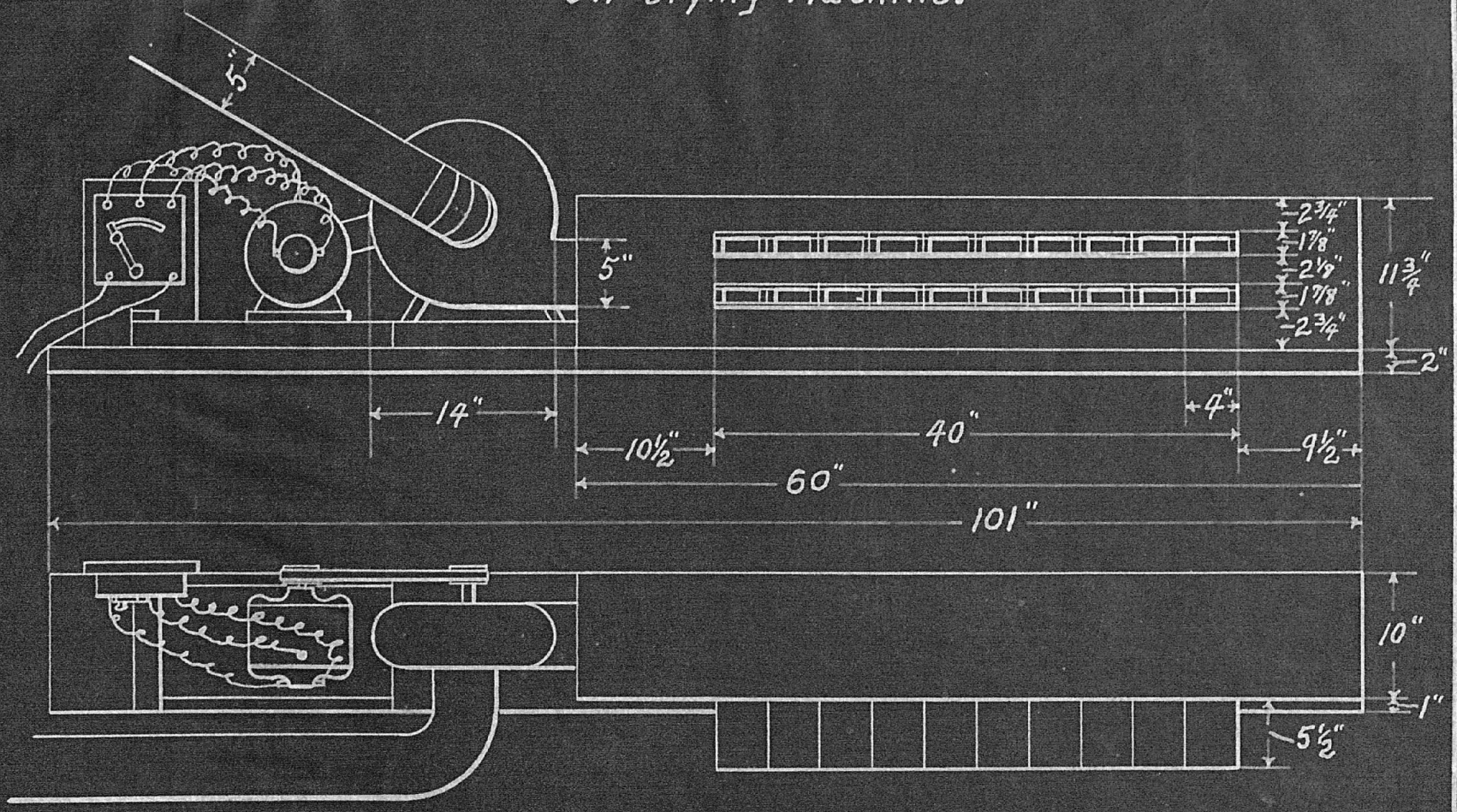


Figure 1.

is formed upon raw tung oil within one or two days, it is soft and non-elastic, and not until after five or six days does it become firm like linoxyn.* (See our curves for time and amount of maximum increase in weight).

We have been unable to find any literature upon the drying of fish and soya bean oils. These two oils have only been recently introduced into the paint industry which probably accounts for the lack of information concerning these oils.

Before taking up the description of the oils we used, we will describe the drying machine.

DRYING MACHINE: The apparatus for drying (Plates 1 and 2, Figures 1 and 2) consisted of a motor, Sturtevant pressure blower, and a main equalizing chamber fitted on the side with twenty small shelf boxes for holding individual plates. The motive power was supplied from the power circuit during the day time and a storage battery at night. The fan was belted to the motor.

Fresh air was brought in from the outside through a 5-inch galvanized pipe in which were placed at two-foot intervals three cheese cloth filters for removing insects, dust, etc. Each filter consisted of three layers of cheese cloth. The open ends of the individual boxes were covered with two thicknesses of cheese cloth to prevent the entrance of insects. Plate I shows the arrange-

ment of this curtain.

The equalizing chamber and individual boxes were constructed of white pine. Figure I gives the dimensions of the equalizing chamber and Figure 2 the dimensions of the individual drying boxes. The interior of the apparatus was coated with melted paraffine and by this means was made air tight, dust and water-proof.

The individual drying boxes were glued into slots cut into the side of the equalizing chamber in such a manner that the oil plates were perfectly level and consequently the oil remained distributed in a uniform film over the plate, with no tendency to flow in any direction.

The air was admitted from the equalizing chamber into the individual drying boxes through a slot (2 1/2 inches by 1/8 inch, See Figure 2).

Care was taken to place the slot midway between the top of the box and the plate; the drying box was 1 inch wider than the plate which prevented eddy currents on the side and allowed the ready removal of the plates for weighing.

The velocity of the air current in the individual boxes was approximately ten miles an hour. This gave an amount of oxygen greatly in excess (7,000,000 times more oxygen than the total absorbed by the oil) of that required for the oxidation of the oils.

Any precautions taken to prevent eddy currents were probably unnecessary since the oxygen is so greatly in

excess of that absorbed by the oil.

LIGHT

The machine was placed in a room where only diffused light entered through drawn yellow window blinds. Very little light entered the drying boxes since the openings were covered by two layers of cheese cloth, in the form of a curtain. Thus the drying during the day was carried out in a dim diffused light.

WEIGHING THE PLATES

The plates were weighed every morning on a balance, sensitive to 1/10 of a milligram.

The plates were removed from the drying boxes and weighed immediately without the use of a dessicator.

The weighings were carried out by removing the supporting tins (D Figure 2) from the boxes, lifting one edge of the glass plate (E Figure 2) with a knife point and inserting underneath a rubber covered two-pronged wire fork (Plate I), by which means it could be lifted and transferred directly to the balance without coming in contact with the hands.

After weighing, the plate was immediately returned to the drying box without touching with the hands.

OILS

The samples of oils used in this research were obtained through the kindness of The American Linseed Company, Chicago; The Chicago Varnish Company, Chicago; L. C. Gillespie & Sons, New York; A. Klipstein & Company, New York, Marden, Orth & Hastings

Chicago; Alden S. Swan & Company, New York; and Frank L. Young & Kimball, Boston.

These samples of oils were recommended to us by these companies, as pure+unadulterated. The constants of these oils determined by us were in close agreement with the constants furnished by the companies' laboratories.

The oils, and companies furnishing them, are as follows:

1. The American Linseed Company, Chicago, Illinois. Linseed Oils, Nos. 1 and 2.

2. The Chicago Varnish Company, Chicago, Illinois. Menhaden Fish Oil, No. 3.

3. Frank L. Young and Kimball, Boston, Massachusetts. Fish Oils, Nos. 4, 5 and 6.

4. Marden, Orth & Hastings, Chicago, Illinois. Soya Bean Oil, No. 7.

5. L. C. Gillespie & Sons, New York, N. Y. Soya Bean Oil, No. 8 and Chinawood Oil, No. 9.

6. A. Klipstein & Company, New York, N. Y. Chinawood Oil, No. 10.

HISTORY OF OILS

Nos. 1 and 2, Linseed Oil - The oils were obtained from the same seed; No. 1 by the cold naphtha process and No. 2 by the hydraulic pressure system. The seed was grown in Southern Minnesota and yielded 35,86% oil and 9.15% moisture. The oil content of the seed was below

normal because of the extreme weather conditions.

No. 3, Menhaden Fish Oil - No history was furnished.

Nos. 4, 5 and 6 - Fish Oils. Sample 4 was winter-pressed fish oil which had been chilled, and grained after which the stearin was pressed out. Sample 5 was white Menhaden fish oil which had been put through the same process as Sample 4, then bleached and repressed after bleaching. Sample 6 was bleached fish oil which had been chilled, grained, settled, pressed and bleached.

No. 7, Soya Bean Oil - The sample is English soya bean oil which has been extracted from the beans by either the ether, naphtha or cold pressed process.

No. 8, Soya Bean Oil - The oil was produced by the cold process at Hankow.

No. 9. Chinawood Oil - This oil was obtained by the cold process at Hankow from chinawood nuts.

No. 10. Chinawood Oil is the average Hankow variety.

The following is a table of constants for the oils used in this investigation which agree closely with the constants given for pure oils. Values from Lewkowitsch have been inserted for comparison of our oils with the average. Both maximum and minimum values are given wherever obtainable.

Table of Constants of Oils.

Number.	Name.	Specific Gravity.	Refractive Index. 20°	Saponification Value.	Acid No.	Iodine. No.	Ash. per-cent.	Specific Temperature Reaction.	Unsaponifiable. Matter. percent.
1	Linseed	0.927	1.4813	193.3	6.17	182.5	0.05	251	0.83
2	Linseed	0.929	1.4813	193.6	1.81	187.0	0.15	235	0.71
Lewkowitsch-Linseed		Max.-0.929 Min.-0.881	1.4812	192.5 190.0	7.2 1.3	205.4 160.0		349 313	1.1 0.65
3	Fish Oil	0.924	1.4785	195.0	46.34*	165.0	trace.	343	1.04
4	Fish Oil	0.927	1.4806	192.5	13.85	186.0	0.05	365	0.69
5	Fish Oil	0.925	1.4800	190.6	7.35	172.5	none.	359	0.57
6	Fish Oil	0.925	1.4804	189.6	10.18	180.5	0.01	369	0.57
Lewkowitsch-Fish Oil		Max.-0.933 Min.-0.927		193.0 188.7		172.6 139.2		306	1.60 0.61
7	Soya Bean	0.924	1.4753	193.9	3.15	133.5	0.09	249	0.96
8	Soya Bean	0.926	1.4753	194.9	1.62	134.5	0.04		0.60
Lewkowitsch-Soya Bean		Max.-0.927 Min.-0.924		192.9 190.6	2.28	124.0 121.3			0.22
9	Chinawood	0.942	1.5200	194.5	1.54	164.0	0.01		1.60
10	Chinawood	0.938	1.5160	194.7	8.83	168.0	0.03	372	0.33
Lewkowitsch-Chinawood		Max.-0.9418 Min.-0.933	1.503	211.0 172.0	6.00 4.00	165.7 149.7			0.5

* 1.01 % Free mineral acid value.

TABLES OF EXPERIMENTAL DATA.

1 - 10

The first five columns are the original data and the remainder are calculated from these.

No.1. Linseed Oil.

Weight of glass plate No.1 = 32.1755. Weight of glass plate No.2.= 39.5920.

No. of Days	Date.	Time.	No.1. Wt.of oil + plate grams.	No.2. Wt.of oil + plate grams.	No.1. Differ--ence. grams.	No.2. Differ--ence. grams.	No.1. Differ-ence. percent	No.2. Differ--ence. percent	Average Differ--ence. percent	Daily Variati-on. percent
1	7/17/12	3:40 P.M.	32.2911	39.6837	0.1156*	0.0917*				
2	7/18/12	6:00 A.M.	32.2911	39.6842	0.0000	+0.0005	0.0	+0.5	+0.2	+0.2
	7/18/12	7:25 P.M.	32.2927	39.6863	+0.0016	+0.0026	+1.4	+2.8	+2.1	+1.9
3	7/19/12	6:25 A.M.	32.2937	39.6877	+0.0026	+0.0040	+2.2	+4.4	+3.3	+1.2
4	7/20/12	8:25 A.M.	32.2980	39.6900	+0.0069	+0.0063	+6.3	+6.9	+6.8	+3.5
5	7/21/12	9:50 A.M.	32.3033	39.6922	+0.0122	+0.0035	+10.6	+9.3	+9.9	+3.1
6	7/22/12	9:45 A.M.	32.3043	39.6941	+0.0132	+0.0104	+11.4	+11.4	+11.4	+1.5
7	7/23/12	8:40 A.M.	32.3035	39.6954	+0.0124	+0.0117	+10.7	+12.8	+11.7	+0.3
8	7/24/12	8:35 A.M.	32.3033	39.6950	+0.0122	+0.0112	+10.6	+12.3	+11.4	-0.3
9	7/25/12	8:50 A.M.	32.3033	39.6951	+0.0122	+0.0114	+10.6	+12.4	+11.5	+0.1
10	7/26/12	8:25 A.M.	32.3028	39.6945	+0.0117	+0.0108	+10.1	+11.8	+10.9	-0.6
11	7/27/12	8:45 A.M.	32.3022	39.6939	+0.0111	+0.0102	+9.5	+11.2	+10.3	-0.6
12	7/28/12	9:30 A.M.	32.3018	39.6935	+0.0107	+0.0098	+9.3	+10.7	+10.0	-0.3
13	7/29/12	9:10 A.M.	32.3009	39.6925	+0.0098	+0.0088	+8.5	+9.6	+9.0	-1.0
14	7/30/12	8:50 A.M.	32.3009	39.6920	+0.0098	+0.0083	+8.5	+9.0	+8.7	-0.3
15	7/31/12	8:06 A.M.	32.3006	39.6920	+0.0095	+0.0083	+8.2	+9.0	+8.6	-0.1
16	8/ 1/12	8:45 A.M.	32.3006	39.6917	+0.0095	+0.0080	+8.2	+8.7	+8.4	-0.2
17	8/ 2/12	8:40 A.M.	32.3003	39.6915	+0.0092	+0.0078	+8.0	+8.5	+8.2	-0.2
18	8/ 3/12	8:35 A.M.	32.3003	39.6914	+0.0092	+0.0077	+8.0	+8.4	+8.2	0.0
19	8/ 5/12	8:30 A.M.	32.3000	39.6914	+0.0089	+0.0077	+7.7	+8.4	+8.0	-0.2
20	8/ 6/12	8:45 A.M.	32.3005	39.6918	+0.0094	+0.0081	+8.1	+8.8	+8.4	+0.4

* these are the weights of the oil films.

No.2. Linseed Oil.

Weight of glass plate No.3 = 28.5811. Weight of glass plate No.4.= 39.5920.

