after three hours' aeration, and between the fifth and sixth hours volatile acids were evolved in amounts sufficient to decolorize 0.01 N NaOH and phenolphthalein solution placed at the outlet side of the gas stream.

Inspection of the data in Table III indicates that the diene number increases with increased values for peroxides and other oxidation products. In fact, the data given in Table III may be related within the limits of experimental error by the equation: D. No. = 0.226 Hydroxyl No. + 0.0127 Peroxide No.

TABLE III.—EFFECT OF ACCELERATED OXIDATION ON THE PROPERTIES OF REFINED SOYBEAN OIL

Aeration time Hours	Peroxide number[7]	Iodine number	Diene number	Hydroxyl number	Acid number	Refractive index n^{25}/D
0..........	18.5 (10)[8]	130.4 (5)	0.7 (18)	3.9 (2)	0.6 (2)	1.4730 (1)
1..........	31.4 (6)	130.5 (6)	1.1 (3)	...	...	1.4730 (3)
2..........	45.1 (6)	130.1 (6)	1.2 (4)	...	...	1.4730 (3)
3..........	60.5 (6)	130.3 (6)	1.1 (4)	4.1 (2)	1.1 (1)	1.4730 (3)
4..........	75.9 (6)	130.1 (6)	1.4 (4)	...	...	1.4731 (3)
5..........	92.4 (6)	129.8 (6)	1.8 (3)	...	...	1.4732 (3)
6..........	111.7 (6)	129.5 (6)	2.3 (3)	4.2 (2)	1.2 (2)	1.4733 (3)
7..........	137.8 (4)	128.8 (4)	3.0 (2)	...	...	1.4734 (2)
8..........	164.5 (5)	128.4 (5)	4.2 (2)	6.1 (2)	2.2 (2)	1.4737 (3)
10..........	341.8 (4)	125.7 (5)	7.9 (2)	11.5 (1)	4.3 (1)	1.4743 (1)

[7]See reference (21).
[8]Values in parenthesis indicate the number of determinations which were made and averaged.

In order to determine the effect of the presence of aldehydes on the magnitude of the diene number butyraldehyde, crotonaldehyde, and octylaldehyde were added in a concentration of 5 percent to samples of refined soybean oils after which the diene numbers were determined in the usual manner. The values found for diene number of the three aldehyde-treated oils were, respectively, 0.8, 1.2, and 1.2, compared with 1.3 for the untreated oil. These values would seem to indicate that aldehydes in amounts in excess of those normally found in natural oils and fats do not affect the magnitude of the diene number.

SUMMARY

An investigation of certain factors affecting the determination of diene values of soybean and other vegetable oils by the Kaufmann and Ellis methods indicates that these methods do not necessarily measure the true extent of conjugation in oils of low diene value.

It has been established that the presence in fats and oils of hydroxyl groups, peroxides, and possibly other oxidation products influences the magnitude of the diene value apparently as a result of the reactivity of these substances with maleic anhydride under the conditions of the Kaufmann and Ellis methods.

Pure hydroxylated compounds having appreciable initial diene values were found to have little or no diene value after acetylation. However, soybean, perilla, and linseed oils having low initial diene values were found to have increased diene values following acetylation. Further work pertaining to the effect and significance of acetylation, as well as other chemical treatments, on the diene value and drying properties of soybean oil will be reported in a separate communication.

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AN INVESTIGATION OF INVISIBLE LOSSES IN EXPELLER OPERATION

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Abstract

Description and results of a test run on a single Expeller mill set up for cotton seed crushing to determine losses. A material balance is included showing that the unaccounted for loss in the process was very small.

RECENTLY there has been considerable discussion centering on the question of whether or not there were so-called invisible losses in Expeller operation in cotton seed milling, and, if so, what has caused them and where they have been located in the course of operation.

In order to ascertain the facts in this matter, a test was arranged and run at one of the larger cotton oil mills in the South.

In order that data obtained might be unbiased and fair to all concerned, all testing, sampling, weighing and analysis was placed in the hands of the Barrow-Agee laboratories of Memphis, Tennessee, Mr. Mays of that organization overseeing all operations.

The test was run over a twenty-four-hour period from eight o'clock of one morning until eight o'clock of the following morning.

Little need be said concerning the equipment. The Expeller was of the type known as the Anderson Super Duo with three high tempering apparatus, extra long vertical drainage barrel and standard main drainage barrel, powered with a forty-horsepower motor. It was equipped to have oil cooling over both barrels. In other words cooled oil was circulated over the barrels to control their temperature to a predetermined point. Auxiliary equipment included a vibrating screen through which all oil produced was strained and from which the separated foots fed back automatically into the lower trough of the tempering apparatus, a recessed plate filter press, and an Anderson gravity scraper meats dryer. The filter press cake was also fed back for repressing through a conveyor system to the lower trough of the tempering apparatus.

