

REPORT OF THE MOISTURE COMMITTEE 1936-7

THIS committee has been assigned the task of studying the application of the forced circulation principle to cottonseed and cottonseed meal moisture problems.

The committee in 1934-35 studied the Freas Horizontal Flow Oven No. 601 and recorded a number of objections to the oven, which they recommended the manufacturer correct. Due to a reorganization of the Freas Company, about a year was required to effect the changes. A new oven (Freas No. 601-233) incorporating the changes recommended by the 1934-35 committee has been in the hands of the chairman for several months.

General Oven Characteristics:

The oven is rectangular and occupies a table space of 39x20 inches. It is 28 inches high. At the right side of the oven is the drying space proper. This space is a 13-inch cube with three removable shelves. The enclosed left half of the oven contains the blower, blower motor, heating elements and relay. The thermostat, of the expanding bar type, is located in the upper right-hand corner of the drying chamber, the contact points being located in a stainless steel box outside and on the top right end of the oven.

The air circulates from the blower through a duct which passes under the oven space and continues upward to the top of the right side of the oven. The right heating chamber wall is perforated with holes ranging from 5/8 to 7/16 inch in diameter, the larger holes being at the bottom and along the front and back sections of the wall, becoming smaller toward the center of the wall. The air passes from the right side of the oven through these perforations, over the shelves, which are of solid construction, and through similar perforations on the left wall of the heating chamber, thence over thermostatically controlled electric resistance heaters to the blower intake. Two adjustable openings are provided to vent a portion of the air and to replace it with fresh air. One of the vents is connected with the oven space, the other is located on the front of the oven and opens into the duct on the suction side of the blower. The perforations in the heating chamber

wall are placed with the bottom of the perforation just at the shelf level. The moisture dish, therefore, covers the opening so that direct blow into the dishes is minimized. An adjustment aperture is provided on the suction side of the blower so that the rate of flow of air through the drying chamber can be controlled through a range of 50 feet per minute to 300 feet per minute.

The oven when connected operates very uniformly. The thermostat appears to be very sensitive, since only a scarcely perceptible change in temperature occurs between the time the heating current is turned on and when it is shut off.

Oven Capacity:

The oven as received was equipped with three shelves of solid construction 12½ inches square. Each shelf has a capacity of 36 dishes, making the total capacity of the oven 108 dishes. However, there is some crowding when 36 dishes are placed on a shelf. The real capacity, without crowding the oven, would be 90 dishes, using 30 dishes per shelf.

The present standard AOCS oven has three shelves, each 10x17 inches, with a total capacity of 120 determinations.

Rate of Drying:

Since the general object of forced circulation is to reduce the required drying interval, some studies on drying rate of whole cottonseed which had been passed through a laboratory crimper were made. The rates were compared with similar

the forced circulation oven required only 40 minutes. The time recorded is elapsed time after loading of the oven.

The results indicate that complete drying is obtained in the forced circulation oven in from 3 to 4 hours under the conditions of the test, while in the AOCS oven the samples are probably not completely dried after 6 hours. The divergences between maxima and minima at any given time are also much smaller in the forced circulation oven. This may be due to the fact that the AOCS oven did not completely recover equilibrium temperature of 101° C. after the disturbances incident to opening of the door and removal of samples every hour, while the forced circulation oven recovered its temperature within about 10 minutes after removal of samples.

The true moisture of the sample of seed used is probably 7.08 per cent, which is the average of a group of 75 samples run to determine the temperature recovery of the forced draft oven, under what was regarded as approximately normal load. In this separate test the time for recovery (40 minutes) was noted and the samples then left without being disturbed for 5 hours after the temperature had returned to 101° C. The maximum in this case was 7.26 per cent and the minimum was 6.94 per cent.

The above results on rate of drying recall the figures obtained by the committee in 1934-35, using cottonseed meal, as follows:

	Moisture			
	1st hr.	2nd hr.	3rd hr.	4th hr.
Horizontal Flow Oven	5.84	5.96	6.04	6.06
AOCS Jacketed Oven.....	5.10	5.61	5.76	5.86

rates determined on the same seed sample in the standard AOCS jacketed oven. The ovens were both operating at a temperature of 101° C. when the tests were started. Following are the results:

These results indicate that practical dryness is attained in the forced circulation oven at the end of two hours, while a loss is still being shown at the end of the fourth hour in the case of the present official

AOCS Oven (101° C.)					Forced Circulation Oven (101° C.)				
Time	No. of Determinations	Max.	Min.	Avg.	Time	No. of Determinations	Max.	Min.	Avg.
2 hrs.....	15	6.22	5.10	5.67	1 hr. 40 min. ..	12	6.74	6.22	6.47
3 hrs.....	15	6.56	5.44	5.92	2 hrs. 40 min. .	12	7.16	6.74	6.90
4 hrs.....	9	6.78	6.08	6.35	3 hrs. 40 min. .	12	7.28	6.80	7.05
5 hrs.....	12	7.00	6.24	6.51	4 hrs. 40 min. .	12	7.28	6.74	7.10
6 hrs.....	9	7.10	6.02	6.42	.....	..	...	...	...