No. of Days	Date	Time.	No.3. Wt.of oil + plate. grams.	No.4. Wt.of oil + plate. grams.	No.3. Differ-ence. grams.	No.4. Differ-ence. grams.	No.3. Differ-ence. percent	No.4. Differ-ence. percent	Average Differ-ence. percent	Daily Variat-ion. percent
1	7/17/12	4:10 P.M.	28.7192	39.0767	0.1381#	0.1771#				
2	7/18/12	6:10 A.M.	28.7198	39.0769	+0.0006	+0.0002	+0.4	+0.1	+0.2	+0.2
	7/18/12	7:30 P.M.	28.7198	39.0771	+0.0006	+0.0004	+0.4	+0.2	+0.3	+0.1
3	7/19/12	6:25 A.M.	28.7200	39.0771	+0.0008	+0.0004	+0.6	+0.2	+0.3	0.0
4	7/20/12	8:30 A.M.	28.7193	39.0740*	+0.0001	+0.0004		+0.2		
5	7/21/12	9:55 A.M.	28.7199	39.0727	+0.0007	+0.0012	+0.5	+0.7	+0.6	+0.3
6	7/22/12	9:45 A.M.	28.7220	39.0703	+0.0028	+0.0028	+2.0	+1.6	+1.8	+1.2
7	7/23/12	8:45 A.M.	28.7255*	39.0725	+0.0063	+0.0050	+4.6	+2.8	+3.7	+1.9
8	7/24/12	8:35 A.M.	28.7269	39.0703	+0.0077	+0.0067	+5.6	+3.8	+4.7	+1.0
9	7/25/12	8:55 A.M.	28.7280	39.0746	+0.0088	+0.0110	+6.4	+6.2	+6.3	+1.6
10	7/26/12	8:30 A.M.	28.7288	39.0777	+0.0096	+0.0141	+7.0	+8.0	+7.5	+1.2
11	7/27/12	8:50 A.M.	28.7295	39.0785	+0.0103	+0.0149	+7.5	+8.4	+7.9	+0.4
12	7/28/12	9:40 A.M.	28.7310	39.0785	+0.0118	+0.0149	+8.5	+8.4	+8.4	+0.5
13	7/29/12	9:15 A.M.	28.7302	39.0774	+0.0110	+0.0138	+8.0	+7.8	+7.9	-0.5
14	7/30/12	8:20 A.M.	28.7303	39.0776	+0.0111	+0.0140	+8.0	+7.9	+7.9	0.0
15	7/31/12	8:25 A.M.	28.7295	39.0769	+0.0102	+0.0133	+7.5	+7.5	+7.5	-0.4
16	8/ 1/12	8:50 A.M.	28.7293	39.0765	+0.0101	+0.0129	+7.4	+7.3	+7.3	-0.2
17	8/ 2/12	8:40 A.M.	28.7289	39.0760	+0.0097	+0.0124	+7.0	+7.0	+7.0	-0.3
18	8/ 3/12	8:40 A.M.	28.7289	39.0760	+0.0097	+0.0124	+7.0	+7.0	+7.0	0.0
19	8/ 5/12	8:30 A.M.	28.7285	39.0756	+0.0093	+0.0120	+6.7	+6.8	+6.7	-0.3
20	8/ 6/12	8:45 A.M.	28.7290	39.0760	+0.0098	+0.0124	+7.0	+7.0	+7.0	+0.3

*some of the oil ran off of the plate. #these are the weights of the oil films.

No.3. Menhaden Fish Oil.

Weight of glass plate No.5.= 39.0740. Weight of glass plate No.6.= 30.9161.

No. of Days.	Date.	Time.	No.5. Wt.of oil + plate. grams.	No.6. Wt.of oil + plate. grams.	No.5. Differ-ence. grams.	No.6. Differ-ence. grams.	No.5. Differ-ence. percent.	No.6. Differ-ence. percent	Average Differ-ence. percent	Daily Variat-ion. percent
1	7/17/12	4:25 P.M.	39.2121	31.1028	0.1381*	0.1867*				
2	7/18/12	6:15 A.M.	39.2217	31.1143	+0.0096	+0.0015	+6.8	+6.2	+6.5	+6.5
	7/18/12	7:35 P.M.	39.2247	31.1203	+0.0126	+0.0175	+9.1	+9.4	+9.2	+2.7
3	7/19/12	6:30 A.M.	39.2257	31.1213	+0.0136	+0.0185	+9.9	+9.9	+9.9	+0.7
4	7/20/12	8:38 A.M.	39.2276	31.1237	+0.0155	+0.0209	+11.2	+11.2	+11.2	+1.3
5	7/21/12	10:05 A.M.	39.2276	31.1239	+0.0155	+0.0211	+11.2	+11.3	+11.2	0.0
6	7/22/12	9:50 A.M.	39.2270	31.1230	+0.0149	+0.0202	+10.8	+10.8	+10.8	-0.4
7	7/23/12	8:50 A.M.	39.2257	31.1212	+0.0136	+0.0184	+9.9	+9.9	+9.9	-0.9
8	7/24/12	8:40 A.M.	39.2250	31.1203	+0.0129	+0.0175	+9.3	+9.4	+9.3	-0.6
9	7/25/12	9:00 A.M.	39.2264	31.1218	+0.0143	+0.0190	+10.4	+10.2	+10.3	+1.0
10	7/26/12	8:40 A.M.	39.2262	31.1218	+0.0141	+0.0190	+10.2	+10.2	+10.2	-0.1
11	7/27/12	8:55 A.M.	39.2257	31.1210	+0.0136	+0.0182	+9.9	+9.8	+9.8	-0.4
12	7/28/12	9:50 A.M.	39.2252	31.1203	+0.0131	+0.0175	+9.5	+9.4	+9.4	-0.4
13	7/29/12	9:20 A.M.	39.2235	31.1179	+0.0114	+0.0151	+8.3	+8.1	+8.2	-1.2
14	7/30/12	8:25 A.M.	39.2239	31.1184	+0.0118	+0.0156	+8.5	+8.4	+8.4	+0.2
15	7/31/12	8:30 A.M.	39.2233	31.1178	+0.0112	+0.0150	+8.1	+8.0	+8.0	-0.4
16	8/ 1/12	8:55 A.M.	39.2232	31.1178	+0.0111	+0.0150	+8.0	+8.0	+8.0	0.0
17	8/ 2/12	8:45 A.M.	39.2227	31.1169	+0.0106	+0.0141	+7.7	+7.6	+7.6	-0.4
18	8/ 3/12	8:40 A.M.	39.2232	31.1174	+0.0111	+0.0146	+8.0	+7.8	+7.9	-0.3
19	8/ 5/12	8:35 A.M.	39.2228	31.1172	+0.0107	+0.0144	+7.7	+7.7	+7.7	-0.2
20	8/ 6/12	8:50 A.M.	39.2235	31.1180	+0.0114	+0.0152	+8.3	+8.1	+8.2	+0.5

*these are the weights of the oil films.

No.4. Menhaden Fish Oil.

Weight of glass plate No.7 = 35.6184. Weight of glass plate No.8 = 35.9154.

No. of Days.	Date.	Time.	No.7. Wt. of oil + plate. grams.	No.8. Wt. of oil + plate. grams.	No.7. Differ-ence. grams.	No.8. Differ-ence. grams.	No.7. Differ-ence. percent	No.8. Differ-ence. percent	Average Differ-ence. percent	Daily Variat-ion. percent
1	7/17/12	4:45 P.M.	35.7805	36.0725	0.1621#	0.1571#				
2	7/18/12	6:20 A.M.	35.7908	36.0840	+0.0103	+0.0115	+6.4	+7.3	+6.8	+6.8
	7/18/12	7:40 P.M.	35.7982	36.0915	+0.0177	+0.0190	+10.9	+12.1	+11.5	+4.7
3	7/19/12	6:35 A.M.	35.8000	36.0924	+0.0195	+0.0199	+12.0	+12.7	+12.3	+0.8
4	7/20/12	8:45 A.M.	35.8020	36.0937	+0.0215	+0.0212	+13.3	+13.5	+13.4	+1.1
5	7/21/12	10:10 A.M.	35.8022	36.0938	+0.0217	+0.0213	+13.4	+13.5	+13.4	0.0
6	7/22/12	9:55 A.M.	35.8015	36.0932	+0.0210	+0.0207	+13.0	+13.2	+13.1	-0.3
7	7/23/12	8:55 A.M.	35.8000	36.0916	+0.0195	+0.0191	+12.0	+12.2	+12.1	-1.0
8	7/24/12	8:45 A.M.	35.7992	36.0906	+0.0187	+0.0181	+11.5	+11.5	+11.5	-0.6
9	7/25/12	9:05 A.M.	35.8007	36.0924	+0.0202	+0.0199	+12.5	+12.7	+12.6	+1.1
10	7/26/12	8:40 A.M.	35.8002	36.0918	+0.0197	+0.0193	+12.2	+12.3	+12.2	-0.4
11	7/27/12	9:00 A.M.	35.7995	36.0911	+0.0190	+0.0186	+11.7	+11.8	+11.7	-0.5
12	7/28/12	9:55 A.M.	35.7992	36.0908	+0.0187	+0.0183	+11.5	+11.6	+11.5	-0.2
13	7/29/12	9:25 A.M.	35.7972	36.0886	+0.0167	+0.0161	+10.3	+10.2	+10.2	-1.3
14	7/30/12	8:30 A.M.	35.7982	36.0891	+0.0167	+0.0166	+10.3	+10.6	+10.4	+0.2
15	7/31/12	8:35 A.M.	35.7968	36.0885	+0.0163	+0.0160	+10.0	+10.2	+10.1	-0.3
16	8/ 1/12	8:55 A.M.	35.7969	36.0885	+0.0164	+0.0160	+10.1	+10.2	+10.1	0.0
17	8/ 2/12	8:50 A.M.	35.7963	36.0880	+0.0158	+0.0155	+9.7	+9.9	+9.8	-0.3
18	8/ 3/12	8:45 A.M.	35.7968	36.0883	+0.0163	+0.0158	+10.0	+10.1	+10.0	+0.2
19	8/ 5/12	8:40 A.M.	35.7967	36.0882	+0.0162	+0.0157	+10.0	+10.0	+10.0	0.0
20	8/6 /12	8:55 A.M.	35.7975	36.0890	+0.0170	+0.0165	+10.5	+10.5	+10.5	+0.5

these are the weights of the oil films.

No.5. Menhaden Fish Oil.

Weight of glass plate No.9.= 37.4158. Weight of glass plate No.10.= 35.3952.

No. of Days.	Date.	Time.	No.9. Wt. of oil + plate. grams.	No.10. Wt. of oil + plate. grams.	No.9. Differ-ence. grams.	No.10. Differ-ence. grams.	No.9. Differ-ence. percent	No.10. Differ-ence. percent	Average Differ-ence. percent	Daily Variat-ion. percent
1	7/17/12	5:00 P.M.	37.5882	35.5852	0.1724#	0.1900#				
2	7/18/12	6:25 A.M.	37.6003	35.5995	+0.0121	+0.0143	+7.0	+7.5	+7.2	+7.2
	7/18/12	7:45 P.M.	37.6075	35.6076	+0.0193	+0.0224	+11.2	+11.8	+11.5	+4.3
3	7/19/12	6:40 A.M.	37.6085	35.6085	+0.0203	+0.0233	+11.8	+12.3	+12.0	+0.5
4	7/20/12	8:50 A.M.	37.6104	35.6101	+0.0222	+0.0249	+12.9	+13.1	+13.0	+1.0
5	7/21/12	10:10 A.M.	37.6104	35.6097	+0.0222	+0.0245	+12.9	+12.8	+12.8	-0.2
6	7/22/12	10:00 A.M.	37.6100	35.6090	+0.0218	+0.0238	+12.6	+12.5	+12.5	-0.3
7	7/23/12	8:55 A.M.	37.6086	35.6073	+0.0204	+0.0221	+11.8	+11.6	+11.7	-0.8
8	7/24/12	8:50 A.M.	37.6076	35.6062	+0.0194	+0.0210	+11.3	+11.0	+11.1	-0.6
9	7/25/12	9:10 A.M.	37.6092	35.6080	+0.0210	+0.0228	+12.2	+12.0	+12.1	+1.0
10	7/26/12	9:45 A.M.	37.6085	35.6071	+0.0203	+0.0219	+11.8	+11.5	+11.6	-0.5
11	7/27/12	9:05 A.M.	37.6081	35.6064	+0.0199	+0.0212	+11.6	+11.2	+11.4	-0.2
12	7/28/12	10:00 A.M.	37.6077	35.6064	+0.0195	+0.0212	+11.3	+11.2	+11.2	-0.2
13	7/29/12	9:30 A.M.	37.6058	35.6042	+0.0173	+0.0190	+10.0	+10.0	+10.0	-1.2
14	7/30/12	8:30 A.M.	37.6060	35.6044	+0.0178	+0.0192	+10.3	+10.1	+10.2	+0.2
15	7/31/12	8:40 A.M.	37.6055	35.6037	+0.0173	+0.0185	+10.0	+9.7	+9.8	-0.4
16	8/ 1/12	9:00 A.M.	37.6055	35.6037	+0.0173	+0.0185	+10.0	+9.7	+9.8	0.0
17	8/ 2/12	8:55 A.M.	37 6051	35.6031	+0.0169	+0.0179	+9.8	+9.4	+9.6	-0.2
18	8/ 3/12	8:50 A.M.	37.6051	35.6035	+0.0169	+0.0183	+9.8	+9.6	+9.7	+0.1
19	8/ 5/12	8:45 A.M.	37.6052	35.6034	+0.0170	+0.0182	+9.9	+9.6	+9.7	0.0
20	8/ 6/12	9:00 A.M.	37.6060	35.6044	+0.0178	+0.0192	+10.3	+10.1	+10.2	+0.5

#these are the weights of the oil films.

No.6. Menhaden Fish Oil.

Weight of glass plate No.11 = 37.8370. Weight of glass plate No.12 = 37.7518.

No. of Days.	Date.	Time.	No.11. Wt.of oil + plate. grams.	No.12. Wt.of oil + plate. grams.	No.11. Differ-ence. grams.	No.12. Differ-ence. grams.	No.11. Differ-ence. percent	No.12. Differ-ence. percent	Average Differ-ence. percent	Daily Variat-ion. percent
1	7/17/12	5:25 P.M.	38.0172	37.9002	0.1302*	0.1484*				
2	7/18/12	6:30 A.M.	38.0294	37.9103	+0.0122	+0.0101	+9.4	+6.8	+8.1	+8.1
	7/18/12	7:50 P.M.	38.0340	37.9163	+0.0168	+0.0161	+12.9	+10.8	+11.8	+3.7
3	7/19/12	6:45 A.M.	38.0340	37.9170	+0.0168	+0.0168	+12.9	+11.3	+12.1	+0.3
4	7/20/12	8:55 A.M.	38.0345	37.9178	+0.0173	+0.0176	+13.3	+11.8	+12.5	+0.4
5	7/21/12	10:15 A.M.	38.0342	37.9190	+0.0170	+0.0188	+13.0	+12.7	+12.8	+0.3
6	7/22/12	10:05 A.M.	38.0335	37.9184	+0.0163	+0.0182	+12.5	+12.2	+12.3	-0.5
7	7/23/12	9:00 A.M.	38.0322	37.9174	+0.0150	+0.0172	+11.5	+11.6	+11.5	-0.8
8	7/24/12	8:55 A.M.	38.0315	37.9163	+0.0143	+0.0166	+11.0	+11.2	+11.1	-0.4
9	7/25/12	9:15 A.M.	38.0332	37.9182	+0.0160	+0.0180	+12.3	+12.1	+12.2	+1.1
10	7/26/12	8:50 A.M.	38.0325	37.9179	+0.0153	+0.0177	+11.8	+11.9	+11.8	-0.4
11	7/27/12	9:10 A.M.	38.0318	37.9171	+0.0146	+0.0169	+11.2	+11.4	+11.3	-0.5
12	7/28/12	10:00 A.M.	38.0316	37.9170	+0.0144	+0.0168	+11.0	+11.3	+11.1	-0.2
13	7/29/12	9:35 A.M.	38.0300	37.9153	+0.0128	+0.0151	+9.8	+10.2	+10.0	-1.1
14	7/30/12	8:35 A.M.	38.0300	37.9153	+0.0128	+0.0151	+9.8	+10.2	+10.0	0.0
15	7/31/12	8:45 A.M.	38.0297	37.9249	+0.025	+0.0147	+9.6	+9.9	+9.7	-0.3
16	8/ 1/12	9:05 A.M.	38.0297	37.9150	+0.0125	+0.0148	+9.6	+10.0	+9.8	+0.1
17	8/ 2/12	9:00 A.M.	38.0295	37.9148	+0.0123	+0.0146	+9.4	+9.8	+9.6	-0.2
18	8/ 3/12	8:55 A.M.	38.0295	37.9149	+0.0123	+0.0147	+9.4	+9.9	+9.6	0.0
19	8/ 5/12	8:45 A.M.	38.0295	37.9148	+0.0123	+0.0146	+9.4	+9.8	+9.6	0.0
20	8/ 6/12	9:05 A.M.	38.0303	37.9155	+0.0131	+0.0153	+10.0	+10.3	+10.1	+0.5

*these are the weights of the oil films.

