Improving Soy Bean Oil Color

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FUNDAMENTAL improvements in Expeller design in recent years have resulted not only in tripling capacities and materially increasing pressing efficiency, but also on some materials they have created problems in oil quality.

On soya beans, for instance, the old Anderson No. 1 type Expeller had a capacity of about 200 bushels of beans in 24 hours when producing cake averaging 4½ to 5% oil content. At this rate it required about 15 HP., and produced a crude oil averaging 20 to 21 red and 100 yellow. The temperature of the barrel or cage of the Expeller when doing this work ranged from about 200 to 230° F. when the temperature of the heated beans entering the barrel was held at 270° F.

Under the same conditions and on the same kind of beans, the Anderson R B Expeller, an improved type which first appeared about ten years ago, had a capacity of about 400 bushels of beans in 24 hours when leaving 4½ to 5% oil in the cake, and at this rate it required about 25 HP. The crude oil averaged 35 to 40 red and 130 yellow, while the barrel temperature ranged from 270 to 320° F. Thus, with an increase of about 100° in barrel temperature and double the capacity, the oil color nearly doubled. Another factor affecting the oil color is the amount of foots squeezed out of the barrel with the oil, and this necessarily increases with the higher pressures and capacities used in the modern Expellers.

Coming to the most modern Expeller of all, the Super DUO, it was found to have a capacity of about 600 bushels of beans in 24 hours when leaving 3.8 to 4.5% oil in cake. At this rate it consumes about 45 HP. and the oil color ran up to 40 to 50 red and 150 yellow, while the barrel temperature was found to be from 320 to 350° F.

Thus the Super DUO, having three times the capacity of the old No. 1 Expeller and leaving about 1% less oil in the cake, produced oil of somewhat more than double the red color. As this color is objectionable for some uses, experiments were made to find out how it could be reduced.

The high temperatures measured in the barrel are due partly to the heat in the material entering the barrel and partly to the frictional heat developed as the material slides forward under high pressure between the worm shaft and the barrel. Since the temperature of the tempered beans entering the Expeller barrel cannot be reduced under 270° F. without affecting the pressing efficiency, it was obviously necessary to control the temperature of the material under pressure.

Using a hollow worm shaft and circulating cooling water through it had no effect on either the barrel temperature or the oil color. Blowing large volumes of cool air against the barrel did materially reduce barrel temperature and improve oil color but created a problem in handling the vaporized oil.

Patents have been applied for, covering the cooling of the barrels by the various means outlined.

Finally the practice of pumping cool oil over the Expeller barrel was adopted, and this proved very effective in controlling barrel temperature and reducing color. By this means both the temperature and oil color were brought down to approximately the same range as for the old No. 1 Expellers, and this oil was regarded as of very choice quality by experts and customers to whom it was submitted.

The apparatus necessary for this operation and the method of using it is quite simple. The oil being produced by the Expeller is allowed to accumulate and form a reservoir in the Expeller bed. From this reservoir the oil, freed from the coarser foots, is pumped through a heat exchanger and sprayed over the barrel in such a manner that it not only cools the barrel effectively, but also keeps it continually washed free from foots.

The efficiency of the cooling is reflected in the cake moisture, which averages about 0.9% when not cooling and 2.0 to 2.5% when cooling, with the same moisture in material entering the barrel.

The oil content of the cake has been found to be about 0.5% lower when cooling the barrel, this being due apparently to the fact that a higher pressure is generated, as evidenced by the slightly higher power consumption at the same capacity.

Summary

1. Increased heat developed in the Expeller barrel as the capacity and efficiency have been increased in the modern types of Expellers has resulted in increasing the color of crude soya bean oil to a point where it is objectionable for some uses.

2. Reducing and controlling the barrel temperature by spraying cool oil over it resulted in materially reducing the color of crude soya bean oil.

