

High Capacity Expeller Operations¹

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DURING this milling season of 1951 and 1952 the Lubbock Cotton Oil Mill at Lubbock, Texas, has operated four Twin Motor Super Duo Expellers at a mill capacity of 205 tons of cottonseed per 24-hour day. Each Expeller, processing the meats from a little over 50 tons of cottonseed per day, produced cottonseed meal containing 4 to 4.5% oil. Although our studies of high capacity Expeller pressing are not yet completed, it has been requested that we review the work on the high capacity pressing of cottonseed.

In 1941 when the Twin Motor Super Duo Expeller was first placed on the market, this machine was designed to operate with a vertical shaft speed of 28 RPM and a horizontal shaft speed of 20.6 RPM. At these speeds this machine would process, for example, 18 to 20 tons of soybeans per 24-hour day producing soybean meals containing 3.8 to 4.3% residual oil. During World War II oil millers were called upon to increase their mill capacity without the addition of major capital equipment. In order to aid in this program the Expellers in many soybean mills were increased in speed to furnish this increased capacity. These Expellers were increased in speed so that the vertical shafts operated at 35.1 RPM and the horizontal shafts at 30.6 RPM. This amounted to a 48.5% increase in the speed of the horizontal shaft. At these increased speeds the Super Duo Expeller could process 27 to 30 tons of soybeans per 24-hour day producing soybean meals ranging in oil content from 4.2 to 4.5%. This amounted to a 50% increase in capacity with an approximate 2.5% loss of oil production to the cake.

After World War II studies were conducted with this machine to adapt it to high capacity pressing of cottonseed, flax, peanuts, and other commodities. These studies indicated that the capacity was primarily dependent upon three factors:

- a) the preparation of the raw material to be pressed;
- b) the R.P.M. of the shafts; and
- c) the arrangement of worms on the shafts.

The preparation of raw material for high capacity pressing has been discussed in previous reports (1, 2, 3). To emphasize the importance of preparation however two selected pilot plant tests concerning this subject will be reviewed. Although this paper primarily concerns the pressing of cottonseed, these two tests on flaxseed have been selected because they clearly and specifically demonstrate the effect of preparation on capacity of an Expeller. These two tests are from a series of runs made in our Cleveland pilot plant wherein all elements of the operations were identical except the cooking procedure. The cooking procedures in the two tests differ as shown in Table I in both the temperature and moisture of the flax during the cooking operation.

In run No. 4 the cooking was conducted at 194°F. at a flax moisture of 12.4%. In run No. 5-A the cooking temperature was maintained at 162°F. at the natural moisture of the flax of 9.4%. In both tests the flax was then dried to approximately 4.4% before entering the downspout of the Expeller. The maximum possible feed rate in test No. 5-A was 573 pounds of

TABLE I
Flax Seed Prepressing Data

Run No.	4	5A
Temperature of Cooking °F.....	194	162
Moisture during cooking, %.....	12.4	9.4
Moisture at expeller downspout, %.....	4.47	4.36
Maximum possible feed rate, lbs./hr.....	739	573
Oil in cake, % (7% moisture).....	10.1	10.9
Foots production, % of feed.....	1.2	3.1

flax per hour. The cake in test No. 5-A contained 10.9% oil, and 3.1% of the feed was recovered as foots in the oil. In test No. 4 it was possible to feed the Expeller at a rate of 739 pounds per hour, producing cakes of 10.1% oil. Only 1.2% of the feed was recovered as foots in the oil. These two tests indicate that with the same Expeller motor loads, shaft speeds, barrel spacings, and final moisture at the downspout the capacity could be increased 29% merely by following a proper cooking procedure.

The capacity, of course, is a function of the speeds of the shafts. The speeds of the shafts however are so closely associated with the shaft arrangements that these two items must be discussed together. For example, one Expeller can process the meats from 25 to 90 tons of cottonseed per day, yielding cottonseed cakes ranging in oil content from 3.5 to 9% depending upon the shaft speeds and the worm arrangements selected.

The shaft arrangement shown in the middle of Figure 1 has a capacity of 1.1 tons of cottonseed per day

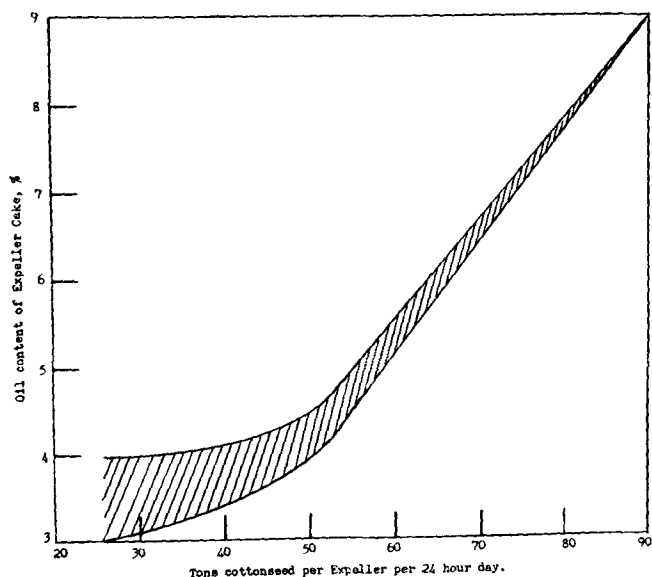


FIG. 1. The relationship of oil content of Expeller cake to capacity of the Expeller.

per RPM. At 30 RPM this shaft can process the meats from 33 tons of cottonseed per day. At 45 RPM this shaft can process the meats from 50 tons of cottonseed per day. At these speeds and these capacities this shaft will produce cakes containing 3.5 to 4.5% oil.

