M. L. SHEELEY:

Wt.	Min. centrifuged	%
.8091	10	84.2
.5285	10	87.6
.6356	10	87.0
.7110	15	83.6
.5630	15	83.9
.6348	15	83.7
.5960	15*	85.3
.6232	15*	85.3
.4224	10	83.9
.4224	10	85.4
.8448	10	84.6
.8448	10	85.0
1.2673	10	84.2
1.2673	10	84.4
1.6897	10	85.9

* Centrifuged 8 min., stopped 2 min., then centrifuged for 7 more min.
No correction for ppt. volume. Average = 84.9

H. C. BENNETT:

83.96 — 82.06 — 83.98 — 84.16
84.42 — 82.31 — 83.54
All samples = 0.9 gm. Average = 83.49
82.44 — 83.31 — 82.26 — 82.66
Volumetric solution aliquots = 0.9 gm.
Average = 82.67
Ppt. correction applied.

W. J. REESE:

Wt.	%	Wt.	%
.8809	86.50	.8647	85.04
.9284	86.45	.6178	84.85
.9037	85.89	.4862	85.15
.9013	87.22	.3468	87.61
.9007	82.56	.9069	88.60
		.9166	88.65

Average = 86.23
Ppt. correction applied.

A Typical Soap Lye Crude
% Glycerol = 85.0 (Acetin)

Wt.	Min. centrifuged	%
.7005	10	86.8
1.1414	10	86.5
.6112	10	86.5
.3502	10	87.5

No correction for ppt. volume. Average = 86.8

A.O.C.S. GLYCERIN ANALYSIS COMMITTEE—(1939-1940)

Ralph W. Bailey—Stillwell & Gladding, Inc., 130 Cedar Street, New York City, N. Y.
H. C. Bennett—Los Angeles Soap Company, 617 East First Street, Los Angeles, California
J. E. Doherty—Lever Brothers Company, Cambridge, Mass.
W. J. Reese—Colgate-Palmolive-Peet Co., Kansas City, Kansas.
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C. C. Zeigler—Swift & Company, Union Stock Yards, Chicago, Illinois.
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J. T. R. Andrews (Chairman)—Procter & Gamble Company, Ivorydale, Ohio.

Quality Changes in the Industrial Storage of Crude and Refined Cottonseed Oil

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PLANT SUPERINTENDENT, INTERSTATE COTTON OIL REFINING COMPANY, SHERMAN, TEXAS

INTRODUCTION

Fats and oils are known to deteriorate to a certain extent on age, depending upon the conditions of storage. Rancidity and other off quality developments on ageing various animal and vegetable oils and fats have been discussed rather widely in the past years, and such factors as light, heat, presence of moisture, auto-oxidation, contact with air, and contact with various metals, have been shown to be the primary causes of these quality changes.

Investigators have shown that crude vegetable oils have certain anti-oxidants naturally present which are largely removed in caustic refining. This finding has led to the conclusion by some persons that when vegetable oils must necessarily be stored, it is more advisable to store them in the crude state rather than as refined, or further processed. On the other hand, others much prefer to store oil as refined rather than as crude, because of previous unsatisfactory experience in storing crude. This latter opinion seems to be the most prevalent.

The present work is divided into two parts: namely, the quality changes in crude and refined cottonseed oil on age, stored under normal atmospheric conditions in (1) small 4 lb. pails and (2) large industrial storage tanks. The various oils used in these tests represent normal receipts of crude cottonseed oil from Texas, Oklahoma, Louisiana, and Arkansas, during the 1939-40 season. Atmospheric and plant conditions of storage represent a normal North Texas Year from September to September.

It is not the purpose of this work to theorize or explain the quality changes shown, but merely to report these changes under the practical conditions of storage encountered, and to discuss the results as applied to manufacturing operations.

SMALL SAMPLE STORAGE PROCEDURE

Four-pound samples of freshly received crude, together with four-pound samples of the corresponding laboratory refined oil from the respective crudes, were stored in four-pound tin pails. The lids of these pails were punched with small holes for normal aeration, covered with inverted 100 lb. cans to exclude light and to minimize daily temperature changes, and stored on the roof of a building.

The crude oil stored represented "as is" samples from tank cars. The refined oil was refined from this crude by the official N.C.P.A. method, and stored after filter paper filtration.

Four sets of samples representing new crop crude were stored in this manner from September 1, to April 1, (7 months). Three other sets of samples representing end of season crude were stored similarly from February 1 to August 1 (6 months).