The method of operation was:

Meats for the Expeller were taken from the meats feed stream. The meats were weighed by hand in one hundred pound batches, dumped into a screw conveyor which carried them to an attrition mill to be cracked. From this they were carried up a drag elevator and dropped across a magnet plate, for retaining scrap iron, then into the dryer, from the discharge of which they were carried through screw conveyors to the hopper over the Expeller. Products from the Expeller, that is, the cake and oil, were weighed, the cake in seventy-five pound batches, and the oil, after being filtered, in one hundred pound batches. Samples were taken of the meats from the conveyor and from the Expeller stream. These were taken simultaneously; in the case of the Expeller stream, a small amount from each batch weighed, in the other, a handful sampled from the lines. Samples were also taken from each batch of cake and oil weighed. These samples were composited every three hours, making a total of eight samples of each material taken during the twenty-four hour period. The seed sample was split from the standard twelve-hour mill sample.

The Expeller was operated for about twenty-one hours prior to the start of the test to bring it up to operating temperature equilibrium. At the start of the twenty-four hour period, the filter press was empty and the oil cooling reservoir filled to a marked level, in order that these same conditions might be obtained at the end of the run.

Inasmuch as one source of possible loss was said to be oil loss through evaporation of oil due to high temperatures, a careful check was kept of temperatures throughout the system. A special thermocouple and pyrometer hook-up was used to read these and the instrument itself was checked against a standard temperature several times during the run to assure the accuracy of readings. The following table shows the average of the hourly readings taken:

TABLE 1

1.	Meats entering dryer	60°F.
2.	Meats leaving dryer	160°
3.	Meats entering down spout	217°
4.	Top of vertical barrel	210°
5.	Middle of vertical barrel	230°
6.	Bottom of vertical barrel	235°
7.	Feed section horizontal barrel	226°
8.	Center section horizontal barrel	226°
9.	Discharge section horizontal barrel	211°
10.	Cooling oil to barrels	129°
11.	Steam pressure on dryer	11.5 lb./sq. in.

was a certain amount of filter press cake which could not be run back through the Expeller. Since, as was possible with the foots run back during the run, this filter press cake could have been pressed with the meats down to the same oil content as the rest of the cake, this item was added in as a material recovered.

It is known that moisture is lost to the atmosphere from the materials being worked. Therefore, the difference between the moisture con-

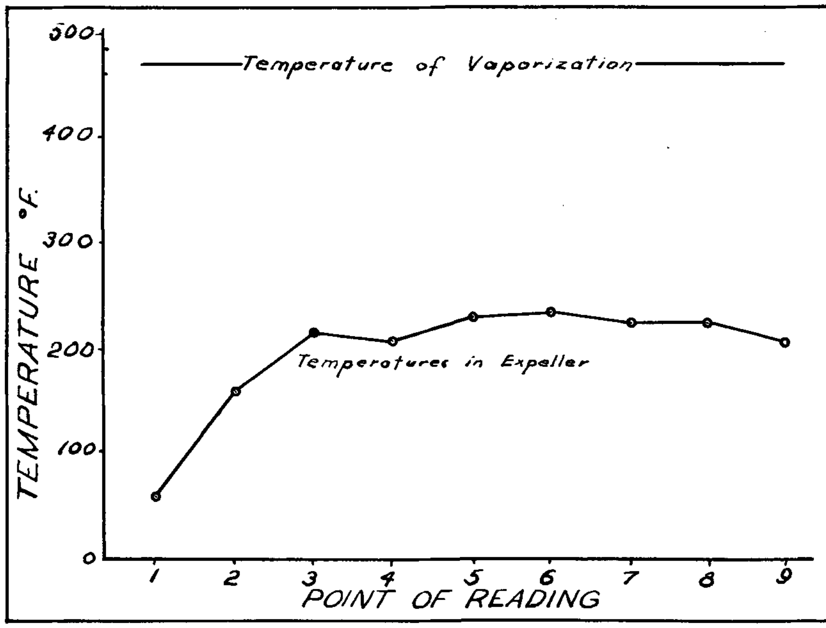

FIGURE 1

Inasmuch as it has been determined by several investigators, and reported in such standard works as Lewkowitsch, that the point at which crude cottonseed oil begins to break down is between 240° C. and 250° C, or 464° F. and 482° F., it would appear obvious from Table I and Figure 1 that no oil was lost through vaporization.

Table 2 is a material balance in which meats weighed in are balanced against products recovered.

Inasmuch as the test had to be stopped exactly on the hour, there

tent of the meats and that of the cake was added in as a product accounted for. The moisture contained in the filter press cake and in the oil was negligible.

It should be noted that in all Expeller operations, no matter whether the material being pressed is cottonseed, flax, soybean or some other product, moisture can be, and is, added back to the cake to bring the moisture content up to from 7 to 12 per cent, depending on what is desired, thus producing a cake containing more or less moisture than

TABLE 2—MATERIAL BALANCE

MATERIAL IN		MATERIAL OUT		
Raw Meats to System	28,000 lbs.	Cake		17,888 lbs.
Analysis		Analysis		
Moisture 10.70% or 2996 lbs.		Moisture	3.51% or 628 lbs.	
Oil 28.39% or 7949 lbs.		Oil	4.81% or 1431 lbs.	
		Oil		7,060 lbs.
		Filter Press Cake		307 lbs.
		TOTAL PRODUCTS RECOVERED		25,255 lbs.
		Moisture Shrinkage, 2996 — 628 lbs.		2,368 lbs.
		TOTAL PRODUCTS ACCOUNTED FOR		27,623 lbs.
		Unaccounted for, 28,000 — 27,623 lbs.		377 lbs.
Total In	28,000 lbs.	Total Out		28,000 lbs.

hydraulic cake, according to the mill superintendent's wish.