No.7. Soya Bean Oil.

Weight of glass plate No.13 = 23.7506. Weight of glass plate No.14 = 32.6270.

No. of Days.	Date.	Time.	No.13. Wt.of oil + plate. grams.	No.14. Wt.of oil + plate. grams.	No.13. Differ-ence. grams.	No.14. Differ-ence. grams.	No.13. Differ-ence. percent	No.14. Differ-ence. percent	Average Differ-ence. percent	Daily Variat-ion. percent
1	7/17/12	5:45 P.M.	28.8591	32.6975	0.1085*	0.0705*				
2	7/18/12	6:35 A.M.	28.8584	32.6982	-0.0007	+0.0007	-0.6	+1.0	+0.2	+0.2
	7/18/12	7;55 P.M.	28.8580	32.6987	-0.0011	+0.0012	-1.0	+1.7	+0.3	+0.1
3	7/19/12	6:50 A.M.	28.8584	32.6987	-0.0007	+0.0012	-0.6	+1.7	+0.5	+0.2
4	7/20/12	8:59 A.M.	28.8593	32.7012	+0.0002	+0.0037	+0.2	+5.2	+2.7	+2.2
5	7/21/12	10:20 A.M.	28.8619	32.7032	+0.0028	+0.0057	+2.6	+8.1	+5.2	+2.6
6	7/22/12	10:10 A.M.	28.8638	32.7040	+0.0047	+0.0065	+4.3	+9.2	+6.7	+1.4
7	7/23/12	9:05 A.M.	28.8660	32.7039	+0.0069	+0.0064	+6.4	+9.1	+7.7	+1.0
8	7/24/12	8:55 A.M.	28.8662	32.7027	+0.0071	+0.0052	+6.5	+7.4	+6.9	-0.8
9	7/25/12	9:20 A.M.	28.8662	32.7028	+0.0071	+0.0053	+6.5	+7.5	+7.0	+0.1
10	7/26/12	8:55 A.M.	28.8653	32.7024	+0.0062	+0.0049	+5.7	+7.0	+6.3	-0.7
11	7/27/12	9:15 A.M.	28.8644	32.7014	+0.0053	+0.0039	+9.4	+5.5	+5.2	-1.1
12	7/28/12	10:10 A.M.	28.8637	32.7012	+0.0046	+0.0037	+4.2	+5.2	+4.7	-0.5
13	7/29/12	9:40 A.M.	28.8626	32.7004	+0.0035	+0.0029	+3.2	+4.1	+3.6	-1.1
14	7/30/12	8:40 A.M.	28.8626	32.7004	+0.0035	+0.0029	+3.2	+4.1	+3.6	0.0
15	7/31/12	8:50 A.M.	28.8620	32.7002	+0.0029	+0.0027	+2.7	+3.8	+3.2	-0.4
16	8/ 1/12	9:10 A.M.	28.8620	32.7002	+0.0029	+0.0027	+2.7	+3.8	+3.2	0.0
17	8/ 2/12	9:05 A.M.	28.8617	32.7007	+0.0026	+0.0027	+2.4	+3.8	+3.1	-0.1
18	8/ 3/12	9:00 A.M.	28.8617	32.7002	+0.0026	+0.0027	+2.4	+3.8	+3.1	0.0
19	8/ 5/12	8:50 A.M.	28.8611	32.7000	+0.0020	+0.0025	+1.8	+3.5	+2.6	-0.5
20	8/ 6/12	9:10 A.M.	28.8614	32.7002	+0.0023	+0.0027	+2.1	+3.8	+2.9	+0.3

*these are the weights of the oil films.

No.8. Soya Bean Oil.

Weight of glass plate No.15 = 36.9150. Weight of glass plate No.16 = 30.8427.

No. of Days.	Date.	Time.	No.15. Wt.of oil + plate. grams.	No.16. Wt.of oil + plate. grams.	No.15. Differ--ence. grams.	No.16. Differ--ence. grams.	No.15. Differ--ence. percent	No.16. Differ--ence. percent	Average Differ--ence. percent	Daily Variat--ion. percent
1	7/17/12	6:00 P.M.	37.0175	30.9475	0.1025#	0.1048#				
2	7/18/12	6:45 A.M.	37.0177	30.9479	+0.0002	+0.0004	+0.2	+0.4	+0.3	+0.3
	7/18/12	8:00 P.M.	37.0179	30.9479	+0.0004	+0.0004	+0.4	+0.4	+0.4	+0.1
3	7/19/12	6:55 A.M.	37.0176	30.9481	+0.0001	+0.0006	+0.1	+0.6	+0.3	-0.1
4	7/20/12	9:05 A.M.	37.0177	30.9477	+0.0002	+0.0002	+0.2	+0.2	+0.2	-0.1
5	7/21/12	10:30 A.M.	37.0182	30.9474	+0.0007	+0.0007	+0.7	+0.7	+0.7	+0.5
6	7/22/12	10:15 A.M.	37.0190	30.9453*	+0.0015	+0.0015	+1.5	+1.4	+1.4	+0.7
7	7/23/12	9:05 A.M.	37.0210	30.9470	+0.0035	+0.0032	+3.4	+3.0	+3.2	+1.8
8	7/24/12	9:00 A.M.	37.0214*	30.9479	+0.0039	+0.0041	+3.8	+3.9	+3.8	+0.6
9	7/25/12	9:20 A.M.	37.0220	30.9486	+0.0045	+0.0048	+4.4	+4.6	+4.5	+0.7
10	7/26/12	9:00 A.M.	37.0215	30.9486	+0.0040	+0.0048	+3.9	+4.6	+4.2	-0.3
11	7/27/12	9:20 A.M.	37.0205	30.9483	+0.0030	+0.0045	+2.9	+4.3	+3.6	-0.6
12	7/28/12	10:15 A.M.	37.0200	30.9479	+0.0025	+0.0041	+2.4	+3.9	+3.1	-0.5
13	7/29/12	9:45 A.M.	37.0187	30.9467	+0.0012	+0.0029	+1.2	+2.8	+2.0	-1.1
14	7/30/12	8:45 A.M.	37.0188	30.9464	+0.0013	+0.0026	+1.3	+2.5	+1.9	-0.1
15	7/31/12	8:55 A.M.	37.0182	30.9460	+0.0007	+0.0022	+0.7	+2.1	+1.4	-0.5
16	8/ 1/12	9:15 A.M.	37.0182	30.9457	+0.0007	+0.0019	+0.7	+1.8	+1.2	-0.2
17	8/ 2/12	9:10 A.M.	37.0179	30.9456	+0.0004	+0.0018	+0.4	+1.7	+1.0	-0.2
18	8/ 3/12	9:00 A.M.	37.0177	30.9452	+0.0002	+0.0014	+0.2	+1.3	+0.7	-0.3
19	8/ 5/12	8:55 A.M.	37.0174	30.9452	-0.0001	+0.0014	-0.1	+1.3	+0.6	-0.1
20	8/ 6/12	9:15 A.M.	37.0174	30.9452	-0.0001	+0.0014	-0.1	+1.3	+0.6	0.0

*some of the oil ran off of the plate. #these are the weights of the oil films.

No.9. Chinawood Oil.

Weight of glass plate No.17 = 36.5495. Weight of glass plate No.18 = 37.1460.

No. of Days.	Date.	Time.	No.17. Wt.of oil + plate. grams.	No.18. Wt.of oil + plate. grams.	No.17. Differ- -ence. grams.	No.18. Differ- -ence. grams.	No.17. Differ- -ence. percent	No.18. Differ- -ence. percent	Average Differ- -ence. percent	Daily Variat- -ion. percent
1	7/17/12	6:18 P.M.	36.7220	37.2870	0.1726*	0.1410*				
2	7/18/12	6;50 A.M.	36.7233	37.2877	+0.0013	+0.0007	+0.7	+0.0	+0.3	+0.3
	7/18/12	8:05 P.M.	36.7231	37.2877	+0.0011	+0.0007	+0.6	+0.0	+0.3	+0.0
3	7/19/12	7:00 A.M.	36.7231	37.2877	+0.0011	+0.0007	+0.6	+0.0	+0.3	+0.0
4	7/20/12	9:10 A.M.	36.7241	37.2895	+0.0021	+0.0025	+1.2	+1.8	+1.5	+1.2
5	7/21/12	10:35 A.M.	36.7282	37.2947	+0.0062	+0.0077	+3.6	+5.5	+4.5	+3.0
6	7/22/12	10:20 A.M.	36.7320	37.2972	+0.0100	+0.0102	+5.8	+7.2	+6.5	+2.0
7	7/23/12	9:10 A.M.	36.7343	37.2986	+0.0123	+0.0116	+7.1	+8.2	+7.6	+1.1
8	7/24/12	9:05 A.M.	36.7370	37.3003	+0.0150	+0.0133	+8.7	+9.4	+9.0	+1.4
9	7/25/12	9:25 A.M.	36.7393	37.3022	+0.0173	+0.0152	+10.0	+10.8	+10.4	+1.4
10	7/26/12	9:00 A.M.	36.7394	37.3020	+0.0174	+0.0150	+10.1	+10.6	+10.2	-0.1
11	7/27/12	9:25 A.M.	36.7391	37.3019	+0.0171	+0.0149	+10.0	+10.6	+10.3	0.0
12	7/28/12	9:20 A.M.	36.7388	37.3012	+0.0168	+0.0142	+9.7	+10.1	+9.9	-0.4
13	7/29/12	9:50 A.M.	36.7379	37.3004	+0.0159	+0.0134	+9.2	+9.5	+9.3	-0.6
14	7/30/12	8:50 A.M.	36.7377	37.3003	+0.0157	+0.0133	+9.1	+9.5	+9.3	0.0
15	7/31/12	9:00 A.M.	36.7375	37.3000	+0.0155	+0.0130	+9.0	+9.2	+9.1	-0.2
16	8/ 1/12	9:20 A.M.	36.7375	37.3000	+0.0155	+0.0130	+9.0	+9.2	+9.1	0.0
17	8/ 2/12	9:15 A.M.	36.7372	37.2997	+0.0152	+0.0127	+8.8	+9.0	+8.9	-0.2
18	8/ 3/12	9:05 A.M.	36.7372	37.2995	+0.0152	+0.0125	+8.8	+8.9	+8.8	-0.1
19	8/ 5/12	9:00 A.M.	36.7368	37.2993	+0.0148	+0.0123	+8.5	+8.7	+8.6	-0.2
20	8/ 6/12	9:15 A.M.	36.7373	37.2995	+0.0153	+0.0125	+8.8	+8.9	+8.8	+0.2

*these are the weights of the oil films.

No.10. Chinawood Oil.

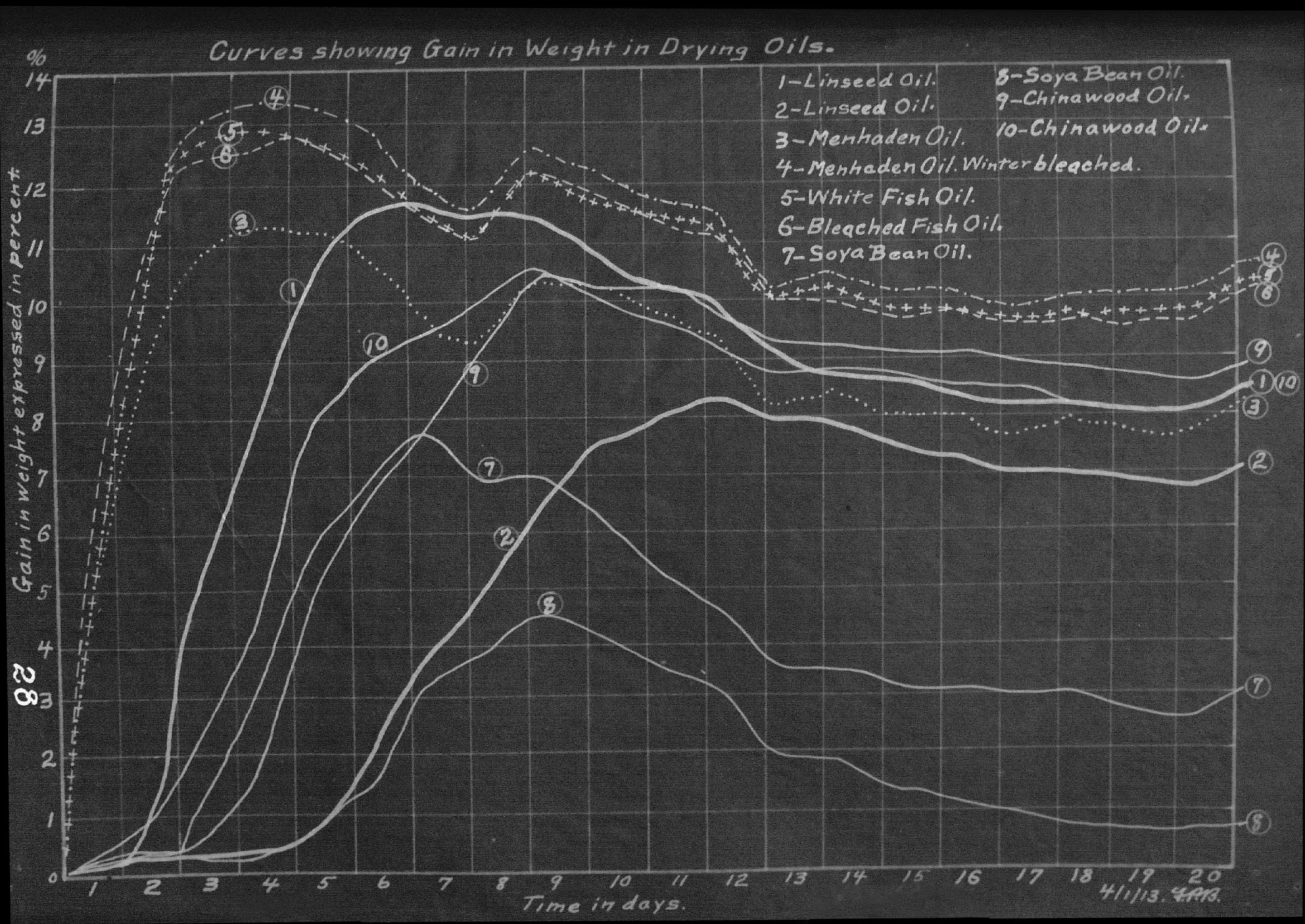
Weight of glass plate No.19 = 33.2022. Weight of glass plate No.20 = 30.8403.