After these respective storage periods the crude oil was laboratory refined in the same manner in which the stored refined oil was produced. Then all refined oils were laboratory bleached using the official N.C.P.A. procedure, except using 2% of natural Texas fuller's earth. These bleached samples were used for the stability tests shown. Conventional or official laboratory procedure was used throughout.

SMALL SAMPLE STORAGE RESULTS

The following results are shown in the data of Table I regarding the relative merits of storing crude vs. refined cottonseed oil:

1.) The average F.F.A. on the stored crude rose .2% while the rise on the stored refined oil was almost negligible, except in one unexplainable case

TABLE No. I.

QUALITY CHANGES AND HISTORY OF CRUDE AND REFINED COTTONSEED OIL STORED ATMOSPHERICALLY IN SMALL CONTAINERS

Analysis as		Source of Crude	Date of Analysis	Sample Age as Analyzed as Cr.	Sample Age as Analyzed as Ref.	% F.F.A.	Settlement Loss %	Other Cup Loss %	Refined Oil Color-R	Official Bleach-R	Flavor	Per. No.	Peroxide No. Aged at 140°F. for ½ week	1 week	2 weeks	3 weeks	4 weeks	5 weeks	Swift Stability (100°C.) Hours to Rancidity	Swift Stability (100°C.) Per No. @ Rancidity
Crude		Central Texas	Sept. 1, 1939	0	....	1.1	4.1	5.6	6.0	1.9	Prime	.....	.....	.....	.....	.....	.....	.....	.....	.....
Crude	(A)	Central Texas	Apr. 1, 1940	7	....	1.1	4.8	7.3	7.0	1.9	Off	.....	.....	.....	.....	.....	.....	.....	.....	.....
Refined		Central Texas	Sept. 1, 1939	....	0	.03	....	....	6.0	1.9	Prime	1.0	.....	.....	.....	.....	.....	.....	.....	.....
Refined	(B)	Central Texas	Apr. 1, 1940	....	7	.03	....	....	5.1	1.9	Off	36.7	.....	.....	.....	.....	.....	.....	.....	.....
Ref. & Bl.**	(A)	Central Texas	Apr. 1, 1940	7	....	....	....	....	....	....		3.3	.....	24.9	55.2	64.4*	.....	.....	13¼	80.0
Ref. & Bl.**	(B)	Central Texas	Apr. 1, 1940	....	7	....	....	....	....	....		39.1	.....	49.7	58.9	86.0*	.....	.....	4¼	91.0
Crude		South Texas	Sept. 1, 1939	0	....	.7	4.4	4.6	4.9	1.1	Prime	.....	.....	.....	.....	.....	.....	.....	.....	.....
Crude	(A)	South Texas	Apr. 1, 1940	7	....	.8	4.6	4.8	5.6	1.2	Off	.....	.....	.....	.....	.....	.....	.....	.....	.....
Refined		South Texas	Sept. 1, 1939	....	0	.03	....	....	5.6	1.1	Prime	1.2	.....	.....	.....	.....	.....	.....	.....	.....
Refined	(B)	South Texas	Apr. 1, 1940	....	7	.03	....	....	4.8	1.2	Off	36.2	.....	.....	.....	.....	.....	.....	.....	.....
Ref. & Bl.**	(A)	South Texas	Apr. 1, 1940	7	....	....	....	....	....	....		3.1	.....	27.0	42.8	76.0*	.....	.....	11¼	59.0
Ref. & Bl.**	(B)	South Texas	Apr. 1, 1940	....	7	(This crude contained excess meal)						37.6	.....	46.3	72.8*	.....	.....	.....	4¼	83.0
Crude		East Texas	Sept. 1, 1939	0	....	1.2	5.6	6.0	4.3	1.2	Prime	.....	.....	.....	.....	.....	.....	.....	.....	.....
Crude	(A)	East Texas	Apr. 1, 1940	7	....	1.3	6.9	7.0	5.6	1.3	Off	.....	.....	.....	.....	.....	.....	.....	.....	.....
Refined		East Texas	Sept. 1, 1939	....	0	.03	....	....	4.4	1.2	Prime	1.4	.....	.....	.....	.....	.....	.....	.....	.....
Refined	(B)	East Texas	Apr. 1, 1940	....	7	.17	....	....	5.4	1.3	Off	47.5	.....	.....	.....	.....	.....	.....	.....	.....