The difference between the material weighed in and the weight of the products accounted for is the invisible loss and amounts, for the twenty-four hour period of the test, to three hundred seventy-seven pounds, or 1.34 per cent of the meats run. Taking a figure of 1263 pounds of meats per ton of clean seed, derived from the seed analyses, gives a figure of 22.17 tons clean seed worked during the twenty-four hours. The invisible loss, calculated on this more common basis, amounts to 0.85 per cent.

Since the total amount of oil produced amounted to 7,060 pounds and analysis showed 860 pounds oil in the cake and 148 pounds oil in the filter press cake, the total oil thus accounted for amounted to 8,068 pounds, or a gain of 119 pounds over the indicated oil content of the original meats. This serves to show that experimental error, probably largely in sampling for analysis and weighing the many batches, introduced an experimental error that might well have made the over all figures show a gain rather than a loss.

It is believed that the data obtained would be considerably more accurate if the test could have been run over a much more extended period of time in order to minimize possible inequalities of start-up and stop times. Furthermore, the samples were, of necessity, taken on one day and run the next, and, while they were kept in tight cans, moisture changes must inevitably have crept in, especially in the cake samples, which were taken hot.

This test thus indicates that there is no more than a negligible amount of unaccounted for loss in Expeller operation on cottonseed.

THE PRESSURE COOKING OF COTTONSEED MEATS AND ITS APPLICATION TO THE EXPELLER

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Abstract

A discussion of the design of and results obtained from a new type of cotton seed cooker with special reference to its effect on the oil produced by the Expeller.

DURING the past several years a considerable amount of work has been done at the University of Tennessee Engineering Experiment Station at Knoxville on the pressure cooking of cottonseed meats. This work showed such great promise that, when the opportunity to install an Expeller in the experimental setup presented itself, it was gladly accepted.

The Expeller used in the work was what is known as an Anderson Half-Size Model DUO. This is a working model of the standard DUO machine, but with one-half the linear dimensions. It is small enough for easy workability and handling but large enough so that its results are directly transferable in practice to the larger machines. It was equipped with an agitated "hat box" feeder of sufficient size to hold batch lots as they were dumped in.

The setup at Knoxville consists of a complete small oil mill. The seed is shipped in delinted but not hulled, and is handled according to standard mill practices until it reaches the cooker. Here, instead of an ordinary stack cooker, the new pressure cooker, designed by Mr. F. W. Weigel and built by the T. V. A. for the Experiment Station, is used. The meats from this cooker are then pressed, either in a box press or in the Expeller.

It would probably be well to say a few words about the pressure cooker and the characteristics of the cooked meats it produces.

In appearance it resembles a large bucket built of steel plates, thirty-three inches in diameter by forty inches in length, internal dimensions, with a cover and resting in a horizontal position. There is a one-inch steam jacket completely surrounding its ends and circumference. Agitation is one of the most important and best worked out features of the cooker. It is supplied by a set of opposed helixes operating on a shaft turning at about 40 r.p.m. These helix blades are two inches in width and three-quarters of an inch thick. They are machined, as is the entire interior of the shell, to obtain the desired one-sixteenth-inch clearance between the blades and the shell. Each pair of helixes tends to throw the material to the center, longitudinally, of the cooker, where there is a one-inch space between the two sets for thermometers or other instruments. The knives in each set are 180° apart and one set is 90° in advance of the other.

Since the scrapers curve as helixes, they cut into the material at an angle of about 45°, not only pushing it, but sliding it, and are thus self-cleaning. Actually, the knives, side walls and thermometer are, at all times, cleaned and polished by the action, although, at one stage of the cooking, the material has the consistency of half-cooked oatmeal. Inasmuch as a two-inch layer of meats is wiped from the bottom and thrown into the upper parts of the cooker 76 to 80 times a minute, the effect is that the meats are, for all practical purposes, in suspension in the cooker. The meats are dumped in through a hole, at the top, sealed by a screw clamp lid on a flange. The meats are released after the cooking and pressure blow-off through a steam-piston actuated, hinged, trap, discharge door.

Besides the jacket steam inlet pipes, the cooker is so equipped as to permit controlled entry of steam to the batch itself. There is an adjustable bleeder valve to control interior pressure, set at present for fifteen pounds. Duration of blow off of pressure at the end of the cook is controlled by a needle valve.

The method of operation is as follows:

The charge of rolled meats, usually from 350 to 500 pounds, is dumped in while the agitator shaft is rotating and the steam jacket carrying from 125-150 pounds per square inch steam pressure. The door is then clamped shut. As the temperature of the meats rises, moisture is given off and a pressure is built up. The objective is a condition, determined to give best results by many trial and error experiments, of from 15 to 17 pounds