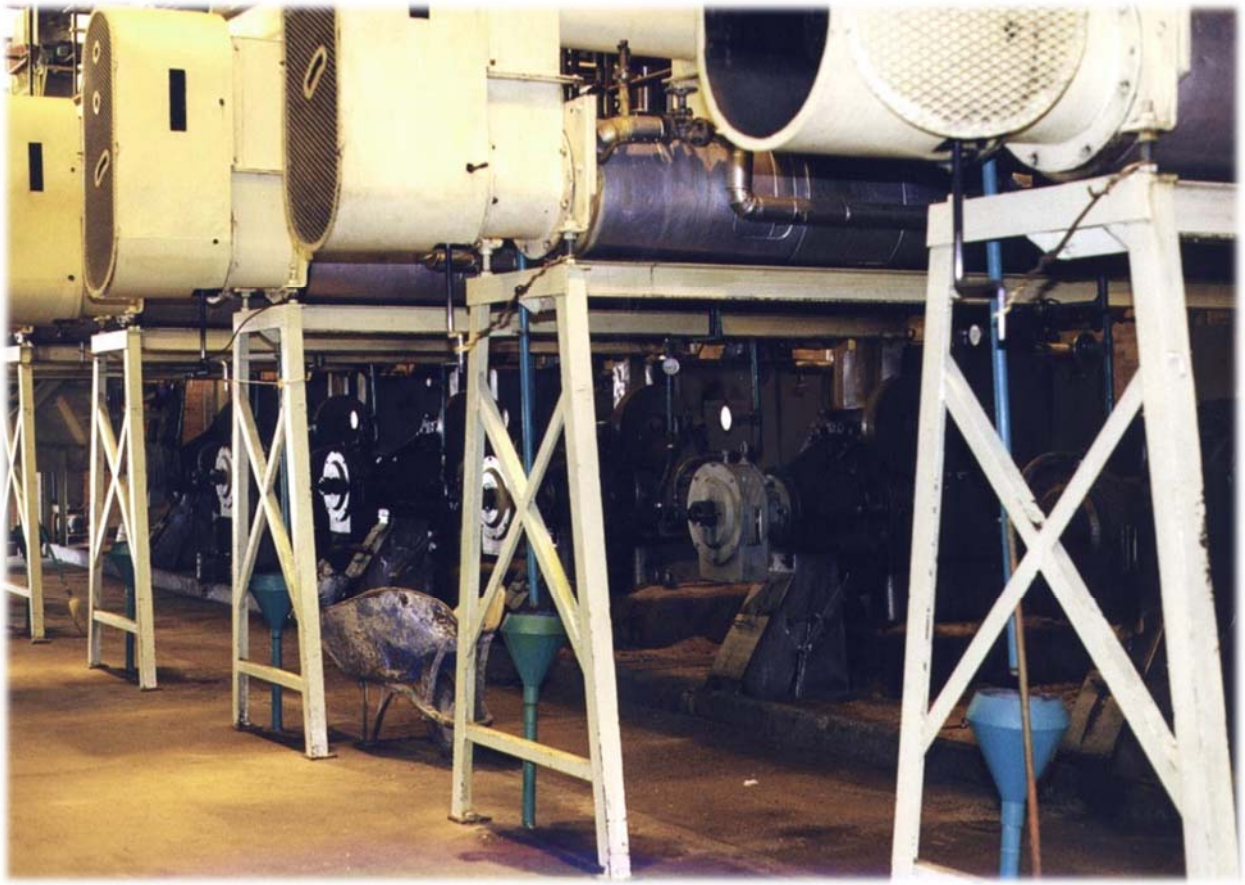
ANDERSON INTERNATIONAL CORP

EXPELLER® PRESSING OF COFFEE BEAN



Anderson International Corp
4545 Boyce Parkway
Stow, OH 44224
216-641-1112

General:

Unlike other kinds of vegetable oils, coffee oil is not produced for the making of oleomargarines, shortenings, salad oils, etc. Coffee oil has a unique quality in the form of various esters and essential oils which make it a concentrated source of the aroma associated with the roasting and brewing of coffee.

In the process of making instant soluble coffee powders, certain of their aromatics are irretrievably lost, which tends to detract from the odor appeal of the finished product. The addition of very small percentages of pressed coffee oil restores to the soluble powder a more desirable fragrance.

Types:

Of the several species of coffee plants, the three most popular are “coffee Arabica”, “coffee Robusta”, and “coffee Liberica” and of the three, “coffee Arabica” produces coffee considered to have the most desirable flavor.