Ref. & Bl.**	(A)	East Texas	Apr. 1, 1940	7	....	....	....	....	....	....		3.6	.....	26.0	55.2	76.5*	.....	.....	11½	46.0
Ref. & Bl.**	(B)	East Texas	Apr. 1, 1940	....	7	....	....	....	....	....		36.3	.....	42.3	71.3*	.....	.....	.....	3¼	72.0
Crude		Louisiana	Sept. 1, 1939	0	....	.6	4.4	4.5	5.0	.4	Prime	.....	.....	.....	.....	.....	.....	.....	.....	.....
Crude	(A)	Louisiana	Apr. 1, 1940	7	....	.7	4.6	4.8	5.6	1.2	Off	.....	.....	.....	.....	.....	.....	.....	.....	.....
Refined		Louisiana	Sept. 1, 1939	....	0	.03	....	....	5.0	.4	Prime	1.4	.....	.....	.....	.....	.....	.....	.....	.....
Refined	(B)	Louisiana	Apr. 1, 1940	....	7	.04	....	....	4.3	1.4	Off	40.5	.....	.....	.....	.....	.....	.....	.....	.....
Ref. & Bl.**	(A)	Louisiana	Apr. 1, 1940	7	....	....	....	....	....	....		2.7	.....	25.3	51.8	79.0*	.....	.....	12¾	71.0
Ref. & Bl.**	(B)	Louisiana	Apr. 1, 1940	....	7	....	....	....	....	....		41.5	.....	52.9	51.1*	.....	.....	.....	3½	90.0
Crude		Oklahoma	Feb. 1, 1940	0	....	.9	6.9	7.2	5.4	1.2	Prime	.....	.....	.....	.....	.....	.....	.....	.....	.....
Crude	(A)	Oklahoma	Aug. 1, 1940	6	....	1.1	7.4	8.9	6.2	2.1	Sl. off	.....	.....	.....	.....	.....	.....	.....	.....	.....
Refined		Oklahoma	Feb. 1, 1940	....	0	.02	....	....	5.4	1.2	Prime	.8	.....	.....	.....	.....	.....	.....	.....	.....
Refined	(B)	Oklahoma	Aug. 1, 1940	....	6	.03	....	....	3.1	1.4	Sl. off	89.0	.....	.....	.....	.....	.....	.....	.....	.....
Ref. & Bl.**	(A)	Oklahoma	Aug. 1, 1940	6	....	....	....	....	....	....		4.1	6.2	7.0	15.9	29.0	38.0	51.0*	7½	87.5
Ref. & Bl.**	(B)	Oklahoma	Aug. 1, 1940	....	6	....	....	....	....	....		24.0	35.1*	.....	.....	.....	.....	.....	1½	40.0
Crude		N. E. Texas	Feb. 1, 1940	0	....	.9	9.2	9.5	5.6	1.4	Prime	.....	.....	.....	.....	.....	.....	.....	.....	.....
Crude	(A)	N. E. Texas	Aug. 1, 1940	6	....	1.2	9.1	9.4	8.7	2.7	Sl. off	.....	.....	.....	.....	.....	.....	.....	.....	.....
Refined		N. E. Texas	Feb. 1, 1940	....	0	.02	....	....	5.6	1.4	Prime	1.5	.....	.....	.....	.....	.....	.....	.....	.....
Refined	(B)	N. E. Texas	Aug. 1, 1940	....	6	.03	....	....	2.9	1.3	Sl. off	68.0	.....	.....	.....	.....	.....	.....	.....	.....
Ref. & Bl.**	(A)	N. E. Texas	Aug. 1, 1940	6	....	....	....	....	....	....		4.2	6.9	8.5	20.1	32.5	43.1	55.0*	11	88.0
Ref. & Bl.**	(B)	N. E. Texas	Aug. 1, 1940	....	6	....	....	....	....	....		32.5	40.0*	.....	.....	.....	.....	.....	3	95.0
Crude		West Texas	Feb. 1, 1940	0	....	.9	6.7	6.7	5.5	1.9	Prime	.....	.....	.....	.....	.....	.....	.....	.....	.....
Crude	(A)	West Texas	Aug. 1, 1940	6	....	1.4	6.5	7.0	7.0	2.6	Sl. off	.....	.....	.....	.....	.....	.....	.....	.....	.....
Refined		West Texas	Feb. 1, 1940	....	0	.02	....	....	5.5	1.9	Prime	1.4	.....	.....	.....	.....	.....	.....	.....	.....
Refined	(B)	West Texas	Aug. 1, 1940	....	6	.03	....	....	2.9	1.4	Sl. off	67.0	.....	.....	.....	.....	.....	.....	.....	.....
Ref. & Bl.**	(A)	West Texas	Aug. 1, 1940	6	....	....	....	....	....	....		3.0	6.6	8.0	17.5	27.8	37.6	50.0	11¼	92.5
Ref. & Bl.**	(B)	West Texas	Aug. 1, 1940	....	6	....	....	....	....	....		25.1	41.0*	.....	.....	.....	.....	.....	3	113.0