The shaft shown at the bottom of Figure 1 has a capacity of approximately two tons of cottonseed per

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day per RPM. At 45 RPM this shaft has a maximum capacity of 100 tons of cottonseed per day. In pressing the meats from 90 tons of cottonseed per day this shaft at 45 RPM will produce cottonseed cakes containing approximately 9% oil. At 70 tons of cottonseed per day and at 45 RPM this shaft will produce cakes containing 6.5% oil.

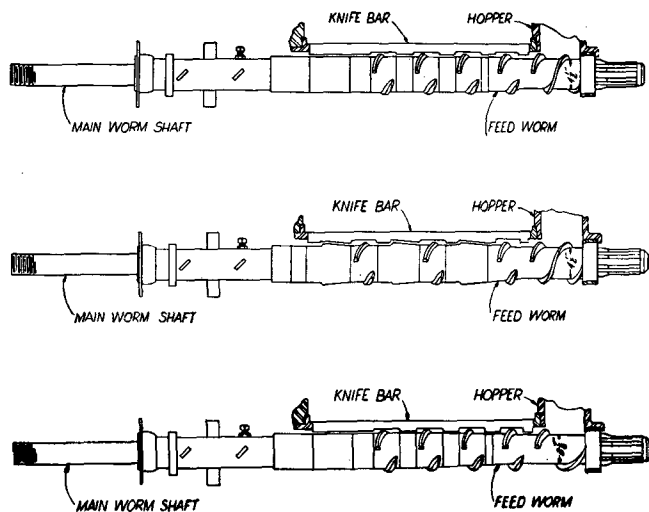


FIG. 2. Different worm arrangements used with cottonseed Expellers.

As illustrated in Figure 2, with proper preparation a Super Duo Expeller may be equipped to process 25 to 35 tons of cottonseed per day furnishing cake containing 3 to 4% oil, or the machine may be equipped to process 40 to 50 tons of cottonseed per day furnishing cake containing 4 to 4.5% oil, or it may be equipped to process 70 to 75 tons of seed per day furnishing cake containing 6½ to 7% oil. A considerable spread has been shown in the curve of Figure 2, particularly at the lower capacity phase of the curve. This range occurs since considerable variation in cake oils may be obtained, depending, of course, upon the seed processed but also to a great measure upon the manner of preparation of the seed before pressing.

Returning to the operation at the Lubbock Cotton Oil Mill, this mill is equipped with four Twin Motor Super Duo Expellers. The horizontal shafts operate at 45 RPM, and the vertical shafts operate at 84 RPM. The shaft used is shown in the middle of Figure 1.

Meats from the separation equipment are rolled in 5-high rolls and then cooked at 205°F. for approximately 15 minutes at 12 to 13½ moisture content. The cooked meats are then dried to approximately 4% moisture at a final temperature of 235 to 240°F.

Both the vertical and horizontal shafts of the Expellers are equipped with 40 HP motors. At a rate of 50 tons of cottonseed per day per machine the motors driving the vertical shafts pull an average of 87% of full load or 34.8 HP. The motors driving the hori-

zontal shafts pull an average of 65.8% full load or 26.3 HP. It is of interest to note that the original shafts are still being used in these machines after two seasons of operation and that each machine has processed 3,600 tons of cottonseed before it became necessary to turn the barrel bars.

During the month of February bollie seed was being processed at the Lubbock Mill at a rate of 51.2 tons of cottonseed per day per Expeller. During this month the cake averaged 4.0% oil and 44.6% protein at 8.0% moisture. Twenty-four tank cars of oil were shipped, which averaged 1.34% free fatty acids and 8.43% refining loss and had a refined color of 6.75 red. Spot samples taken at this mill during February gave the following data. The cakes ranged in oil content from 3.74 to 4.37% oil. They averaged 42.3% protein and 0.038% free gossypol at a moisture content of 8%. The cake analysis indicated that 16.1% of the protein was soluble in .5/NaCl. The spot oil samples contained 1.2% free fatty acid and had a refining loss of 8.6%, a refined red color of 6.2, and a Lovibond bleached red color of 2.0. All of the oil analyses reported are based on the slow break method.

During the month of October 1951 prime seed was being processed. The cakes during this month averaged 4.1% oil and 43.1% protein at an 8% moisture content. The oil averaged .64% free fatty acid, 5.64% refining loss, and 5.24 refined red color.

If a mill is presently equipped with Expellers operating at 25 RPM and processing 25 to 27 tons of cottonseed per day, the capacity of the meats processing equipment can therefore be approximately doubled by increasing the speed of the shafts of the Expellers and increasing the cooking capacity or employing the proper cooking procedure. The shafts are increased in speed by changing the gears in the gear cases. The cooking capacity is increased, preferably by adding one or more 36" horizontal cookers ahead of the present vessels. It should be emphasized however that a mill owner must not think it possible to increase or double his mill capacity merely by increasing the speed of the shafts. In order to increase the Expeller capacity, to obtain uniform production of hydraulic quality oil, and to insure low maintenance costs, adequate cooking equipment that is properly controlled must be used.

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