Although the oils for addition to instant soluble coffee powders are conventionally produced from roasted coffee beans, oils from green or un-roasted beans have been produced for experimental purposes. Both roasted beans and green beans appear to have equivalent oil yield values, which, by extraction with petroleum ether, may range from 5% to 12% of the weight of the input seed calculated to a moisture free basis. Yield values as low as 2.7% and as high as 17.4% of a dry basis have been occasionally reported. Ordinarily encountered values of yield using solvent extraction appear to be between 10% and 15%.

The yield of oil as obtained in Expellers is, of course, not as great as that obtained by solvent extraction, since the residual oil in press cake will be somewhat higher than the residual oil in extracted meal. Expeller® yields have been noted as ranging from 6% to 10%, with 8% to 9% being normally encountered values.

Coffee is harvested from the tree in the form of a coffee cherry which usually contains two coffee beans. The beans are separated from the cherries by either the dry or a wash process. In the dry process, the cherries are washed and spread out on the floor to dry in the air and sun. The coffee is repeatedly run through panning and hulling machines to clean the beans. The wet process is more frequently used in modern processes. The cherries are pulped in a machine and fermented for about 24 hours in a tank. The fermentation is washed from the berries and the latter allowed to dry in the air and sun.

The flow of the coffee from the green bean to ground roasted, packaged coffee in a typical plant is described below.

The green beans from storage are cleaned of light foreign material by high pressure air in a cleaner. The various types and grades of coffee are blended to the roaster's preference in a green coffee mixer before being roasted. The roaster is a direct fired rotating cylinder. An average roaster can process 500 pounds of coffee in about 18 minutes. The roaster temperature is approximately 900°F. The beans are cooled after roasting in an open pan by circulating cool air over the beans for about 10 minutes. The cool beans are removed from the heavy foreign materials by air blowing the beans from a stoner to a hopper which is placed at the top of the building. From the hopper the beans flow to a grinder where they are ground and taken to the packaging and storage room.

The exact chemical changes are not known but the following have been observed:

1. A loss of water as water and also from the carbohydrates.
2. Partial decomposition as observed by the formation of CO_2.
3. The caffeine present in the green beans is not altered by roasting.
4. The aromatic and flavor constituents of coffee are far less stable in the roasted bean.
5. The degree of roasting is dependent on time and temperature.
6. There is a 15% weight shrinkage of coffee during roasting.

The primary economic considerations of a coffee processing plant in order of importance are:

1. Depreciation of initial capital investment.
2. Cost of maintenance.
3. Rent or cost of building.
4. Labor.
5. Fuel (37,000 BTU's are required to roast 100 pounds of green coffee).

6. Power.

Soluble coffee is produced basically by passing hot water through a coarse grind coffee in a cylinder called a percolator. The coffee rich effluent liquid is clarified and then is evaporated to a flake solid or cooled and dried on a drum dryer. Spray drying in a tower gives a beady particulate powder.

An average size percolator is a stainless steel tower three feet in diameter and seven feet high, packed with roasted and ground coffee. The extraction of coffee takes place in a line of five to eight percolators, resulting in a total contact time of approximately two to eight hours.

The extraction of coffee is carried out by one of two processes. Hot water can only extract 25% soluble solids from freshly ground roasted coffee. A higher yield would naturally result in better economics for the process. Higher yields can be obtained by extraction with hot water, called hydrolysis, at 325°F. The main method of increasing yield is to use superheated water under pressure in part of the percolator line. The extract from this process is spray dried at temperatures below 120°F.

The water used for the extraction of roasted coffee is filtered and treated to remove chlorine and metallic substances. The high pressure and temperature extraction of coffee is controlled to yield 35% or more of the roasted coffee with an extract concentration of from 30% to 36%. The soluble yield can be raised but the quality of the flavor is adversely affected.

A system used at present consists of four to eight percolators. The water flows from the bottom of the percolator up through the coffee to the top and on to the next percolator and so on down the line. The first percolator contains spent grounds and is operated with water above 320°F and at 150 to 400 PSI pressure. Each percolator down the line contains coffee less spent and operates at a lower temperature until the final percolator, which contains fresh coffee and is operated at 170°F. The flow to this percolator contains about 25% coffee solubles. When the coffee in the final percolator is partially spent, the most spent coffee in the first percolator is blown out and replaced with fresh coffee.