** Laboratory Bleached using 2% natural Texas fuller's earth.

*Organoleptic Rancidity Point

TABLE No. II.

QUALITY CHANGES AND HISTORY OF STORED CRUDE COTTONSEED OIL SUBSEQUENTLY REFINED AND STORED IN LARGE INDUSTRIAL STORAGE TANKS

Date of Sample or History	Avg. Atm. Temp. °F. Past Mo.	D Storage—Max. capacity 2,000,000 lbs.—Contents—Crude cottonseed oil								E Storage—Max. capacity—2,000,000 lbs.—Contents—Crude cottonseed oil							
		Avg. Age Mos.	Lbs. in Storage	% F.F.A.	Settlement Loss %	Other Cup Loss %	Refined Color-R.	Official Bleach-R.	REMARKS	Avg. Age Mos.	Lbs. in Storage	% F.F.A.	Settlement Loss %	Other Cup Loss %	Refined Color-R.	Official Bleach-R.	REMARKS
Nov. 1, 1939	69	....	0	....	....	....	....	....		....	175,000	....	....	....	....	....	Filling tank direct from currently received tank cars.
Dec. 1, 1939	61	....	0	....	....	....	....	....		....	650,000	....	....	....	....	....	Filling tank direct from currently received tank cars.
Jan. 1, 1940	49	....	740,000	....	....	....	....	....	Filling tank directly from currently received tank cars.	1	1,900,000	0.7	5.0	....	4.7	0.9	This analysis average of all cars put in storage.
Feb. 1, 1940	34	....	980,000	....	....	....	....	....	Filling tank directly from currently received tank cars.	2	1,900,000	....	....	....	....	....	Stored untouched.
Mar. 1, 1940	43	1	1,830,000	0.8	5.7	....	5.0	1.0	This analysis-avg. of all cars put in storage.	3	1,900,000	....	....	....	....	....	Stored untouched.
Apr. 1, 1940	56	2	1,900,000	0.8	6.1	6.3	5.6	1.5	Store untouched.	4	1,900,000	0.7	5.0	5.0	5.5	1.5	Stored untouched.
May 1, 1940	65	3	1,900,000	0.8	5.8	6.1	5.8	1.9	Store untouched.	5	940,000	0.7	5.3	5.2	5.6	1.9	1,000,000 lbs. refined during April.
June 1, 1940	71	4	0	0.8	5.8	6.3	6.0	2.1	All of this crude refined in May.	....	0	....	....	....	....	....	Remaining oil refined during May.
		(All of this oil was consumed as refined)								(Part of this oil as refined was put in storage)							

Date of Sample or History	Avg. Atm. Temp. °F. Past Mo.	A Storage—Max. capacity 1,000,000 lbs.—Contents—Refined CSO from Crude Stored in E Storage													C Storage—Max. capacity 330,000 lbs.—Contents—Refined CSO from Crude Stored in E Storage											
		Avg. Age Mos.	Lbs. in Storage	% F.F.A.	Per. No.	Color-R.	Official Bleach-R.	Flavor	Impurities	% Moisture	% Volatile	Soap P.P.M.	Per No. Aged at 140° F. 1 wk.	2 wks.	3 wks.	Avg. Age Mos.	Lbs. in Storage	% F.F.A.	Per. No.	Color-R.	Official Bleach-R.	Flavor	Impurities	% Moisture	% Volatile	Soap P.P.M.	Per No. Aged at 140° F. 1 wk.	2 wks.	3 wks.
Apr. 1, 1940	56	0	0	....	....	....	....	....	....	....	....	....	....	....	....	....	0	.03	0.8	6.3	2.5	Prime	None	As refined and put into storage					
May 1, 1940	65	0	0	.04	0.8	6.2	1.9	Prime	None	As refined and put into storage						....	280,000	.03	3.3	6.3	2.5	Prime						
May 15, 1940	68	½	1,060,000	.03	1.7	6.8	2.3	Prime	None							1½	Re-refined and put back into storage											
June 1, 1940	71	1	1,060,000	.04	3.5	6.2	2.0	Prime	None	None	.07	36	18.0	35.0*	....	2	280,000	.02	1.4	6.0	1.9	Prime	None	....	.09	78	19.0	30.0*	....
July 1, 1940	77	2	970,000	.05	4.4	5.5	2.5	Prime	None	None	.08	71	41.5*	....	....	....	0	....	....	....	....	....	....	....	....	....	....	....	....
July 15, 1940	79	....	0	....	....	....	....	....	....	....	....	....	....	....	....	....													
		A Storage Bottoms—same as above except sample taken at very bottom														C Storage Bottoms—same as above but sample taken at very bottom												
June 1, 1940	71	1	1,060,000	.04	4.2	6.2	2.0	Prime	None	None	.11	63	29.0	49.0	90.0*	2	280,000	.02	1.4	6.1	1.9	Prime	None	None	.11	236	16.8	25.5*	.....