Effect on Refining Results of Mixing Expeller and Hydraulic Cottonseed Oil

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FOR MANY years it has been known that crude cottonseed oil produced by the Anderson Expeller process contains relatively large amounts of free gossypol, as compared with the small amounts of gossypol in oil produced by the hydraulic press process. Although the amount of gossypol in Expeller oil is greater when using the old cold pressing process on whole seed, still it exists in quantities ranging from 0.4% to 1.2% in oil produced by the modern hot pressing process, either from whole seed or from the separated meats. Hydraulic press oil, on the other hand, ranges from none to about 0.2% as determined by Royce's pyridine-aniline method.

In the alkali refining of crude cottonseed oils, the foots from Expeller oils usually separate in a hard, compact form containing relatively little entrained or emulsified neutral oil, while the foots from hydraulic press oils frequently are soft and spongy and contain large proportions of emulsified neutral oil. Royce has shown (1) that the refining losses of certain types of hydraulic press oils are reduced 1 to 3% by the addition of fractional percentages of pure, crystalline gossypol, and he concluded that the gossypol probably reacted with some of the emulsifying agents in the oil to render them more or less inactive.

The present experiment was designed to determine whether mixing small proportions of high gossypol content Expeller crudes with large proportions of low gossypol content hydraulic press crudes would reduce the refining loss of the latter.

Samples of hydraulic press and Expeller crude cottonseed oil were obtained from different sections of the country, and analyzed for gossypol content (pyridine-aniline method) and refining results. Nine samples of hydraulic press oil were selected covering a wide range of quality, and three samples of Expeller oil were selected, these latter being chosen for their range of gossypol content, and for their relatively poor quality. It was thought best to use low quality Expeller oils in these tests to make it more certain that any improvement found would be due to the high gossypol content of the Expeller oil rather than to any other factor. The three Expeller oils had .48, .88, and 1.10% gossypol, while the hydraulic press oils ranged from none to .06%.

Refining tests were made by the official A.O.C.S. methods, on mixtures of each of the Expeller oils with each of the hydraulic press oils, in the proportion of 30% Expeller oil to 70% hydraulic press oil. These proportions gave a gossypol range in the mixtures from .14% to .37%.

Comparing the actual refining results of these mixtures with the weighted average results calculated from the individual results of the separate components, it was found that the refining loss was reduced in 22 of the 27 tests. The refined oil color was increased in some of these tests, but in 14 tests the sum of refining loss and refined oil color was decreased. In 2 tests there was no change, and in 11 tests the sum was increased.

Hydraulic press oils, Nos. 8 and 2, were of especial interest. By themselves, both of these gave very soft soapstocks which were difficult to drain, and stronger lyes and larger amounts of lye than those given in the A.O.C.S. tables had to be used to get the results shown. No. 8 was a poor quality crude, and showed a reduction of about 2.5 in the sum of loss plus color when mixed with each of the three Expeller oils, making it better than prime.

No. 2 was a very good quality, light colored crude, yet with all three Expeller oils it showed decided improvement in refining loss which was maintained in repeated checks. This improvement averaged about 2% loss, and although the color was increased somewhat,