Equipment:

In the conventional Expeller® coffee oil process, the beans to be pressed are continuously drawn from the hot discharge of the roasters as it passes to the grinders and brewing vessels. The beans are led into a small surge bin located just ahead of the Expeller®, from which they are metered to the Expeller® through a variable speed star valve. The star valve is mounted above a 9" screw conveyor. In addition, there is a provision for the addition of small quantities of water to the feed stream.

Because of very high power requirements essential for the pressing of coffee bean, pressing cannot be safely carried out in a Red Lion Expeller® due to the mechanical limitations. On the other hand, the relatively low percentage of oil contained in the bean does not require a vertical barrel which makes the use of a Twin Motor Super Duo Expeller® unjustifiable. Therefore, the Expeller® model conventionally used for coffee oil pressing is the Duo.

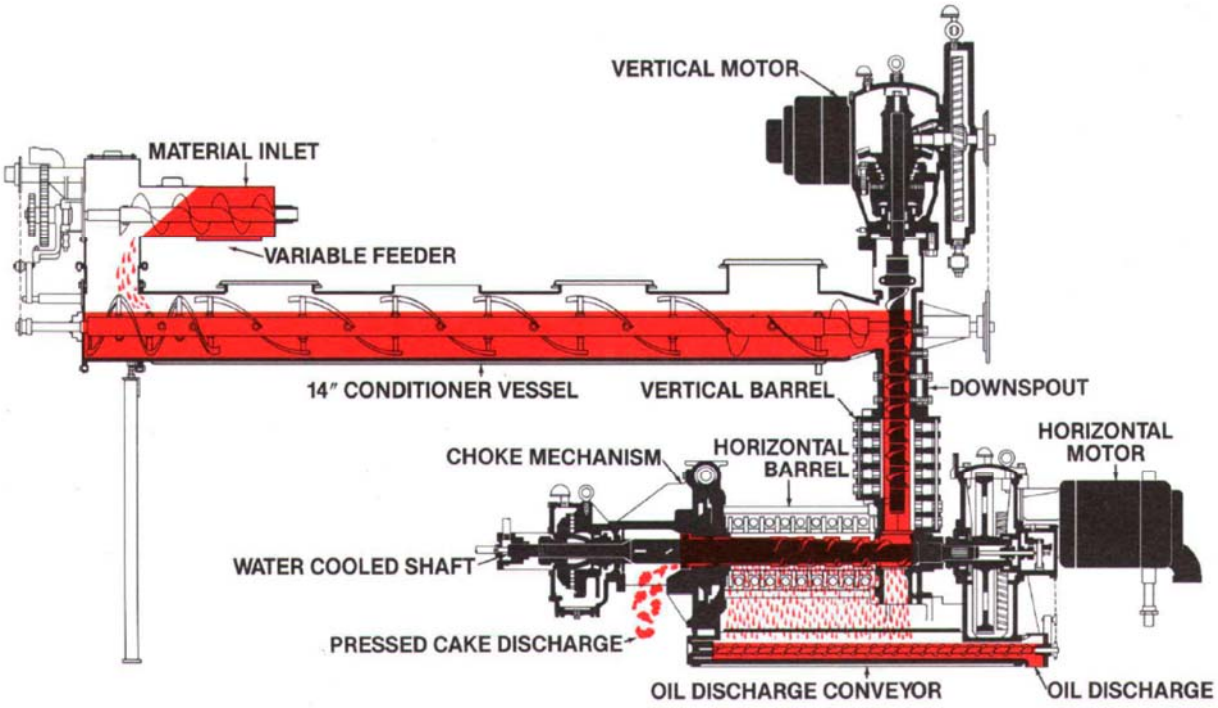
The power required for pressing coffee beans amounts to approximately 10 HP days per ton of input beans. Thus, a Duo Expeller® rated at four tons of beans per day has applied to it a total of 40 HP. This horsepower is applied as a 30 HP motor driving the horizontal shaft and a 10 HP motor driving the vertical shaft and feeding equipment. The operation of the 10 HP motor is automatically controlled by the degree of load assumed by the 30 HP horizontal motor. If the Duo Expeller® is rated at less four tons per day, it will have corresponding lower horsepower applications. A machine rated at 1 ½ tons per day has a 15 HP shaft or pressing shaft drive. In this case the beans are fed from the star valve into a conveyor which discharges directly into the feed hopper of the Expeller®. In view of the relatively high horsepower used, all horizontal motors are of normal starting torque type.