*Organoleptic rancid point on rapidly aged refined oil as sampled.

(.03 to .17%). On the new crop oil, both as crude and as refined, the F.F.A. rise was less than on end of season oil. However, the end of season oil was stored in warmer months.

2.) The average refining loss on the stored crude increased about .6% although results were quite variable; some samples increasing none and others increasing as much as 1.5% with no apparent reason for the differences, including the presence of meal in the original crude.

3.) The average refined color on the stored crude rose 1.3 red while on the stored refined oil it dropped 1.2 red. The greatest changes in colors were apparent on the end of season oils which were, however, stored in the warmest months.

4.) The average official bleach on the stored crude rose .6 while on the stored refined oil it rose only .3 red. This rise in official bleach on both stored crude and refined oil varied from zero to 1.0 red without any apparent reason for the difference.

5.) No conclusions are made from the peroxide number development in storage or development on rapidly aged samples at 140° F., since the induction period cannot be ascertained from the limited data, and further, since it is doubtful whether peroxide development bears any direct relationship to stability under these noncomparable conditions.

6.) The average organoleptic rancid point on one set of samples rapidly aged at 140° F. was 3 weeks on bleached oil from stored crude and 2 weeks on bleached oil from stored refined oil. On another set, the extreme difference of 5 weeks on bleached oil from stored crude vs. ½ week on bleached oil from stored refined oil was noted.

7.) The average rancid point with the Swift Stability test was 11 hours on bleached oil from stored crude and 3 hours on bleached oil from stored refined oil.

SMALL SAMPLES STORAGE CONCLUSIONS

From the results of the small sample storage tests it is concluded that:

1.) From the standpoint of refining loss, free fatty acid development, and bleachability, it is more desirable to store cottonseed oil as refined than as crude.

2.) From the standpoint of stability, as measured by organoleptic rancidity development, it is much more desirable to store cottonseed oil as crude than as refined. (Note later contradictory results.)

3.) Cottonseed oil definitely deteriorates in storage regardless of whether stored as crude or as refined. The refined color rise in stored crude, as compared with the color drop in stored refined oil, may or may not be objectionable and might even indicate greater stability for the crude storage if the color change cycle were known. Again, this color change may be independent of the color cycle resulting from oxidation, being merely a solution of colored particles during storage.

INDUSTRIAL STORAGE PROCEDURE

In the past season's plant refining operations a certain amount of the current receipts of crude cottonseed oil were stored for 3 to 5 months in large outside storage tanks. The crude stored represented middle season production and only the best quality crude received during the months of December, January, and February, were selected for storage. Selection was based on crude being free from suspended meal or foreign matter and having an official laboratory bleach of 1.0 red or under. These selected cars of crude were pumped directly from tank cars to storage tanks without any treatment. After the storage period this crude was plant refined, and a certain portion of the produced refined oil from this stored crude was subsequently stored in outside storage tanks for a period of about 2 months.

The remainder of the season's crude receipts not stored was currently refined as received, and a certain portion of this freshly refined oil was stored in large outside storage tanks for periods as long as nine months.

All plant refining of the crude cottonseed oil, whether from currently received or stored crude, was done in the same conventional centrifugal refining procedure using Sharples equipment, double water washed, vacuum dried, and the produced refined oil pumped to storage directly after drying without filtration.