The AOCS oven required approximately two hours for recovery of temperature after loading, while

AOCS oven.

In view of the above results on drying rate, it was thought advis-

able to check the work by running a test which would eliminate the disturbances of equilibrium incident to opening the oven doors and would, at the same time, determine whether a shorter drying interval in the forced circulation oven would give the same results as the standard interval of 5 hours in the standard oven. Accordingly, ten samples of the same seed were placed in each oven, removed from the AOCS oven at the end of 5 hours and from the forced circulation oven at the end of 3 hours, with the following results:

	No. of Determinations	Maximum	Minimum	Average
Forced Circulation Oven.....	10	7.24	6.84	7.07
AOCS Jacketed Oven.....	10	7.36	6.88	7.23

These figures indicate that results obtained in 3 hours with the forced circulation oven are practically identical with those obtained in 5 hours using the standard AOCS oven. Results check within reasonable limits and closely approach the probable true moisture of 7.08 mentioned above.

when a five-hour drying time was used. Even in this test, with a drying interval not nearly sufficient for complete drying, the maximum deviation was only 0.74.

The above experiments on cottonseeds were conducted with oven damper in position 5, corresponding to an air velocity of 110 feet per minute. The ventilator at the top venting air from the heating chamber was operated with a 4 mm. opening, the intake ventilator on the front of the oven with a 3 mm. opening.

These losses are insignificant and with the high rate of air flow certainly establish that there is very little likelihood of meal blow-out in this arrangement of the new oven. Care was taken to stop the blower before opening the doors, as opening of doors while the air is still moving would result in eddy currents being set up, with attendant danger of blow-out.

Recommendations:

This committee feels that the forced circulation oven which it has studied can be recommended as an alternate standard oven. Since the forced circulation oven has already been tentatively adopted for cottonseed, this recommendation would mean that the oven could also be used as an alternate standard oven for cottonseed meal.

While the work indicates that the drying interval in the forced circulation oven could also be reduced, the committee feels that this should be checked into further before definite recommendations are made in this regard.

Acknowledgment is due Mr. G.

Tests on Cottonseed Meal Blow-Out:

Cottonseed meal samples were placed in the oven 1 inch from the right wall where the air is admitted and 3 inches from the left wall where the air leaves the heating chamber. Three samples were

	Top Shelf			Middle Shelf			Bottom Shelf		
	Front	Center	Back	Front	Center	Back	Front	Center	Back
Right side	6.48%	6.48%	6.56%	6.52%	6.50%	6.52%	6.46%	6.52%	6.50%
Left side	6.40	6.48	6.46	6.50	6.50	6.48	6.56	6.50	6.56

Uniformity of Temperature:

As a check on the uniformity of drying in various parts of the oven, the following test was made, spacing samples at various points in the oven and using a short drying interval of 40 minutes. It was felt that the moisture removed under these conditions would indicate any irregularity in temperature distribution through the oven.

placed at each wall on each shelf. With the adjustable damper set in position 5, corresponding to an air velocity of about 110 ft. per minute, the samples were dried for 4 hours with the above results.

The extreme regularity of these results practically precludes the possibility of any meal having blown from the dishes. No visible blow-out was detected.

A. Ayer and Mr. H. L. Kevern, of Swift & Company Laboratories, for their performance of the analytical work.

- N. C. HAMNER
 - C. P. BRENNER
 - A. SCHRODER
 - A. D. RICH
 - H. L. ROSCHEN
- Chairman.

	Top Shelf					Middle Shelf					Bottom Shelf				
	Left 1	2	3	4	Right 5	Left 1	2	3	4	Right 5	Left 1	2	3	4	Right 5
Back row	5.12	...	...	...	5.84	5.52	...	...	...	5.78	5.68	...	...	...	5.66
4th row .....	...	5.26	...	5.40	...	...	5.14	...	5.42	...	...	5.56	...	5.70	...
3rd row .....	...	...	5.36	...	...	...	...	5.62	...	...	...	...	5.58	...	...
2nd row .....	...	5.20	...	5.20	...	...	5.10	...	5.56	...	...	5.70	...	5.84	...
Front row	5.40	...	...	...	5.64	5.34	...	...	...	5.74	5.50	...	...	...	5.76

This tabulation indicates that the temperature is probably somewhat higher on the right side of the oven and drops as the left side is approached. However, this does not appear to be a significant difference, in view of the fact that a maximum deviation of 0.32 per cent was obtained on the 75 samples tested

The dried samples were then returned to the same positions in the oven and dried further for 1 hour with the adjustable damper in the zero position, corresponding to an air velocity of approximately 300 feet per minute. The samples were then reweighed and gave the following added losses:

	Top Shelf			Middle Shelf			Bottom Shelf		
	Front	Center	Back	Front	Center	Back	Front	Center	Back
Right side	0.10%	0.06%	0.02%	0.02%	0.02%	0.02%	0.02%	0.04%	0.04%
Left side	0.06	0.02	0.06	0.04	0.04	0.06	0.04	0.04	0.04