EFFECT ON REFINING RESULTS OF MIXING 30% CRUDE EXPELLER C.S. OIL WITH 70% HYDRAULIC PRESS OIL

Type and Source of Oil Sample, and Composition of Mixture	Best Actual Refining Results: % FFA	% Refining Loss	Refined Oil Color (35 Y)	Sum of Loss and Color	Calculated Weighted Average Refining Results: Loss	Color	Sum	Difference Between Actual and Calculated Results: Loss	Color	Sum	% Free Gossypol in Oil (Royce Method): Exp.	Hydr.	Mixt.	Character of Soapstock	Test No.
A—Expeller—California	0.8	3.8	7.8 Red	11.6	...	..	...	....	....	....	.480	....	....	Hard	19
B—Expeller—California	0.9	4.0	8.5	12.5	...	..	...	....	....	....	.480	....	....	Hard	65
C—Expeller—California	0.8	4.2	9.4	13.6	..	..	...	....	....	....	.480	....	....	Hard	53
D—Expeller—Missouri	1.9	7.2	8.0	15.2	...	..	...	....	....	....	.877	....	....	Hard	90
E—Expeller—Tennessee	1.9	10.4	7.6	18.0	...	..	...	....	....	....	1.104	....	....	Hard	94
F—Expeller—Missouri	1.9	7.6	10.7	18.3	...	..	...	....	....	....	.877	....	....	Hard	69
G—Expeller—Tennessee	2 0	10.3	9.0	19.3	..	..	...	....	....	....	1.104	....	....	Hard	174
1—Hydraulic Press—Tennessee	0.6	2.9	5.4	9.3	...	..	...	....	....	....	0	....	....	Hard	152
2—Hydraulic Press—California	0.5	5.5	3.6	9.1	...	..	...	....	....	....	0	....	....	Soft	176
3—Hydraulic Press—Tennessee	1.2	5.7	5.2	10.9	...	..	...	....	....	....	.011	....	....	Hard	40
4—Hydraulic Press—Tennessee	1.2	5.1	6.2	11.3	...	..	...	....	....	....	.011	....	....	Hard	104
5—Hydraulic Press—Georgia	1.3	6.9	4.9	11.8	...	..	...	....	....	....	.061	....	....	Medium	123
6—Hydraulic Press—No. Carolina	1.8	5.9	7.4	13.3	...	..	...	....	....	....	.002	....	....	Hard	59
7—Hydraulic Press—Alabama	1.9	7.7	6.4	14.1	...	..	...	....	....	....	.049	....	....	Medium	49
8—Hydraulic Press—Georgia	1.9	10.3	6.1	16.4	...	..	...	....	....	....	.029	....	....	Very soft	62
9—Hydraulic Press—Mississippi	2.8	10.1	7.7	17.8	...	..	...	....	....	....	.028	....	....	Hard	133
10—Hydraulic Press—Georgia	3.5	11.7	8.1	19.8	...	..	...	....	....	....	.041	....	....	Medium	22
11—Hydraulic Press—Georgia	3.6	11.9	10.0	21.9	...	..	...	....	....	....	.041	....	....	Medium	101
30% of E—70% of 8	1.9	7.7	6.5	14.2	10.3	6.6	16.9	—2.6	— .1	—2.7	.331	.020	.351	Medium	82
30% of B—70% of 8	1.6	6.3	6.5	12.8	8.4	6.8	15.2	—2.1	— .3	—2.4	.144	.020	.164	Medium	84
30% of D—70% of 8	1.9	7.8	6.0	13.8	9.4	6.7	16.1	—1.6	— .7	—2.3	.263	.020	.283	Hard	88