All outside storage tanks used for storing the crude or refined oil were conventional sheet iron tanks of capacities between one and 2½ million pounds of oil each. None of these tanks were equipped with heating coils, so no heat was applied during the storage period. The stored oils were untouched during their respective storage periods.

All tanks were sampled monthly by compositing depth samples at every five feet of oil in the tanks, and laboratory analyses were run promptly. Conventional or official laboratory procedure was used throughout.

INDUSTRIAL STORAGE RESULTS

The following results are shown in the data of Table II regarding the quality changes occurring in the storage of crude oil and subsequent storage of the refined oil produced from this stored crude:

1.) The F.F.A. on the stored crude or the subsequently stored refined oil did not change during storage.

2.) The refining loss on the stored crude rose very slightly in storage, averaging only .2% increase.

3.) The average refined color on the stored crude increased 1.0 red in storage while the color of the subsequently refined oil decreased .5 red in storage.

4.) The average official bleach on the stored crude increased 1.0 red (1.0 to 2.0), and on the subsequently stored refined oil the official bleach showed a slight increase although the data are confusing.

5.) No appreciable change in flavor, either on the stored crude or subsequently stored refined oil, could be noted.

The following results are shown in the data of Table III regarding the quality changes occurring in the storage of refined cottonseed oil produced from unstored crude:

1.) There was no appreciable change in F.F.A.

2.) There was no appreciable change in color.

3.) There was no appreciable change in the official laboratory bleach.

4.) No appreciable change in flavor could be noted.

Comparing the data on Table II and Table III, the following results are shown regarding the comparative

TABLE No. III.

QUALITY CHANGES AND HISTORY OF REFINED COTTONSEED OIL PRODUCED FROM FRESH CRUDE AND STORED IN LARGE INDUSTRIAL STORAGE TANKS

Date of Sample or History	Avg. Atm. Temp. °F. Past Mo.	F Storage—Max. capacity 2,500,000 lbs.—Contents—Refined CSO from fresh crude														G Storage—Max. capacity 2,500,000 lbs.—Contents—Refined CSO from fresh crude												
		Avg. Age Mos.	Lbs. in stg.	% F.F.A.	Per. No.	Color-R.	Official Bleach-R.	Flavor	Impurities	% Moisture	Volatile	Soap P.P.M.	Per No. Aged at 140° F. 1 wk.	2 wks.	3 wks.	Avg. Age Mos.	Lbs. in stg.	F.F.A.	Per No.	Color-R.	Official Bleach-R.	Flavor	Impurities	% Moisture	% Volatile	Soap P.P.M.	Per No. Aged at 140° F. 1 wk.	2 wks.	3 wks.
Oct. 1, 1939	84	....	0	....	....	....	....	....	.....	.....	....	.....	.....	.....	.....	.....	0	....	....	....	....	....	.....	.....	....	.....	.....	.....	.....
Nov. 1, 1939	69	0	160,000	.03	.2	6.3	1.9	Prime	None	As refined and put into storage						0	....	....	....	....	....	.....	.....	....	.....	.....	.....	.....
Dec. 1, 1939	61	1	2,500,000	....	....	....	....	....	.....	.....	....	.....	.....	.....	.....	.....	0	....	....	....	....	....	.....	.....	....	.....	.....	.....	.....
Jan. 1, 1940	49	2	2,500,000	....	....	....	....	....	.....	.....	....	.....	.....	.....	.....	0	260,000	.04	.2	6.5	1.9	Prime	None	As refined and put into storage				
Feb. 1, 1940	34	3	2,500,000	....	....	....	....	....	.....	.....	....	.....	.....	.....	.....	1	1,830,000	....	....	....	....	....	.....	.....	....	.....	.....	.....	.....
Mar. 1, 1940	43	4	2,500,000	.03	....	5.8	2.3	Prime	None	.....	....	.....	.....	.....	.....	2	2,500,000	.04	....	7.0	2.5	Prime	None	.....	....	.....	.....	.....	.....
Apr. 1, 1940	56	5	2,500,000	.02	....	6.3	1.9	Prime	None	.....	....	.....	.....	.....	.....	3	2,500,000	.03	....	6.3	1.9	Prime	None	.....	....	.....	.....	.....	.....
May 1, 1940	65	6	2,400,000	.03	4.6	6.3	1.9	Prime	None	.....	....	.....	.....	.....	.....	4	2,000,000	.04	3.5	6.3	2.0	Prime	None	.....	....	.....	.....	.....	.....
June 1, 1940	71	7	2,400,000	.04	4.2	5.9	1.9	Prime	None	None	.07	74	16.0	20.3	40.0*	5	2,500,000	.04	3.2	6.3	1.8	Prime	None	None	.09	39	14.8	23.3	34.4*
July 1, 1940	77	8	2,000,000	.05	4.1	6.3	2.1	Prime	Trace	None	.06	107	21.0	.....	.....	6	2,500,000	.05	3.4	7.0	2.1	Prime	Trace	None	.09	162	22.9	.....	.....
Aug. 1, 1940	81	9	700,000	.04	5.4	5.3	2.1	Prime	None	None	....	133	17.6	33.1	.....	7	2,200,000	.04	4.2	6.3	1.9	Prime	None	None	....	104	15.0	29.2	.....
**Aug. 15, 1940	84	9½	60,000	.05	5.8	4.8	2.1	Prime	Some	Trace	....	342	20.4	30.3*	.....	7½	60,000	.06	3.8	7.0	1.7	Prime	Some	Trace	....	265	27.8	38.4*	.....
		* Organoleptic rancidity point on rapidly aged refined oil as sampled														* organoleptic rancidity point												
June 1, 1940	....	7	Bottoms	.04	3.8	5.8	1.9	Prime	None	None	.06	87	18.0	23.5	46.0*	.....	Bottoms	.04	3.1	6.4	1.9	Prime	Some	Trace	.10	120	15.0	21.1	39.9*