No. of Days.	Date.	Time.	No.19. Wt.of oil + plate. grams.	No.20. Wt.of oil + plate. grams.	No.19. Differ- -ence. grams.	No.20. Differ- -ence. grams.	No.19. Differ- -ence. percent	No.20 Differ- -ence. percent	Average Differ- -ence. percent	Daily Variat- -ion. percent
1	7/17/12	6:35 P.M.	[illegible]	[illegible]	0.1310#	0.1222#				
2	7/18/12	8:55 A.M.	33.3341	30.9650	+0.0009	+0.0005	+0.7	+0.4	+0.5	+0.5
	7/18/12	8:10 P.M.	33.3350	30.9640	+0.0018	+0.0015	+1.4	+1.2	+1.3	+0.8
3	7/19/12	7:05 A.M.	33.3353	30.9647	+0.0021	+0.0022	+1.6	+1.8	+1.7	+0.4
4	7/20/12	9:15 A.M.	33.3375	30.9680	+0.0046	+0.0055	+3.5	+4.5	+4.0	+2.3
5	7/21/12	10:40 A.M.	33.3420	30.9726	+0.0088	+0.0101	+6.7	+8.3	+7.5	+3.5
6	7/22/12	10:25 A.M.	33.3433	30.9740	+0.0106	+0.0115	+8.1	+9.4	+8.7	+1.2
7	7/23/12	9:15 A.M.	33.3437	30.9745	+0.0115	+0.0120	+8.8	+9.8	+9.3	+0.6
8	7/24/12	9:10 A.M.	33.3437	30.9748	+0.0125	+0.0123	+9.5	+10.1	+9.8	+0.5
9	7/25/12	9:30 A.M.	33.3467	30.9756	+0.0135	+0.0131	+10.3	+10.7	+10.5	+0.7
10	7/26/12	9:05 A.M.	33.3461	30.9750	+0.0129	+0.0125	+9.9	+10.2	+10.0	-0.5
11	7/27/12	9:25 A.M.	33.3457	30.9744	+0.0125	+0.0119	+9.5	+9.7	+9.6	-0.4
12	7/28/12	10:25 A.M.	33.3453	30.9738	+0.0121	+0.0113	+9.2	+9.3	+9.2	-0.4
13	7/29/12	9:55 A.M.	33.3446	30.9732	+0.0114	+0.0107	+8.7	+8.8	+8.7	-0.5
14	7/30/12	8:55 A.M.	33.3448	30.9733	+0.0116	+0.0108	+8.8	+8.8	+8.8	+0.1
15	7/31/12	9:00 A.M.	33.3446	30.9730	+0.0114	+0.0105	+8.7	+8.6	+8.7	-0.1
16	8/ 1/12	9:20 A.M.	33.3446	30.9727	+0.0114	+0.0102	+8.7	+8.4	+8.5	-0.2
17	8/ 2/12	9:20 A.M.	33.3445	30.9727	+0.0113	+0.0102	+8.6	+8.4	+8.5	0.0
18	8/ 3/12	9:05 A.M.	33.3442	30.9724	+0.0110	+0.0099	+8.4	+8.1	+8.2	-0.3
19	8/ 5/12	9:00 A.M.	33.3441	30.9723	+0.0109	+0.0098	+8.3	+8.0	+8.1	-0.1
20	8/ 6/12	9:20 A.M.	33.3445	30.9725	+0.0113	+0.0100	+8.6	+8.2	+8.4	+0.3

#these are the weights of the oil films.

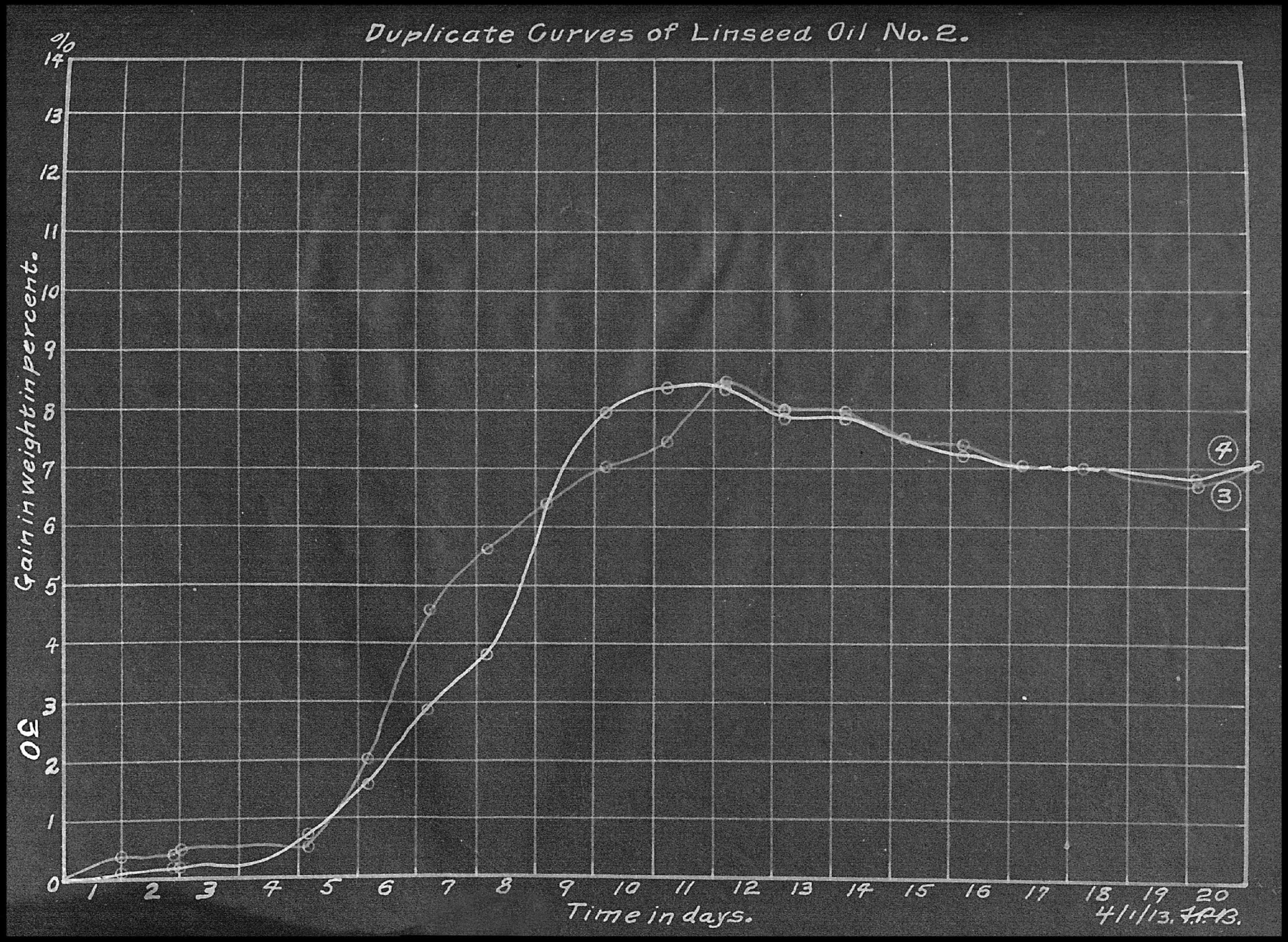
OIL DRYING CURVES.

The first ten curves (1 - 10) represent the gain in weight, expressed in percent, of the oils as they dried over a period of twenty days. The gain in weight is given as the ordinates and the time in days as the abscissa.


Curves showing Gain in Weight in Drying Oils.
%
Gain in weight expressed in percent.
Time in days.
1-Linseed Oil.
2-Linseed Oil.
3-Menhaden Oil.
4-Menhaden Oil. Winter bleached.
5-White Fish Oil.
6-Bleached Fish Oil.
7-Soya Bean Oil.
8-Soya Bean Oil.
9-Chinawood Oil.
10-Chinawood Oil.
4/1/13.

28


Duplicate Curves of Linseed Oil No. 1.
%
Gain in weight in %.
Time in Days.
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
1
2


Duplicate Curves of Linseed Oil No. 2.
%
Gain in weight in percent.
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Time in days.
4
3
4/1/13. H.P.B.