Because of the sensitiveness of pressed coffee oil to degradation by metal contamination, coffee oil Expellers conventionally use a large amount of stainless steel in their manufacturing. Barrel bars, barrel frames and pressing shaft parts are usually stainless steel. Similarly, the bed of the Expeller® is normally fitted with a stainless steel oil collection pan which leads to stainless steel pumping facilities equipped with stainless steel lines. The oil containing a small percentage of solid matter is pumped to a centrifuge where the solids are discharged back into the feed stream and where the clarified oil is passed to storage.

Similarly, the sensitivity of the oil to degradation by oxidation has required some of the more recently constructed Expellers to be fitted with stainless steel shrouds which permit the

horizontal barrel from which the oil is pressed to be surrounded by an atmosphere of carbon dioxide or some inert gas.

The high horsepower as used in this process may cause temperatures in the horizontal barrel of 280°F or higher. If these temperatures are permitted to raise much above 300°F, some degradation of oil may occur. For this reason, Expellers are fitted with water cooled shafts. Oil cooling of the barrels has not to date been looked upon with favor by the processors of coffee oil because of the possible hazards to oil quality which might exist in repeated heating and cooling of the oil as it re-circulates. Both assembled shafts and integral shafts have been used. The assembled shafts have the advantage of relative ease of repair and the integral shafts have the advantage of better heat transfer between the cooling water and the material being pressed.



COFFEE EXPELLER® PROCESS

Preparation:

The preparation of coffee beans for the pressing operation is largely out of the hands of the Expeller® operator. The particular combination of beans used at a given plant will be a function of established formulation. The hardness, dryness, temperature, etc. of this bean mixture will, in turn, be dependent to a large extent upon the roasting techniques employed.

Ordinarily, the discharge stream from the roaster will have a moisture content of 2% to 3%, which is essentially suitable for oil processing. Quite frequently, however, it has been found that a small but continuous addition of water to the bean stream as it enters the downspout of the Expeller® is desirable to the end of smoothing out the flow of beans through the Expeller®, and making a firmer, harder cake with better removal of oil. The over addition of water can also cause excessive quantities of solid matter in the coffee oil.

Expeller® Start-up:

When starting up a new Expeller®, open the choke wide and set the feed rate at half of the Expeller®'s rated value. Start the horizontal motor and then the vertical motor. Check the oil filter pressure gauge to be sure that lubricating oil is circulating in the filter system. Do not start the product oil pump until a sufficient quantity of coffee oil has been produced to insure adequate lubrication of the pump rotor and starter. Operation of the pump without product oil lubrication of the stator will result in pump damage.

Start a flow of coffee beans into the downspout of the Expeller®. Because of the hardness, the relatively low moisture content and the relatively low oil content of the beans, and the unpolished surfaces of the new Expeller® parts, the passage of the beans through the machine will be accompanied by a considerable amount of squealing noise. This noise can be initially reduced and eventually eliminated by adding a small drop of water into the bean stream just ahead of the Expeller® downspout. Do not add excessive water because such addition will tend to over lubricate the bean particles in their passage through the machine and thereby reduce the applied pressure and the consequent yield of oil. The over addition of water can also cause excessive quantities of solid matter in the coffee oil.

In passing through the horizontal shaft and barrel of the Expeller®, the beans will be ground into a finely divided powder which will discharge from the Expeller®. Operate the machine in this fashion for 10 to 15 minutes, allowing the metal parts to pick up the temperature and permitting the loading of the horizontal shaft to reach a condition of equilibrium.

Now begin to gradually increase the rate of feed of beans. It will be noted that relatively slight increases in feed rate will cause quite large changes in horsepower demand. Therefore, it will be necessary to make the feed rate adjustments in a cautious fashion, allowing sufficient time intervals between adjustments to permit the machine to completely assume its new load value.

For the first day or two it will probably not be possible to make the Expeller® accept its rated quantity of the beans because sufficient horsepower will not be available to both press beans and polish the shaft at the rated throughput level. However, after a day or two of operation the machine parts will become polished and it will be noted that the horsepower load at a given bean throughput rate will begin to drop. As this falling of horsepower loading occurs, additional feed to the Expeller® can be added until the rated value is reached.

Oil will begin to flow from the barrel when the temperature of the barrel bars reaches a value somewhat in excess of 200°F and in conjunction with the establishment of 70% to 80% of load on the horizontal motor. The first oil produced may be relatively viscous and contain an appreciable amount of solids. The quantity of solids contained in the oil will tend to lessen as the temperature of the Expeller® rises further and as the oil, as a consequence, becomes less viscous and flows with greater ease out of the barrel slots.