Date of Sample or History	Avg. Atm. Temp. °F. Past Mo.	K Storage—Max. capacity 2,500,000 lbs.—Contents—Refined CSO from fresh crude														L Storage—Max. capacity 2,500,000 lbs.—Contents—Refined CSO from fresh crude												
		Avg. Age Mos.	Lbs. in stg.	% F.F.A.	Per. No.	Color-R.	Official Bleach-R.	Flavor	Impurities	% Moisture	Volatile	Soap P.P.M.	Per No. Aged at 140° F. 1 wk.	2 wks.	3 wks.	Avg. Age Mos.	Lbs. in stg.	F.F.A.	Per No.	Color-R.	Official Bleach-R.	Flavor	Impurities	% Moisture	% Volatile	Soap P.P.M.	Per No. Aged at 140° F. 1 wk.	2 wks.	3 wks.
Nov. 1, 1939	69	....	0	....	....	....	....	....	.....	.....	....	.....	.....	.....	.....	.....	0	....	....	....	....	....	.....	.....	....	.....	.....	.....	.....
Dec. 1, 1939	61	0	200,000	.04	.2	6.6	2.1	Prime	None	As refined and put into storage						0	1,300,000	.04	.2	6.9	2.3	Prime	None	As refined and put into storage				
Jan. 1, 1940	49	1	2,500,000	....	....	....	....	....	.....	.....	....	.....	.....	.....	.....	1	2,500,000	....	....	....	....	....	.....	.....	....	.....	.....	.....	.....
Feb. 1, 1940	34	2	2,500,000	....	....	....	....	....	.....	.....	....	.....	.....	.....	.....	2	2,500,000	.06	....	6.3	2.5	Prime	None	.....	....	.....	.....	.....	.....
Mar. 1, 1940	43	3	2,500,000	.05	....	6.5	1.9	Prime	None	.....	....	.....	.....	.....	.....	3	2,500,000	.03	....	6.3	2.1	Prime	None	.....	....	.....	.....	.....	.....
Apr. 1, 1940	56	4	2,500,000	.03	....	6.3	2.1	Prime	None	.....	....	.....	.....	.....	.....	4	2,300,000	.04	1.9	7.0	2.5	Prime	None	.....	....	.....	.....	.....	.....
May 1, 1940	65	5	2,500,000	.05	2.6	7.2	2.1	Prime	.....	.....	....	.....	.....	.....	.....	5	1,000,000	.04	2.8	6.2	2.1	Prime	Trace	None	.06	29	29.6	43.9	57.7*
June 1, 1940	71	6	2,000,000	.04	3.3	6.3	2.1	Prime	Trace	None	.09	32	14.8	19.0	30.6*	.....	0	....	....	....	....	....	.....	.....	....	.....	.....	.....	.....
July 1, 1940	77	7	1,000,000	.05	4.6	7.5	2.5	Prime	Trace	None	.08	141	16.5	.....	.....	.....	0	....	....	....	....	....	.....	.....	....	.....	.....	.....	.....
Aug. 1, 1940	81	....	0	....	....	....	....	....																					
		* Organoleptic rancidity point on rapidly aged refined oil as sampled														* organoleptic rancidity point												
June 1, 1940	....	6	Bottoms**	.04	2.8	6.4	2.0	Prime	Trace	Nine	.07	90	17.2	23.8	51.0*	5	Bottoms**	.04	2.7	6.3	2.3	Prime	Trace	None	.08	40	30.1	47.0	72.8*