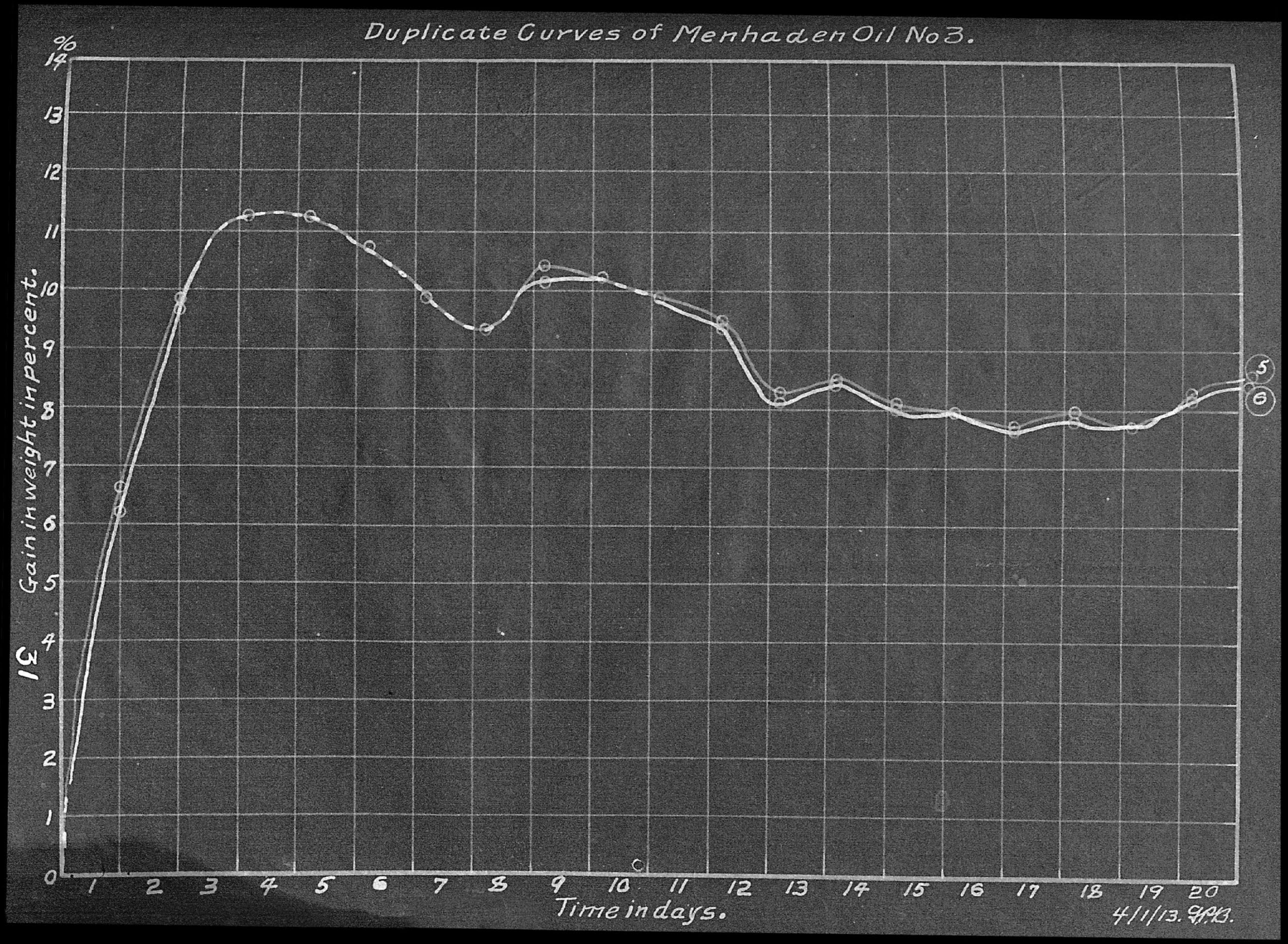
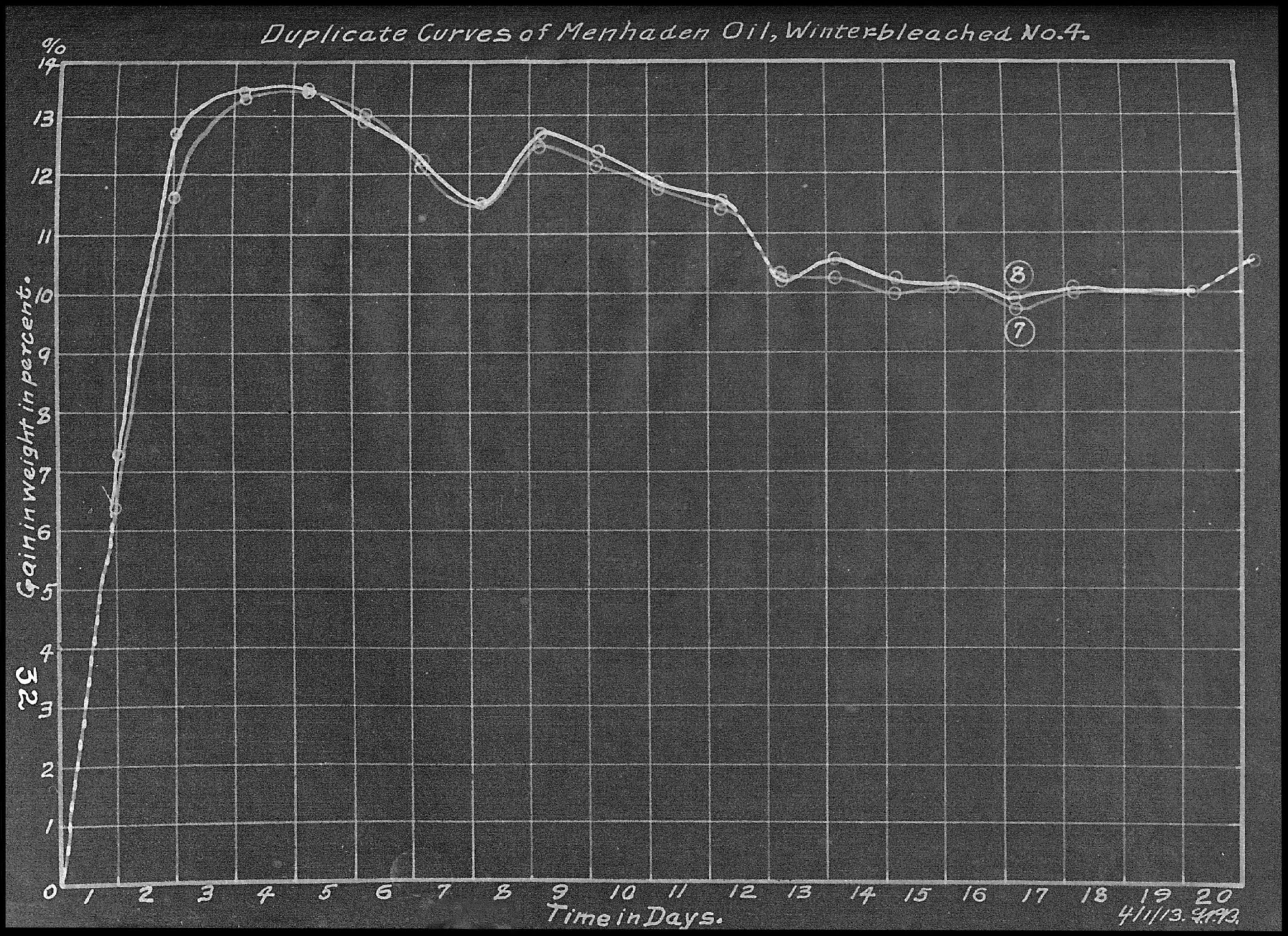
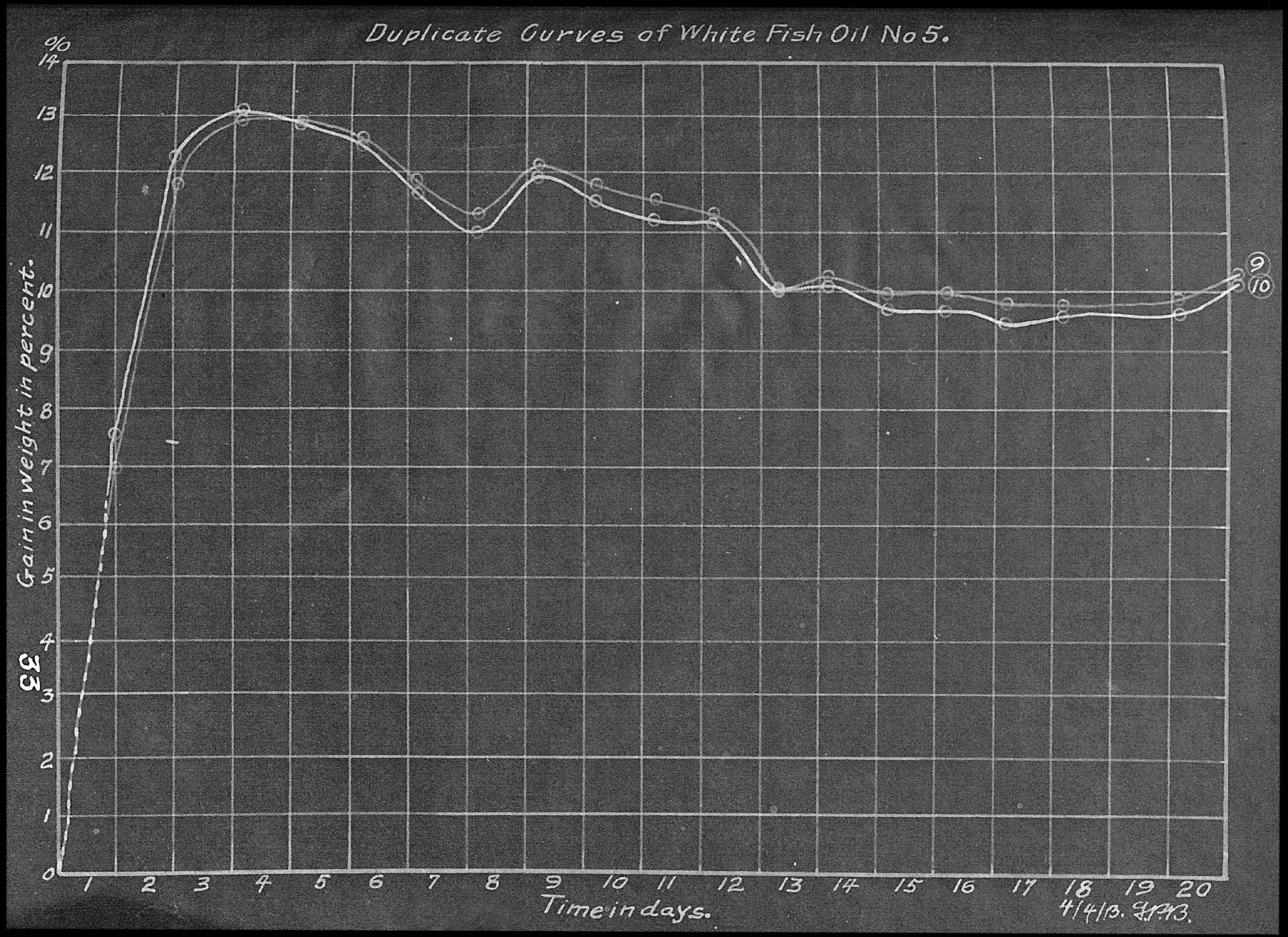
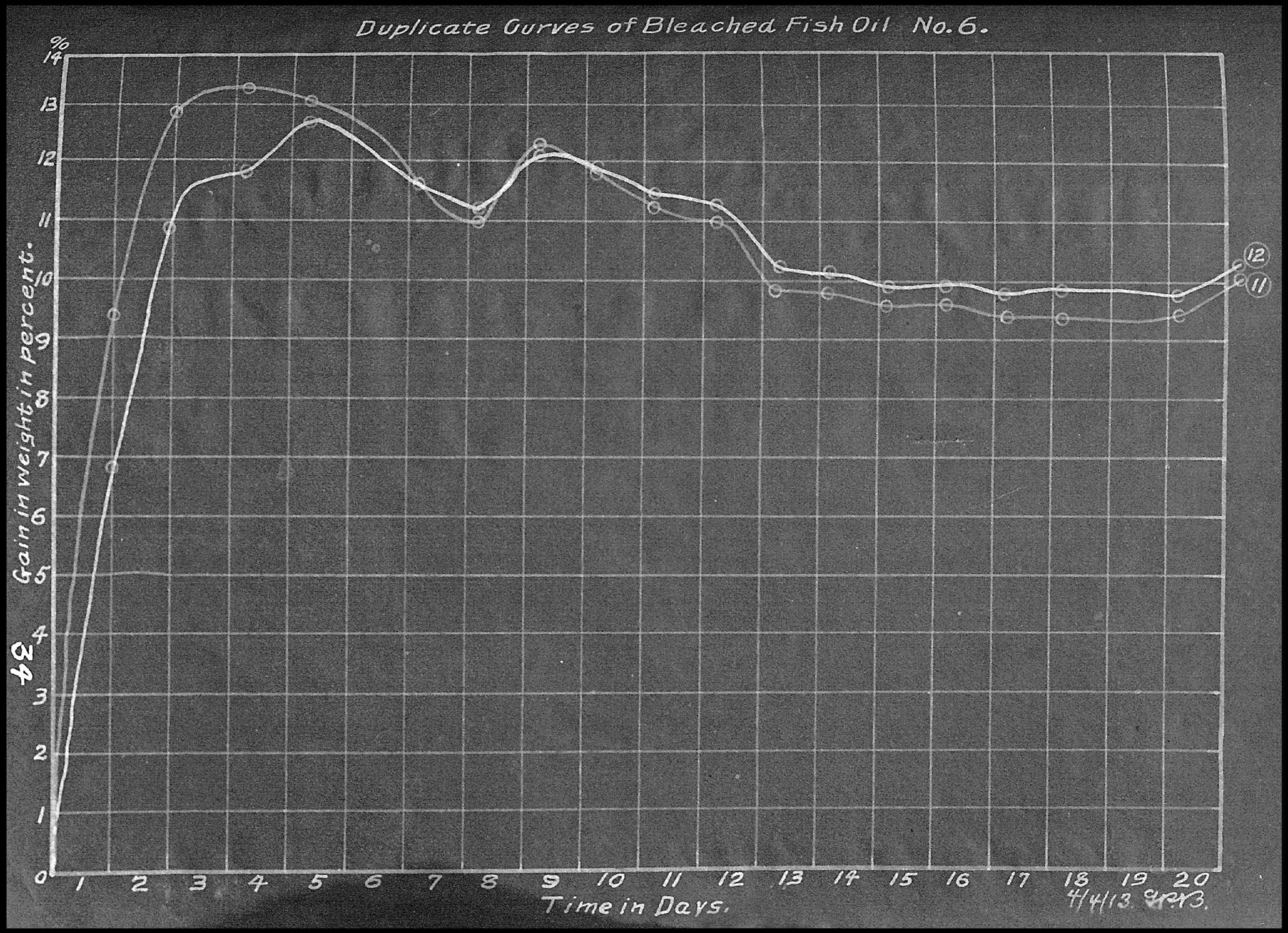
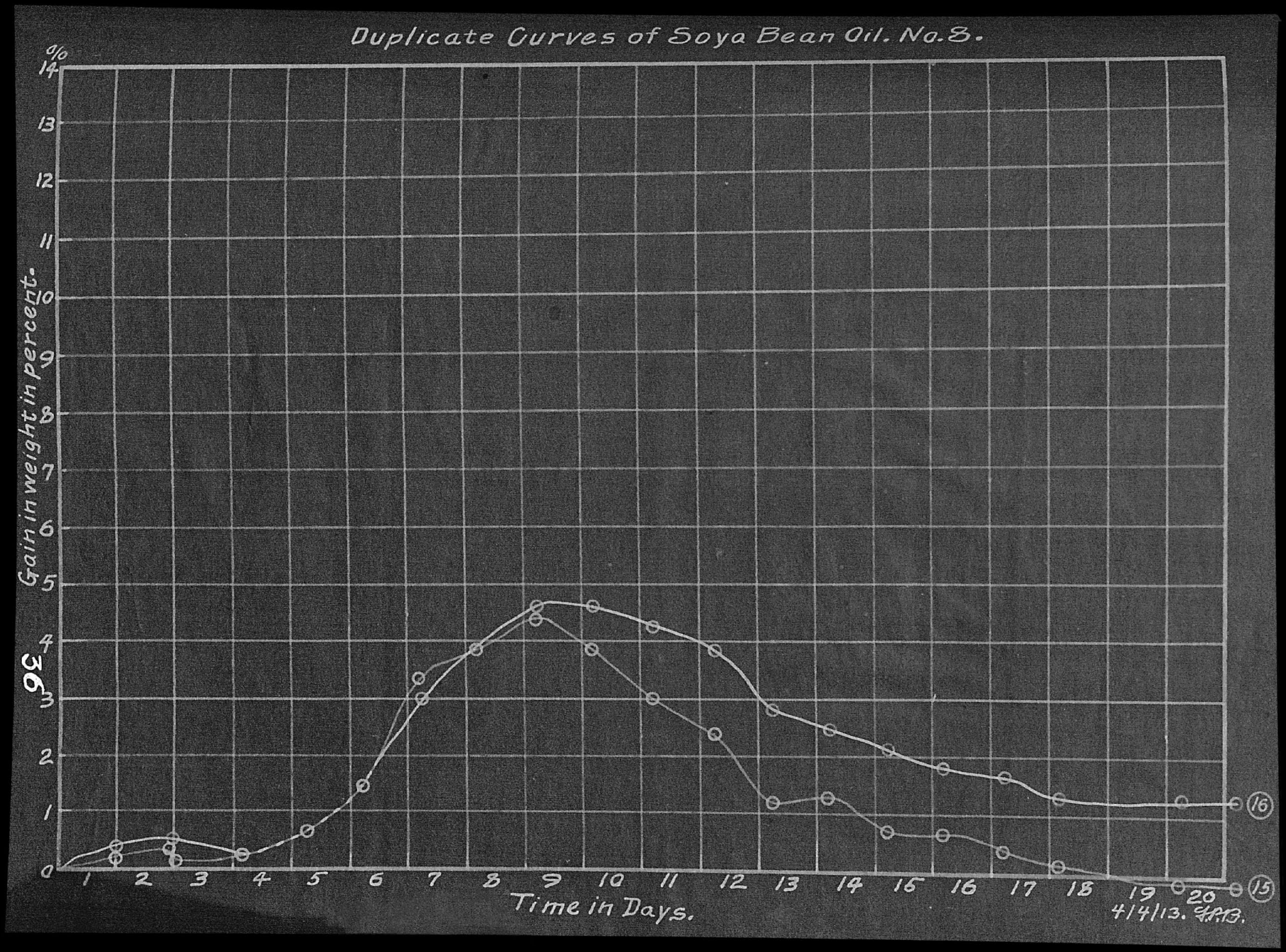

Duplicate Curves of Menhaden Oil No 3.
%
Gain in weight in percent.
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Time in days.
5
6
4/1/13.