30% of E—70% of 6	1.9	5.4	6.8	12.2	6.3	7.6	13.9	— .9	— .8	—1.7	.263	.001	.264	Hard	76
30% of B—70% of 2	0 6	3.1	6.1	9.2	5.1	5.1	10.2	—2.0	+1.0	—1.0	.144	.000	.144	Very hard	146
30% of D—70% of 2	1.0	3.8	6.1	9.9	6.0	4.9	10.9	—2.2	+1.2	—1.0	.263	.000	.263	Very hard	148
30% of C—70% of 7	1.5	5.2	7.0	12.2	5.3	7.8	13.1	— .1	— .8	— .9	.144	.001	.145	Hard	73
30% of B—70% of 6	1.6	6.2	7.0	13.2	6.7	7.3	14.0	— .5	— .3	— .8	.144	.034	.178	Hard	51
30% of E—70% of 11	3.1	11.0	9.3	20.3	11.5	9.3	20.8	— .5	—0	— .5	.331	.029	.360	Hard	97
30% of D—70% of 11	3.1	11.3	8.2	19.5	10.5	9.4	19.9	+ .8	—1.2	— .4	.263	.029	.292	Hard	100
30% of E—70% of 7	2.0	7.3	7.7	15.0	8.5	6.8	15.3	—1.2	+ .9	— .3	.331	.034	.365	Hard	121
30% of A—70% of 3	1.1	4.8	6.1	10.9	5.1	6.0	11.1	— .3	+ .1	— .2	.144	.008	.152	Very hard	36
30% of B—70% of 9	2.2	8.4	7.7	16.1	8.3	8.0	16.3	+ .1	— .3	— .2	.144	.020	.164	Hard	133
30% of G—70% of 9	2.6	9.0	9.1	18.1	10.2	8.1	18.3	—1.2	+1.0	— .2	.331	.020	.351	Hard	142
Average	1.9	7.0	7.2	14.2	8.0	7.2	15.2	—1.0	0	—1.0	.232	.017	.249		
30% of D—70% of 7	2.0	6.8	7.7	14.5	7.6	6.9	14.5	— .8	+ .8	0	.263	.034	.297	Hard	117
30% of E—70% of 6	1.9	7.0	7.7	14.7	7.2	7.5	14.7	— .2	+ .2	0	.331	.001	.332	Medium	79
Average	2.0	6.9	7.7	14.6	7.4	7.2	14.6	— .5	+ .5	0	.297	.018	.315		
30% of E—70% of 4	1.4	6.6	7.0	13.6	6.7	6.6	13.3	— .1	+ .4	+ .3	.331	.008	.339	Hard	112
30% of D—70% of 4	1.4	6.8	6.2	13.0	5.7	6.7	12.4	+1.1	— .5	+ .6	.263	.008	.271	Hard	108
30% of B—70% of 5	1.2	5.9	6.7	12.6	6.0	6.0	12.0	— .1	+ .7	+ .6	.144	.043	.187	Medium	160
30% of D—70% of 9	2.6	8.9	8.8	17.7	9.2	7.8	17.0	— .3	+1.0	+ .7	.263	.020	.283	Hard	138
30% of A—70% of 10	2.7	9.8	8.2	18.0	9.3	8.0	17.3	+ .5	+ .2	+ .7	.144	.029	.173	Medium	29
30% of G—70% of 2	1.0	5.2	7.6	12.8	6.9	5.2	12.1	—1.7	+2.4	+ .7	.331	.000	.331	Medium	182
30% of B—70% of 1	0.7	3.1	7.1	10.2	3.2	6.3	9.5	— .1	+ .8	+ .7	.144	.000	.144	Hard	154
30% of D—70% of 5	1.5	6.6	7.0	13.6	7.0	5.8	12.8	— .4	+1.2	+ .8	.263	.043	.306	Hard	162
30% of G—70% of 5	1.5	6.1	9.2	15.3	7.9	6.1	14.0	—1.8	+3.1	+1.3	.331	.043	.374	Hard	164
30% of D—70% of 1	1.0	4.8	7.1	11.9	4.2	6.2	10.4	+ .6	+ .9	+1.5	.263	.000	.263	Very hard	156
30% of G—70% of 1	1.0	4.9	9.1	14.0	5.1	6.5	11.6	— .2	+2.6	+2.4	.331	.000	.331	Hard	158
Average	1.4	6.3	7.6	13.9	6.5	6.5	13.0	— .2	+1.1	+ .9	.255	.018	.273		