With the establishment of a feed rate, subsequent loading of the Expeller® motor is accomplished by a gradual closing of the choke jaws at intervals. After several days of operation and with the Expeller® completely broken in, the feed rate and choke jaw setting should be such as to produce a loading on the Expeller® barrel in excess of 85% and preferably between 90% and 95%.

As soon as oil is observed coming from the Expeller® barrel, the observation doors in the Expeller® shrouds can be closed and the inert atmosphere around the barrels established. When sufficient oil has accumulated in the drip pan reservoir in the Expeller® bed to cover the pump intake, the oil pump may be started. On the higher rated Expeller® about 10 to 15 minutes of oil production will be necessary to fill the system up to the centrifuge. Therefore, the centrifuge should be put into operation about this time.

When the Expeller® has been in operation 30 minutes to one hour, the temperature of the discharging cake may be high enough to cause some breakdown of the cake and resultant fuming. If and when this happens, start a flow of water through the water cooled shaft. Control this flow with a valve in the discharge water piping so that the horizontal shaft is kept full at all times. The discharge water line is fitted with a temperature gauge and it is usually most expeditious to maintain a temperature of 180°F to 200°F at this point.

Shutting Down:

As the end of the Expeller® operation approaches and before the bean supply is exhausted, completely open the choke jaws. Continue feeding beans at the established rate through the machine until the horizontal motor has reduced in load value as much as it wants to. At this time the press cake discharging from the Expeller® will be loosely formed and may even have some identifiable bean particles in it. Allow the horizontal shaft to run until no more material will discharge from it. At this time the horizontal motor load should have fallen off to a maximum degree. Shut off the water to the horizontal shaft. Stop the flow of inert gas, shut off the oil pump, open the inspection ports and clean out the oil collecting pan area. The Expeller® is now ready for subsequent start-up.

POST EXPELLER® COFFEE TREATMENT

Oil Treatment:

The product oil is pumped continuous through a centrifuge at a rate somewhat exceeding that at which it is produced. For this reason, the pump tends to deliver the oil in surges and the centrifuge should be virtually fines free. If it is not, refer to the instruction book accompanying the centrifuge, following the recommendations and instructions found therein.

As pointed out above, coffee oil is very susceptible to oxidation and therefore should be isolated as completely as possible from air. Also, it should be stored in containers which are, for practical purposes inert with respect to the oil. Experience has shown that stainless steel containers and aluminum containers are quite satisfactory for this purpose. They should be provided, however, with necessary fittings for maintaining an inert atmosphere over the oil, and this implies that they should be containers suitable for containing slightly elevated pressures. One processor has found surplus CO_2 dispensers to be ideal for the storage of coffee oil since they will contain an internal pressure of some magnitude, are equipped with fittings which permit the introduction of inert atmospheres and will permit the emptying of the vessels by the use of gas pressure. Other processors have found stainless steel milk cans to be suitable.

The coffee oil produced will normally have a free fatty acid value of 2% to 2 ½%. The oil can be held for long periods at this value by storing the coffee oil under an inert gas at temperatures of 40°F or less. At these temperatures the oil will take on butter like consistency and remain of good quality indefinitely.

To use the oil, the containers are brought up to room temperature and the oil is sprayed as such onto the instant powder. Ordinarily, no further processing of the oil is required. It has been found that the best method of adding the oil to the powder is to do so in the form of tiny droplets rather than as an atomized spray. An atomized spray coats the surface of the solid particles with oil, thereby causing them to stick to conveying ducts and chutes ultimately causing a plugging of the duct. On the other hand, spraying the oil on the powder in small droplets causes each droplet to collect around itself an aggregation of dry solid particles which do not cause any adhering of solids to the metal surfaces of the chutes, and thus do not cause plugging. The droplets of oil enter the final glass package in this fashion and the oil does not completely disperse itself through the balance of the solid material until sometime after the glass jar goes into storage.

Cake Treatment:

The cake issuing from the Expeller® will, by virtue of the choke setting, have a thickness of 1/16” to 1/8” and will be, for the most part, in the form of chips or flakes 1” to 2” across. There will also be in the cake discharge a fair amount of finer material, primarily in the form of discreet flint-like particles. In certain instances this cake has been recombined with the material going to the brewing vessels without apparent difficulty of handling or extracting. Other processors have seen fit to arbitrarily dispose of the press cake by burning or discarding.

Duo™ Model Sizes

Model	Connected HP		Capacity (MTPD)
	Vertical	Horizontal	
Duo™ 33	10-15	40-50	10-15
Duo™ 55	10-15	50-75	15-20
Super Duo™ 33	40-60	50-75	20-25
Super Duo™ 55	40-60	75-100	25-30