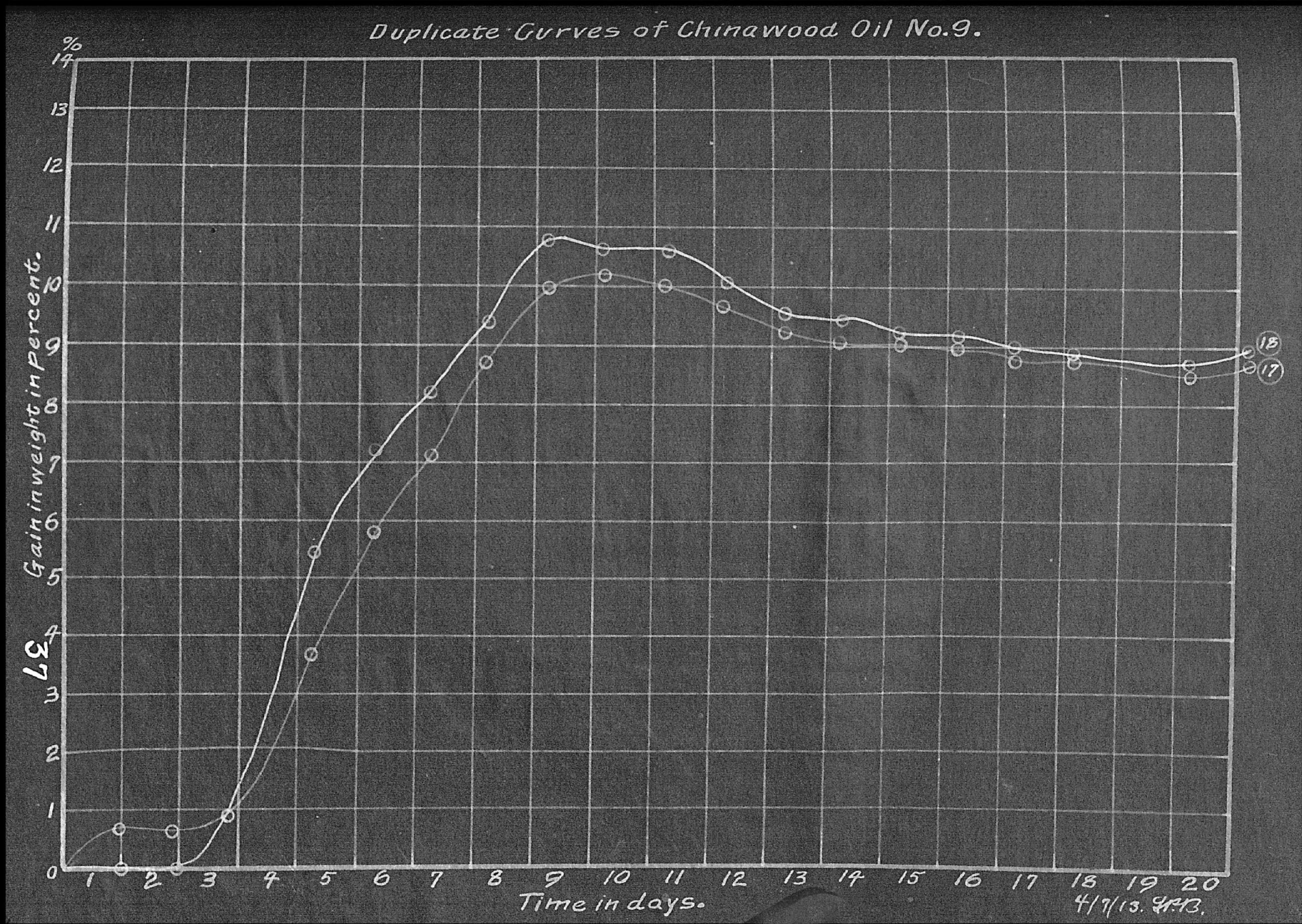
Fig 3

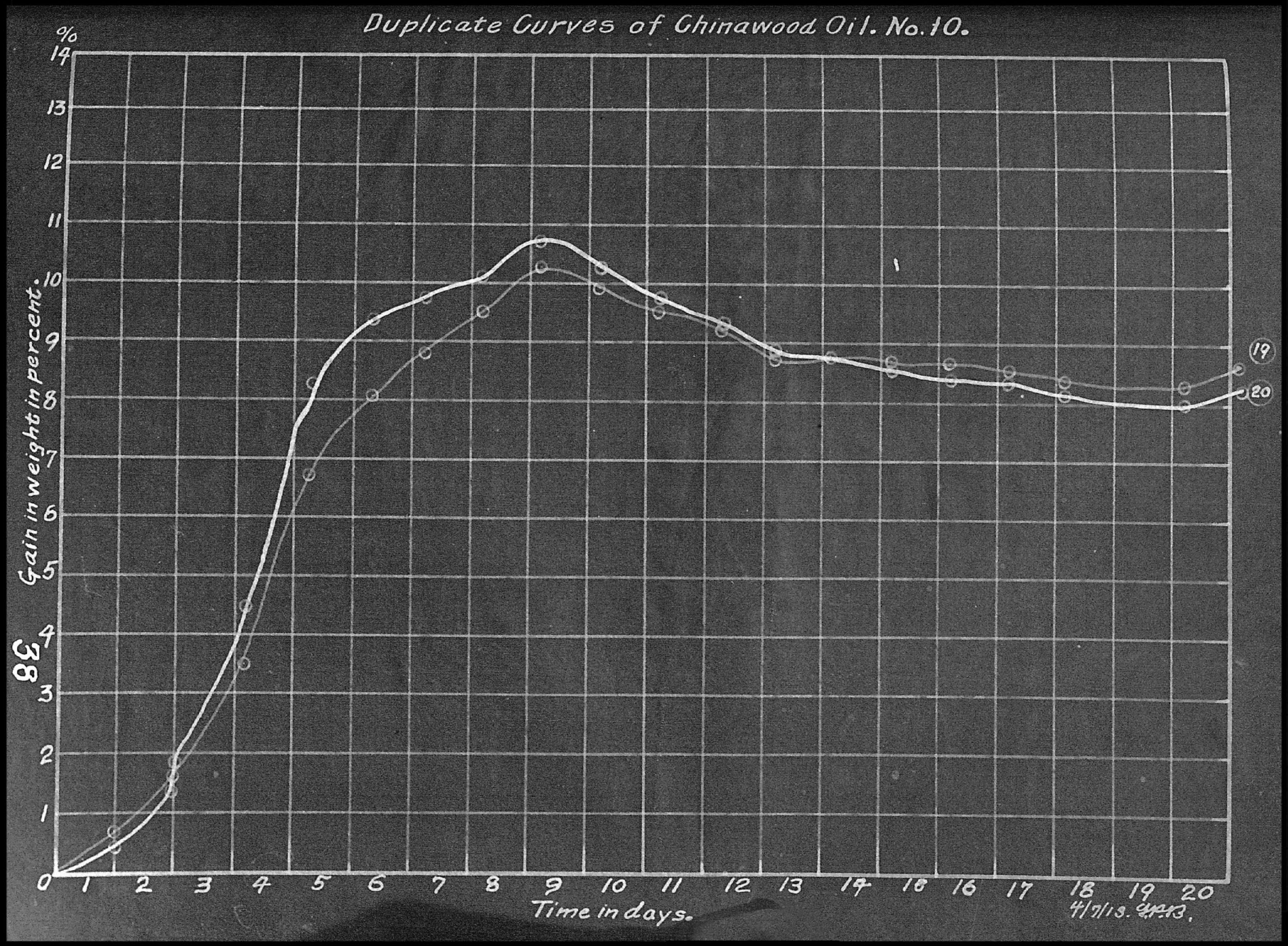

Duplicate Curves of Menhaden Oil, Winter-bleached No. 4.
%
Gain in weight in percent.
Time in Days.
8
7
4/1/13. 4.1.13.


Duplicate Curves of White Fish Oil No 5.
%
Gain in weight in percent.
Time in days.
9
10
4/4/13. 4/4/13.


Duplicate Curves of Bleached Fish Oil No. 6.
%
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Gain in weight in percent.
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Time in Days.
12
11
4/4/13.


Duplicate Curves of Soya Bean Oil. No. 8.
%
Gain in weight in percent.
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Time in Days.
16
15
4/14/13. H.A.B.


Duplicate Curves of Chinawood Oil No.9.
%
Gain in weight in percent.
Time in days.
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
18
17
4/7/13.


Duplicate Curves of Chinawood Oil. No. 10.
%
Gain in weight in percent.
Time in days.
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
19
20
4/7/13.

DESCRIPTION OF THE CURVES

Linseed Oil No. I, Curves 1 and 2.

An increase in weight began at the end of the first day. The first sample reached its maximum increase (13%) on the seventh day. Both coats set up into tough, slightly sticky films. They can not be marred by the finger tip, but are easily scratched with the finger nail. There is a slight odor of linseed. The film is transparent.

Linseed Oil No. 2, Curves 3 and 4.

Owing to accidental loss of oil on both plates, these curves do not follow the regular form. They show that the oil reached a maximum on the eleventh day and from that time gradually decreased. The description of the oil at the end of the test is the same as for Linseed Oil No. 1.

Menhaden Fish Oil No. 3, Curves 5 and 6.

The increase in weight was very rapid at the beginning of the experiment, 6.5% being absorbed at the end of the first day and a maximum weight of 11% increase was reached at the end of the fourth day. A continual decrease is shown from the fifth to the twentieth day. An irregularity is noticed in the curves between the seventh and eighth days on all the fish oils (Curves 5 - 12). This was the highest temperature (86° F.) reached during the experiment and the lowest

humidity 54.

The fish oils lost most of their odor after two days drying.

The films are yellowish in color. They can be easily marred by the finger tips and are sticky like fly paper, being very soft and stringy.

Menhaden Fish Oil No. 4 Curves 7 and 8.

These curves are about the same as those of Fish Oil No. 3, but the maximum gain in weight is about 2% greater, being 13.5% . These films dried better than Nos. 5 and 6. They are more sticky than Nos. 5 and 6. The color is slightly yellowish.

Fish Oil. No. 5, Curves 9 and 10.

These curves follow closely the two fish oils already described and show a maximum gain of 13% at the end of the third day.

At the end of the experiment, the properties of the films were the same as those of Nos. 7 and 8. The film is yellow and transparent.

Fish Oil No. 6, Curves 11 and 12.

These curves follow the same general form as those of the other fish oils and show a maximum gain of 13.5% at the end of the third day.

The properties of the films at the end of the test are similar to Nos. 7 and 8,and 9 and 10.

Soya Bean Oil No. 7, Curves 13 and 14.

Curve 14 shows a slow increase (2%) the

first two days and a rapid increase, (6%) for the third and fourth days. The maximum increase of 9% on the 6th sixth day. A general decrease then followed to the end. Curve 13 shows a decrease for the first two days which is probably due to a loss of oil from the plate, which was not noticed at the time.

These films set up in fair shape, althouh a little more sticky than Linseed Oils, No. 1 and 2. The films are very white in color and transparent.

Soya Bean Oil No. 8, Curves 15 and 16.

No definite conclusions can be drawn from these curves as some of the oil was lost. The curves do show, however, a maximum gain at the ninth day. A general decrease followed to the end of the experiment.

The descriptions of these films are the same as for Nos. 13 and 14.

Chinawood Oil No. 9, Curves 17 and 18.

The curves show very little increase in weight for the first three days. On the third day the oils began to show a characteristic translucent whitening simultaneous with a rapid increase in weight. The increase reached its maximum of 10.7% on the ninth day and the weight of the films decreased from that time to the end of the experiment on the twentieth day.

The films at the end of the experiment were translucent white, with a frosty appearance and have a wood

oil odor. The films, when rubbed between the fingers, are of a mealy nature like art gum. They are not easily scratched by the finger nail and are not in the least sticky to the touch, or tacky.

Chinawood Oil. No. 10, Curves 19 and 20.

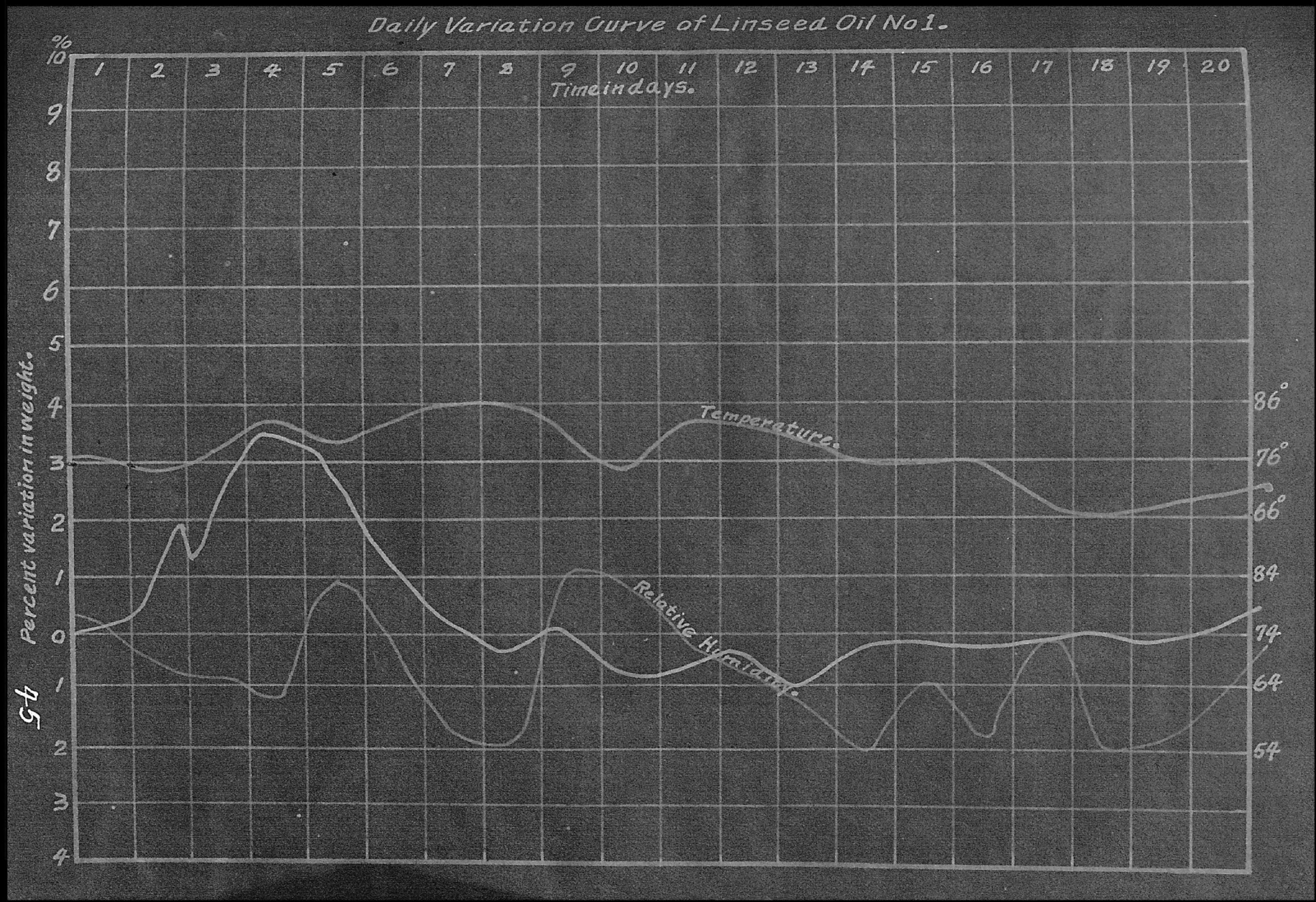
These curves have the same general characteristics as Curves 17 and 18. One difference is noticeable; the oil began to whiten at the end of the second day and a rapid increase in weight is also noticeable. The maximum increase (10.5%) in weight was reached on the ninth day and from that time the decrease was continuous to the end of the experiment.

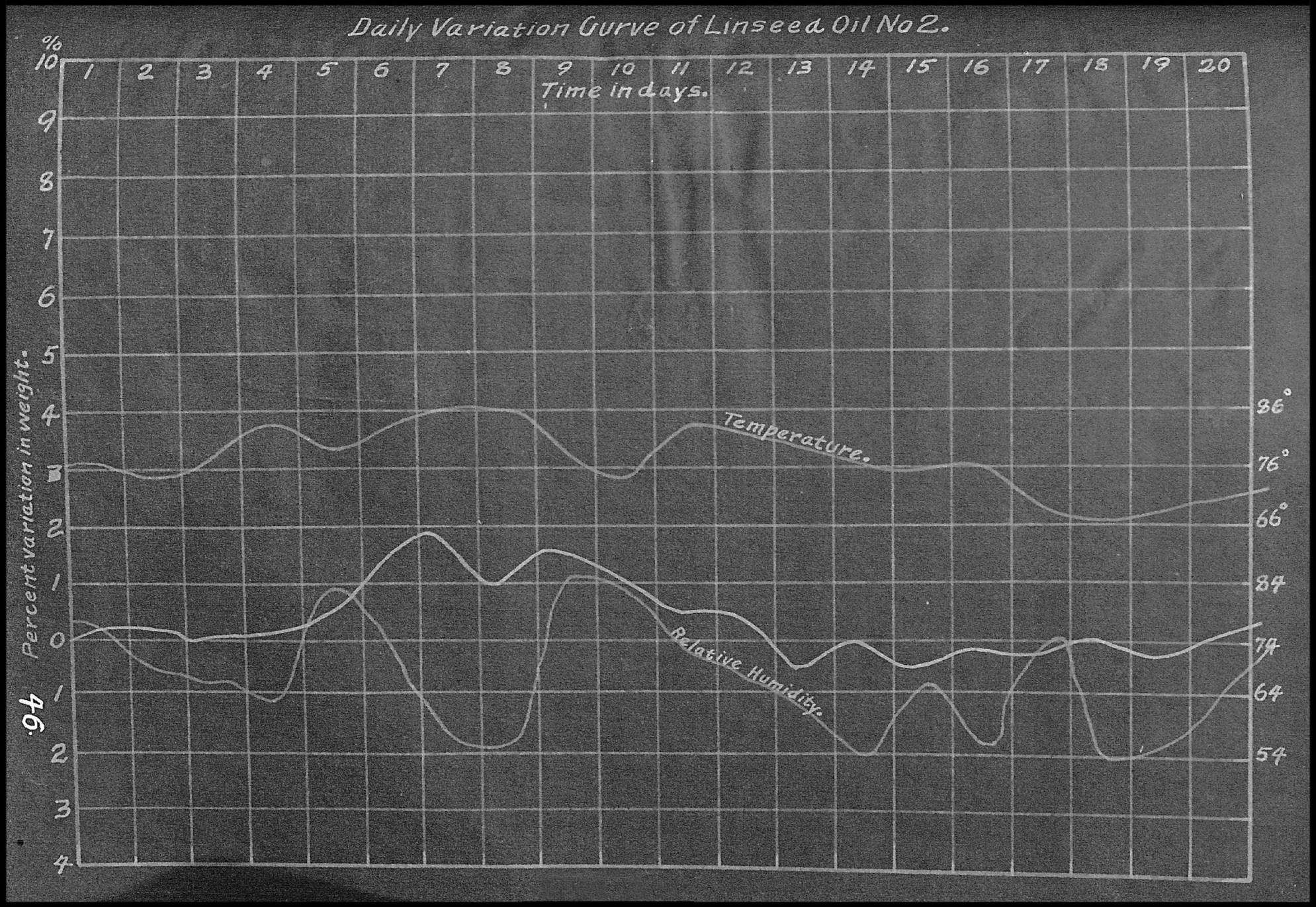
The description of the films is the same as for Oil No. 9.