it was still prime, so that the full benefit of the saving in loss would be realized.

In the table, all the tests showing an improvement in loss plus color are averaged in one group, and all those showing no improvement in another. In the improved group the average refining results are somewhat higher than those of the other groups, indicating that mixing Expeller oil with hydraulic press oil is more likely to effect improvement in the case of the poorer quality oils. While this may be true on the average, there are notable exceptions, such as, oil No. 2, which showed decided improvement even though exceptionally good quality originally.

The data does not show any relation between the amount of improvement effected and with either the gossypol content of the original hydraulic press oil or the total gossypol content of the mixture. This is probably due to the influence on refining results of factors other than gossypol content; also possibly the oil mixtures contained gossypol in excess of the amounts necessary to produce maximum effect on final refining loss.

Summary

1. The refining loss of some hydraulic press cottonseed oils were reduced by mixing them with 30% of Expeller oils before refining.
2. This improvement apparently was due to the high gossypol content of the Expeller oils.
3. The amount of improvement was greatest for hydraulic press oils which gave soft, oily soapstocks when refined alone.
4. The amount of improvement was not primarily dependent on the quality of the hydraulic press oil treated, since one very good quality oil gave a decided improvement under the conditions of these tests.

Literature Cited

(1) Royce and Lindsey—Ind. & Eng. Chem., 25, 1047 (1933).

Press Room Operation As It Affects The Quality of Cottonseed Oil*

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IN discussing this subject, the speaker well recognizes the fact that much has been said and written previously. However, some of the points raised in this paper are of sufficient importance to justify repetition.

In this paper the factors influencing the quality of the oil will be limited to the cooking of meats and settling of the oil since an extended discussion of all factors involved would require more time than has been allotted.

Perhaps the first thing to discuss would be the rate of heating as it influences the refining loss. For years it was the general practice for the rolled meats to be slowly raised to the correct cooking temperature, then held at that temperature for sufficient time to obtain maxmium yields. Numerous experiments have shown that the more rapidly the meats are raised to 190 degrees Fahrenheit, or above, the lower the refining loss and the better the color. The following table shows this very definitely:

TABLE I.—EFFECT OF RATE OF HEATING ON REFINING LOSS

No.	Time for temp. to reach 190°	Final temp.	Total time in cooker	F. F. A. per cent	Refining loss per cent	Color Red
1	30 min.	235° F.	40 min.	1.75	9.00	5.8
2	15 min.	235° F.	40 min.	1.8	7.4	5.3
3	29 min.	225° F.	40 min.	1.5	8.75	5.5
4	15 min.	225° F.	40 min.	1.4	7.00	5.0
5	30 min.	220° F.	40 min.	1.6	9.00	5.0
6	14 min.	220° F.	40 min.	1.65	6.8	4.7

The above figures are the average of several runs under similar conditions from the same seed and show that rapid heating of the seed in the early stages of cooking is beneficial.

The method of adding moisture to the meats has been studied and the results given in the following tables:

TABLE II.—EFFECT OF TIME AND TEMPERATURE AT WHICH WATER WAS ADDED TO THE FOLLOWING MEATS.

No.	Time water added	Temp. of water	Temp. of meats when added	Final Temp.	F.F.A.	Refining Loss	Color
1	Beginning	90° F.	Cold	225° F.	4.0	10.0	8.0
2	After 15 min.	190° F.	195° F.	225° F.	3.3	8.6	6.5
3	Beginning	90° F.	Cold	225° F.	1.4	9.0	7.1
4	After 15 min.	190° F.	190° F.	225° F.	1.5	5.6	5.0

In the above table, experiments Nos. 1 and 2 were made with seed from one source while experiments 3 and 4 were made with seed from a different source. All conditions except those indicated were constant.

This indicates that if the water is added after the meats are hot, there is a decided lowering in the refining loss. It might be stated that the oil content of the cake in those experiments where water was added to the hot meats was lower than when added at the beginning. In other experiments along this line it was shown that there were no water balls formed when hot water was added to hot meats, even though enough water was added to slush around in the kettle. Under similar tests cold water on cold meats gave large numbers of water balls.

The effect of length of time of cooking at the different temperatures was next studied. In this case, the protein in the meats was uniform, though the protein in the cake varied about 1.5 per cent. The time required to bring the meats to the cooking temperature was 25 minutes. The moisture added to the meats was increased as the cooking temperature increased to compensate for the additional evaporation. It is recognized that this will influence the results to some

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