** Last 60,000 removed from tank.

quality changes in stored refined oil produced from stored crude vs. fresh crude:

1.) There was no appreciable difference in the two types of oil regarding F.F.A. or flavor change.
2.) The refined oil from stored crude indicated a slight rise in color and bleach while no appreciable change in these two characteristics was noted on the refined oil from fresh crude.
3.) The average rancid point to organoleptic rancidity on the stored oils as rapidly aged at 140° F. showed 2 weeks for the refined oil produced from stored crude and 3 weeks for the refined oil produced from fresh crude.
4.) Peroxide number development on the two types of refined oil during these storage periods showed a more rapid development in the oil produced from the stored crude than from the freshly refined crude.
5.) The peroxide number development on rapidly aged samples at 140° F. was greater in the case of the stored refined oil produced from stored crude than that produced from fresh crude, although the data are limited and somewhat confusing.
6.) No conclusions are made from the data shown on moisture, volatile matter, impurities or soap content as the data are too limited or erratic.

INDUSTRIAL STORAGE CONCLUSIONS

From the results of quality changes in cottonseed oil stored in large industrial storage tanks, it is concluded that:

1.) Good quality crude cottonseed oil can be successfully stored for 5 months at least in cool but not necessarily cold weather without any appreciable change in F.F.A., refining loss, color, or flavor; but the ease of bleaching is noticeably decreased and the stability of the oil is probably decreased appreciably.
2.) Refined cottonseed oil produced from good quality stored crude can be successfully stored, but the ease of bleaching and stability will be somewhat inferior to that of stored refined oil produced from average fresh crude.
3.) Most quality characteristics studied indicate that it is more desirable to store cottonseed oil as refined than as crude. No quality characteristic studied indicated the desirability of storing crude.

PLANT OPERATING NOTES AND CONCLUSIONS

On refining the stored crude oil, plant data indicated that the refining loss may have been slightly higher than if the crude had been refined fresh. However, this observation, as measured by comparison with the entire season's refining losses by months, was within the limits of error on plant data and other related information to be considered. The increase in loss, if any, probably did not exceed .3%.

No deviations from normal refining behavior could be noticed. The relationship between laboratory and plant colors, and bleached colors, seemed to be normal.

In plant bleaching of the refined oil produced from the stored crude, it was found to be somewhat more difficult to get the same color as compared with bleaching comparable stored refined oil produced from fresh crude. This tendency toward lesser color drop in bleaching seemed also to be reflected in deodorization. Standard Shortening made from refined and bleached stored crude did not drop in color during deodorization as much as comparable shortening at the same pre-deodorizing color made from stored refined and bleached oil from fresh crude.

All refined oil stored was clear and free from visible impurities at the time of initial storage, although none of the oil stored was filtered. However, when the storage tanks were emptied after the storage period, some impurities had settled to the bottom of all tanks; although the bulk of the oil above the bottom foot of depth was still clear and free from impurities.

No operating differences between the processing of the two types of oil could be noticed in hydrogenation, winterization, or plasticization.

No conclusion can be made as to any differences in stability of packed products using the two types of oil, as routine data indicative of stability showed only normal results.

GENERAL CONCLUSIONS

If cottonseed oil is to be stored industrially, it is preferable to do so in the refined state rather than as crude, considering almost all quality and economic factors involved.

The advantages of storing cottonseed oil as crude, from a stability point of view as shown by the results of the small sample storage tests, are contradicted by the results of the large industrial storage tests. The writer emphasizes the results of the latter tests under large scale operating conditions, minimizing the results of the small sample storage tests, to the conclusion that storing cottonseed oil as crude lessens the stability of the subsequently refined oil as compared with stored refined oil made from comparable fresh crude.

Good quality crude cottonseed oil can be stored industrially under the conditions herein described without any prohibitive deterioration in quality characteristics or marked increase in subsequent processing costs.