CONDITION OF FILMS

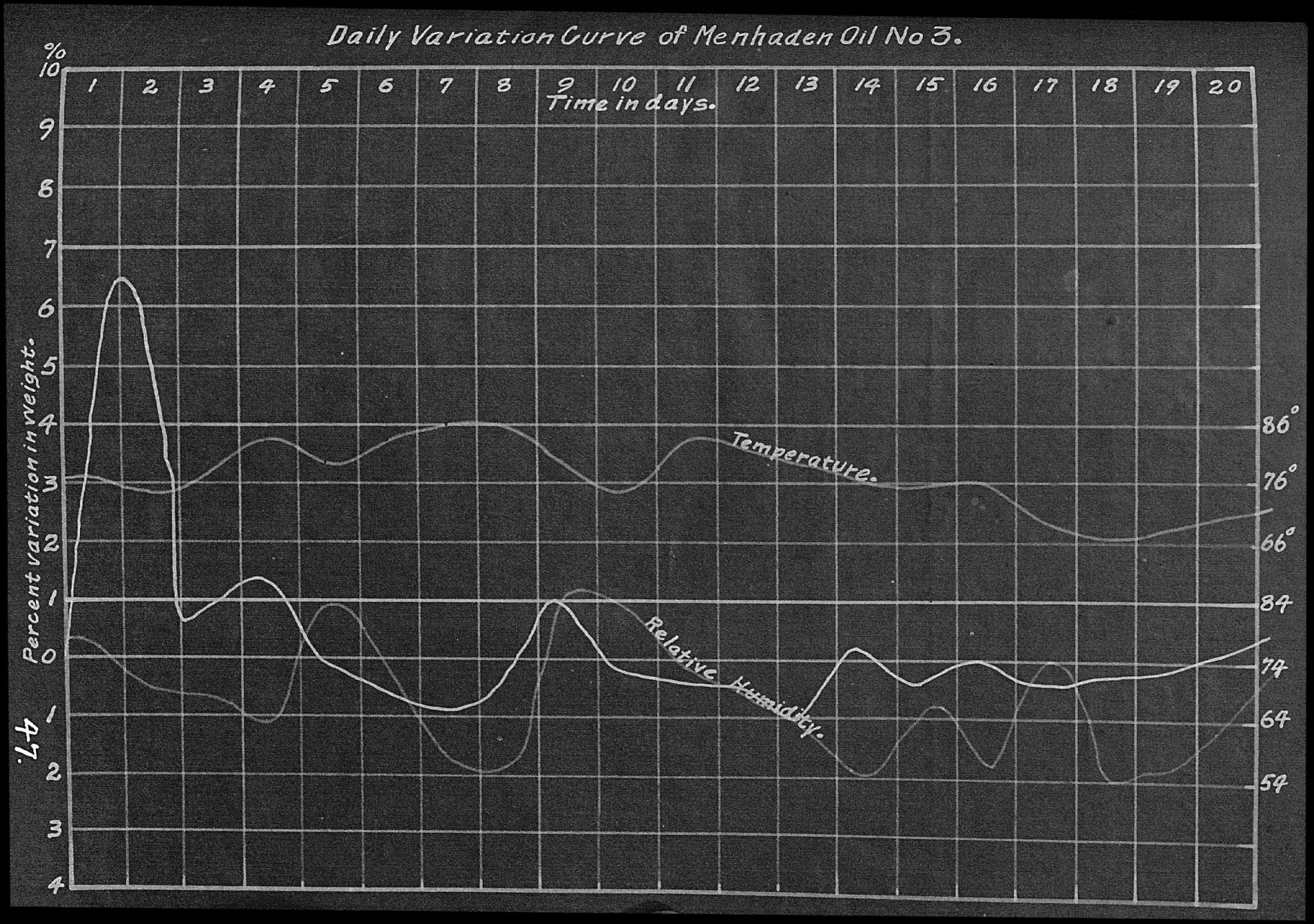
The oils had not begun to set up, except the chinawood oil, at the end of the fifth day, at which time most of the oils ~~ha~~ had absorbed the maximum amount of oxygen. This has already been noticed by Sabin.[1] He noted a break in the curve representing the loss in weight after the film has reached its maximum increase. This break is at the fifteenth day for one set of curves and the tenth day for the second set. In our curves a similar break is shown on the thirteenth day. This break is probably due to a point being reached at which the loss of volatile products just equals the gain by oxidation.

DAILY VARIATION CURVES.

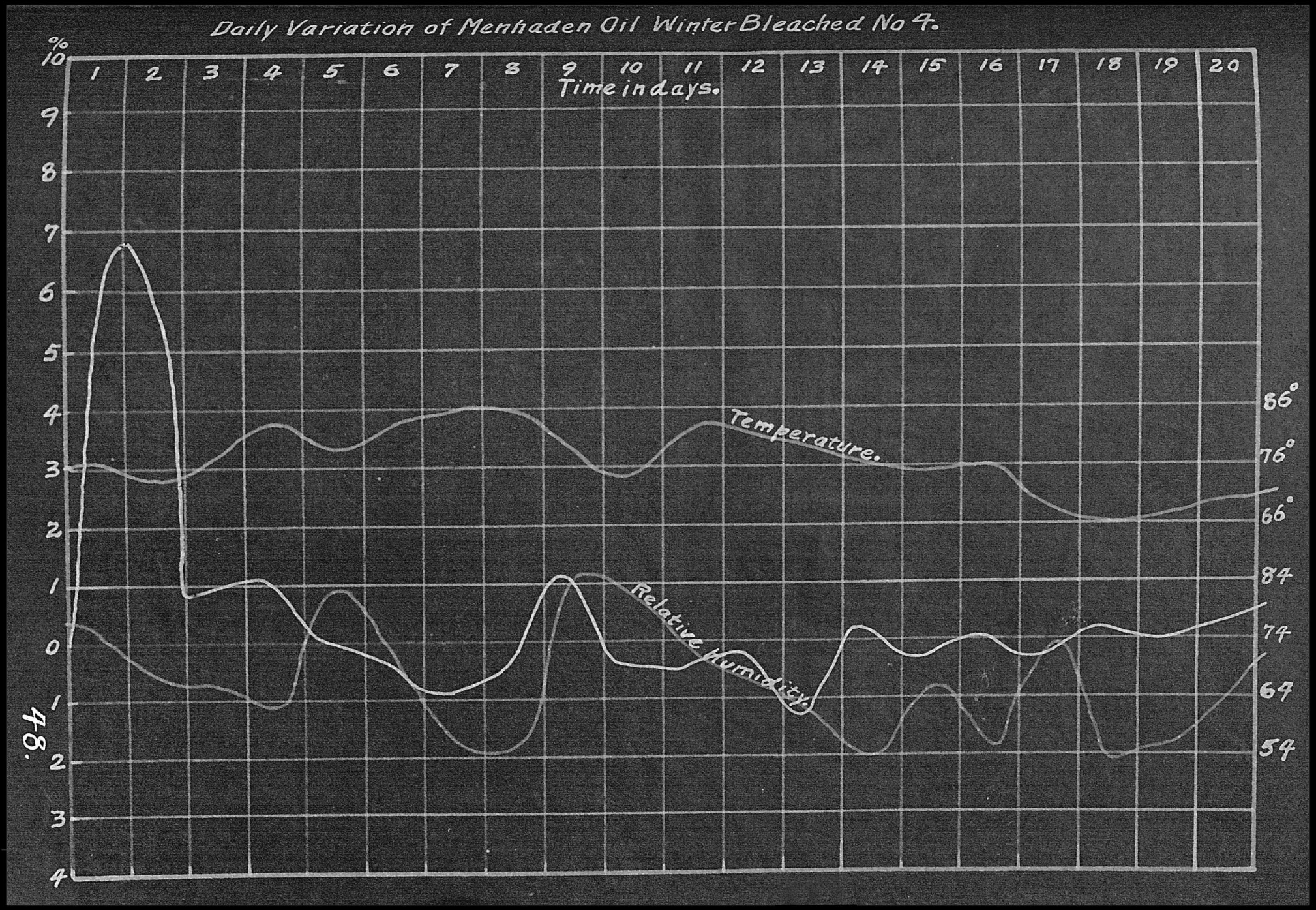

Daily Variation Curve of Linseed Oil No 1.
%
10
9
8
7
6
5
4
3
2
1
0
1
2
3
4
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Time in days.
Percent variation in weight.
Temperature.
Relative Humidity.
86°
76°
66°
84
74
64
54


Daily Variation Curve of Linseed Oil No 2.
%
10
9
8
7
6
5
4
3
2
1
0
1
2
3
4
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Time in days.
Percent variation in weight.
Temperature.
Relative Humidity.
86°
76°
66°
84
74
64
54

46.


Daily Variation Curve of Menhaden Oil No 3.
%
10
9
8
7
6
5
4
3
2
1
0
1
2
3
4
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Time in days.
Percent variation in weight.
Temperature.
Relative Humidity.
86°
76°
66°
84
74
64
54

47.


Daily Variation of Menhaden Oil Winter Bleached No 4.
%
10
9
8
7
6
5
4
3
2
1
0
1
2
3
4
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Time in days.
Temperature.
Relative Humidity.
86°
76°
66°
84
74
64
54

48.

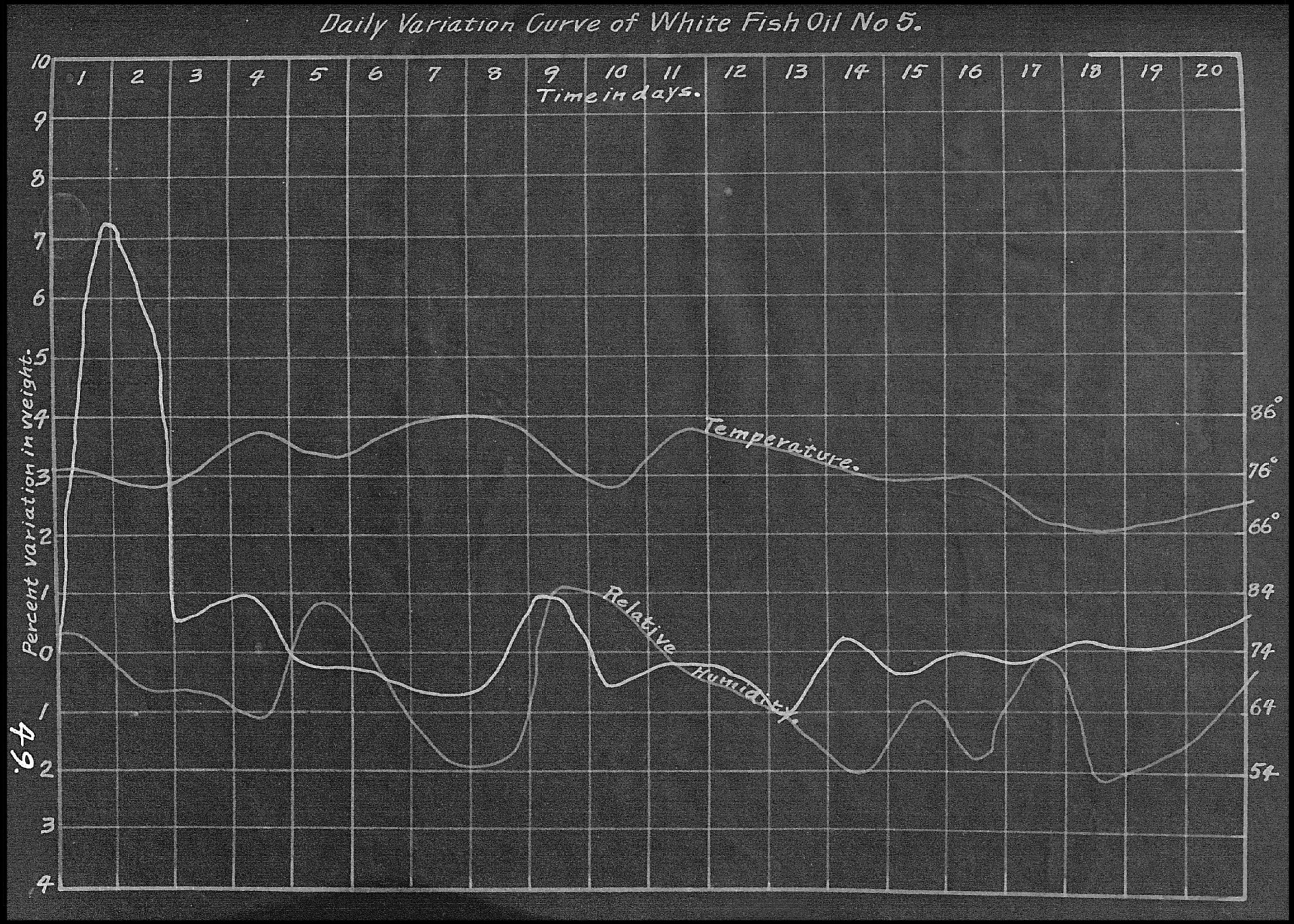
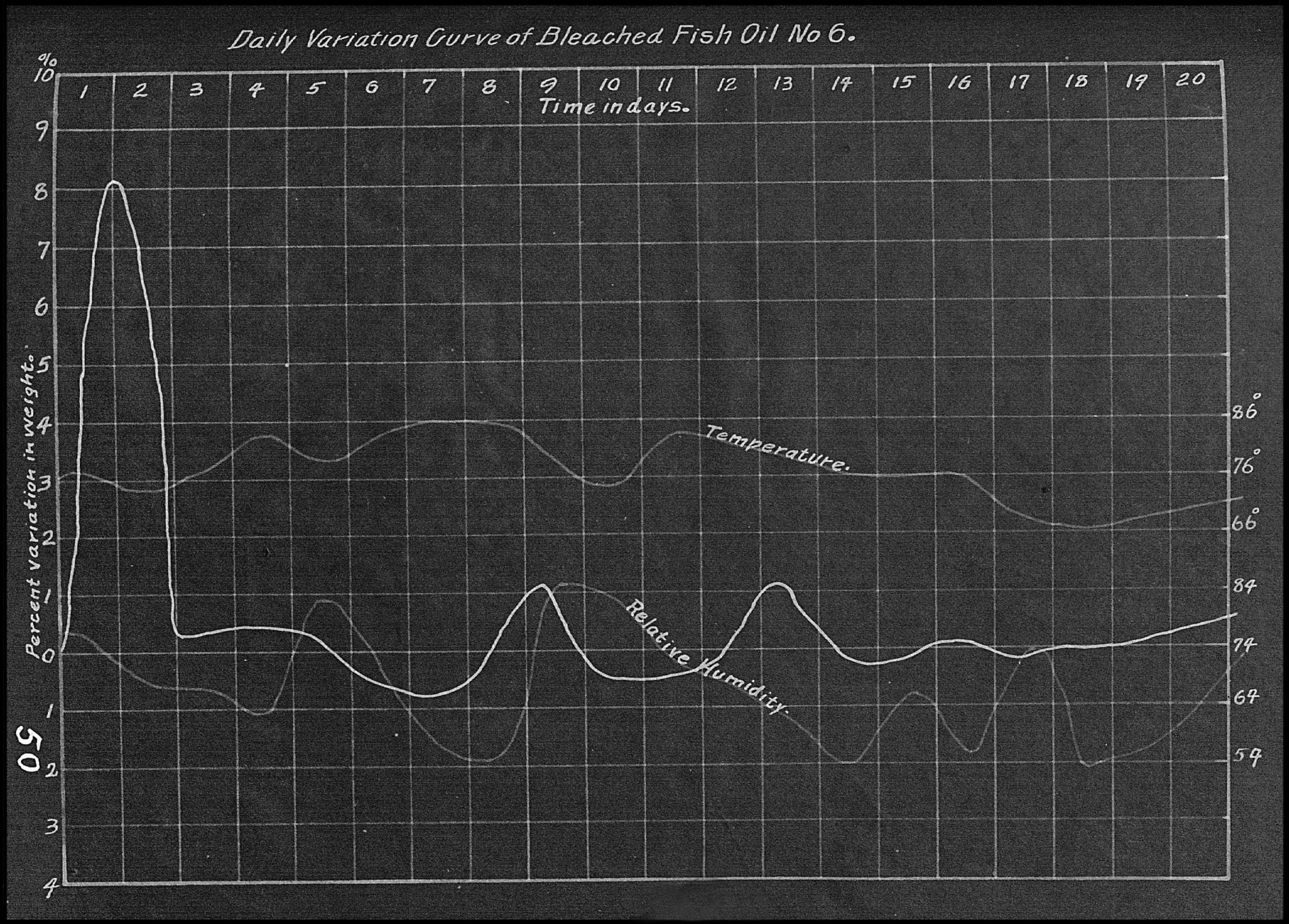
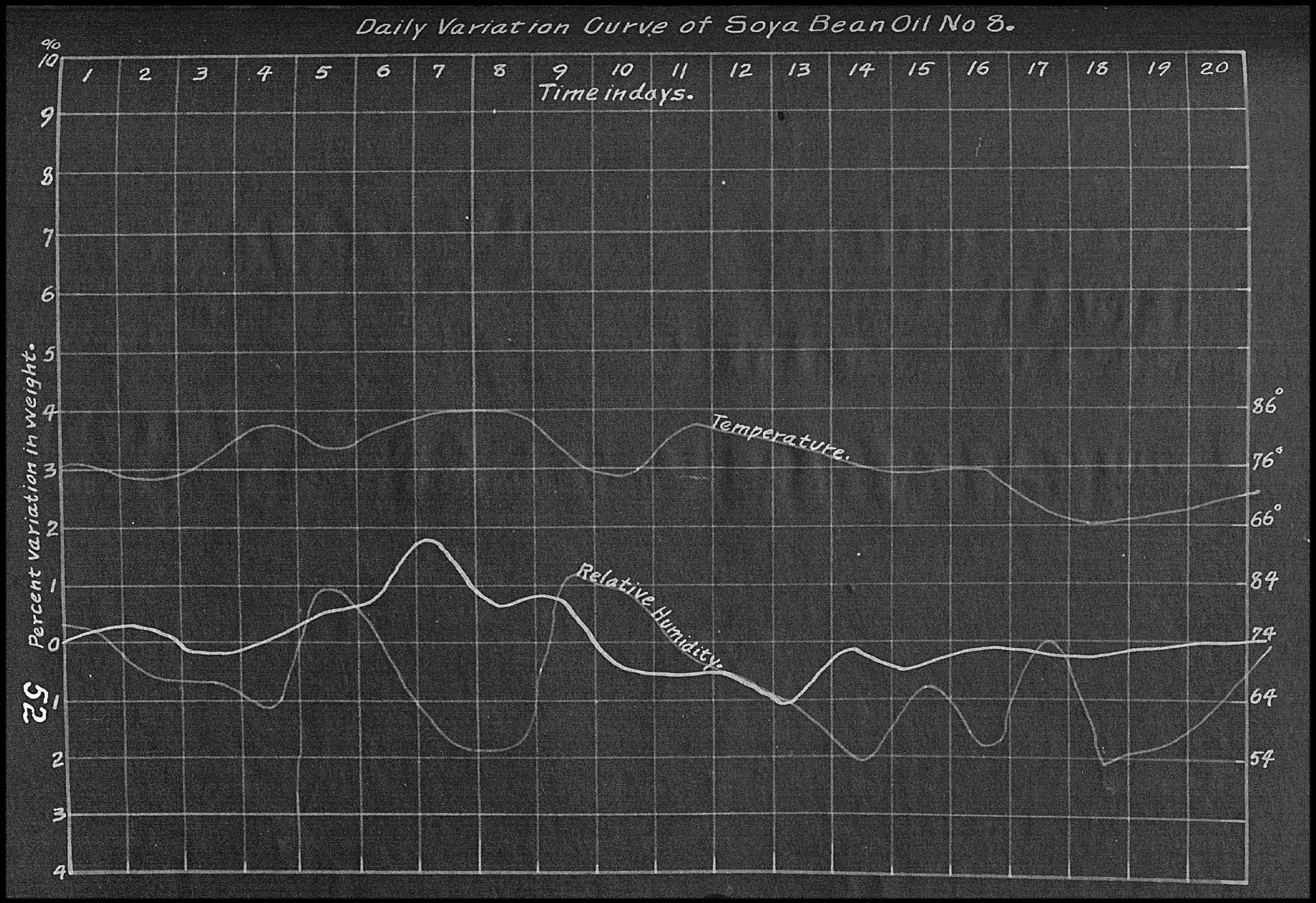

Daily Variation Curve of White Fish Oil No 5.
Time in days.
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Percent variation in weight.
10 9 8 7 6 5 4 3 2 1 0 1 2 3 4
Temperature.
Relative Humidity.
86° 76° 66°
84 74 64 54

Fig. 49.


Daily Variation Curve of Bleached Fish Oil No 6.
%
10
9
8
7
6
5
4
3
2
1
0
1
2
3
4
Percent variation in weight.
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Time in days.
Temperature.
Relative Humidity.
86°
76°
66°
84
74
64
54


Daily Variation Curve of Soya Bean Oil No 7.
%
10
9
8
7
6
5
4
3
2
1
0
1
2
3
4
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Time in days.
Percent variation in weight.
Temperature.
Relative Humidity.
86°
76°
66°
84
74
64
54


Daily Variation Curve of Soya Bean Oil No 8.
%
Time in days.
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
10 9 8 7 6 5 4 3 2 1 0 1 2 3 4
Percent variation in weight.
Temperature.
Relative Humidity.
86° 76° 66°
84 74 64 54

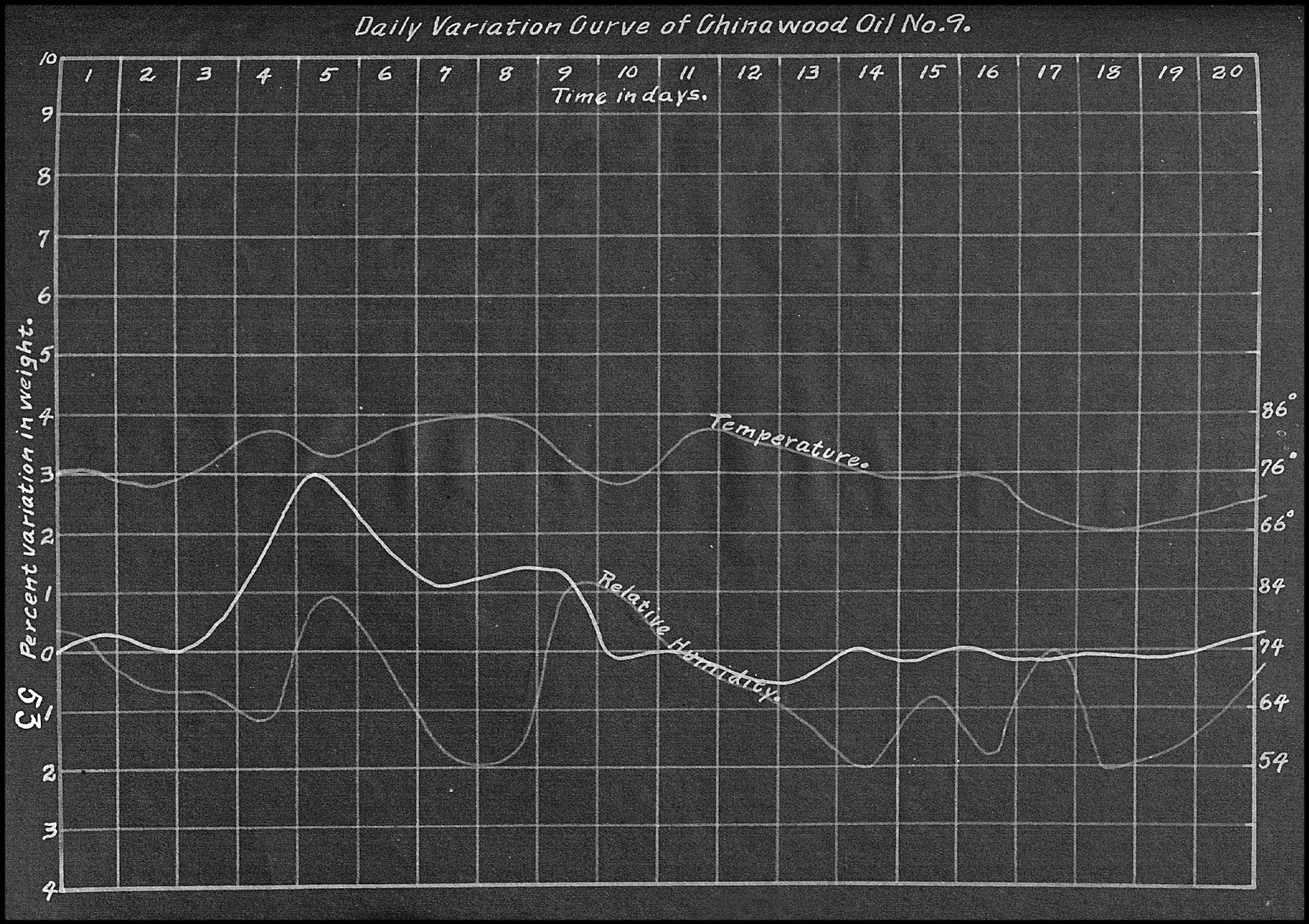
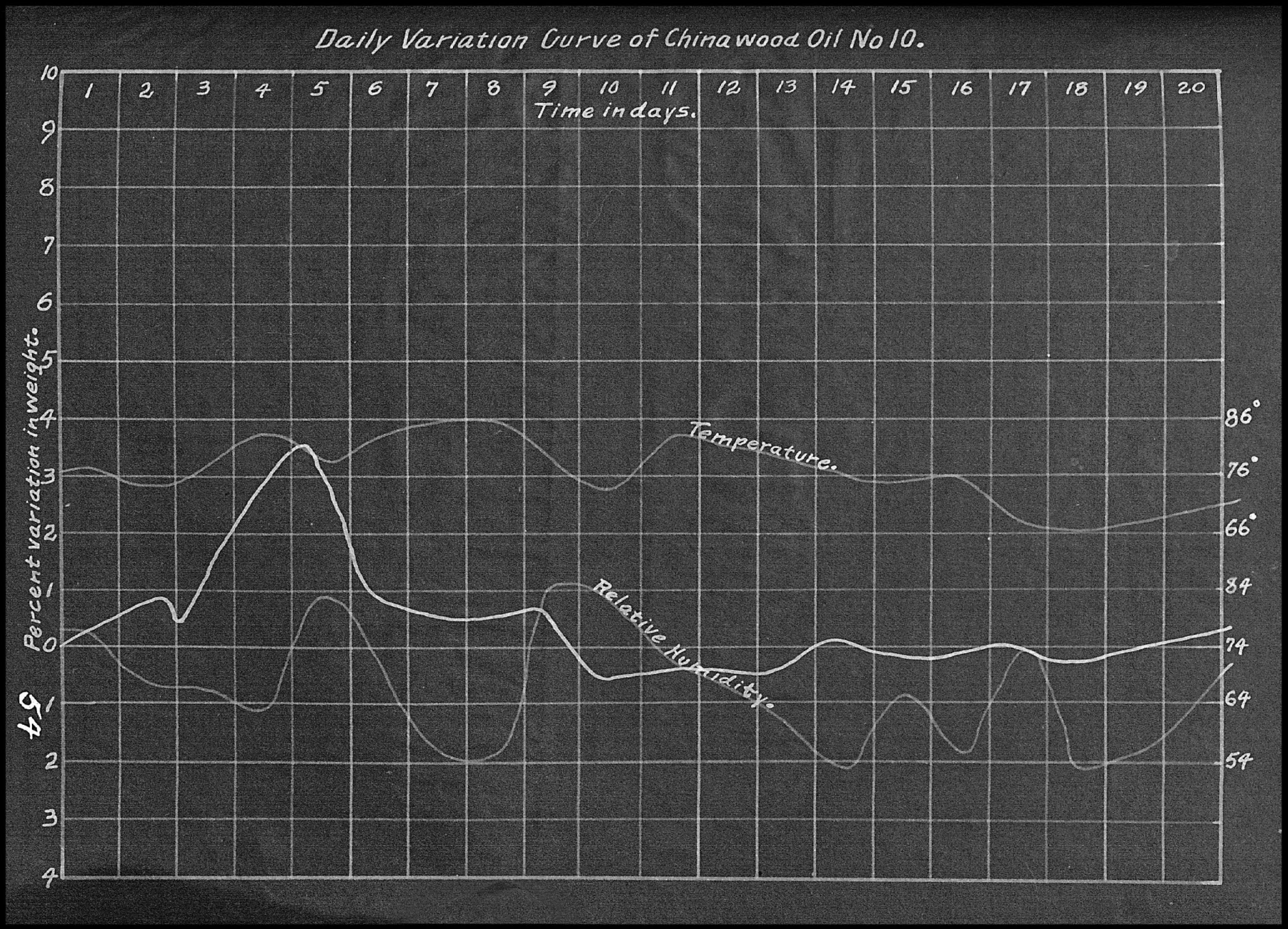

Daily Variation Curve of China wood Oil No. 9.
Time in days.
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Percent variation in weight.
10 9 8 7 6 5 4 3 2 1 0 1 2 3 4
Temperature.
Relative Humidity.
86° 76° 66°
84 74 64 54

Fig 3


Daily Variation Curve of China wood Oil No 10.
Time in days.
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Percent variation in weight.
10 9 8 7 6 5 4 3 2 1 0 1 2 3 4
86° 76° 66° 84 74 64 54
Temperature.
Relative Humidity.

DAILY VARIATION CURVES 1 - 10

The daily variation curves were plotted for percent increase in weight, giving the time in days as the abscissa and the percent variation in weight as the ordinates.

The average temperature and humidity curves were plotted on the same graphs, the object being to detect if possible some relation between the rate of drying of the oil, the temperature and the humidity.

In general, no conclusions can be drawn as to the effect of humidity and temperature on the rates of drying. The only noticeable irregularity which can be explained by humidity is in the fish oil curves on the ninth day. There is a noticeable increase in each of the eight samples of about 2% when the humidity had increased 30%. This agrees with what has been noticed by previous investigators, that fish oils are hydroscopic in warm, moist air.

The curves show that the linseed oils were increasing in weight most rapidly on the fourth and seventh days. The eight samples of fish oil were increased in weight very rapidly for the first two or three days, the soya bean oil samples increased most rapidly on the fifth day and the four samples of chinawood oil increased most rapidly on the fourth and fifth days. None of the samples of the oils show any marked decrease in weight from the fourteenth to the twentieth day.

CONCLUSIONS

1. At the end of the twenty days the linseed oils had set up to a dry tough transparent film which could be scratched by the finger nail.

2. The fish oils did not set up like a drying oil but remained a sticky viscous, transparent yellowish liquid with a slight fish oil odor.

3. The soya bean oils set up to a firm transparent film. The film was much lighter in color, but was not equal to linseed oil in toughness.

4. The chinawood oils gave excellent films. The films however possessed an inferior surface, frosty in appearance and unsuitable for varnishes.

5. It was very noticeable in the drying of the chinawood oils that the frosted surface began to appear simultaneous with the rapid increase in weight of the film and reached its maximum weight simultaneously with the complete frosting.

6. The fish oils gained weight much more rapidly than any of the other oils and the total gain was greater, the average maximum gain being about 12.5%. The linseed oils were next in order in the rate of increase in weight. Both in the rate and the amount (11.5%) absorbed.

The chinawood oil and soya bean oil gained weight at a slower rate than the fish and lin-

seed oils. However, they gain weight at about the same rate, as is shown by Curves 7, 9 and 10 on the composite figure. The maximum gain (10.5%) for chinawood oil is 1% less than that of linseed oil and the maximum gain (7.7%) for soya bean oil is 2.8% less than that of chinawood oil. Curves 2 and 8 were left out in drawing these conclusions, since some of the oil was lost from these plates.

7. Linseed, chinawood oil and soya bean oils dry within twenty days to a solid film without the addition of artificial driers.

8. All the fish oil samples remained tacky, viscous liquids after twenty days of drying.

9. The gain in weight is not as large and the rate of gain is slower for the raw oils than for the corresponding oils with added drier.