Old and New in Winterizing[1]

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ABSTRACT

Winterizing is the process of removing stearines from vegetable oils. The procedures have been developed over the past 75 years and vary according to the type of oil treated or the kind of process used such as batch, continuous systems, or whether in the miscella stage. Dewaxing is also considered a form of winterizing.

INTRODUCTION

The winterization or destearinization of vegetable oil has been practiced in this country for the past 75 years. Its purpose is to produce oil which will remain clear at reduced temperatures. The need for a clear product at lower temperatures was encountered as the use of domestic ice boxes and later, refrigerators, became more prevalent. Cottonseed oil at that time was our largest source of salad oil. It was natural that the first methods of winterizing were developed for it. A sample of unwinterized cottonseed oil as compared to winterized oil when both have been kept in a refrigerator is shown in Figure 1. The sales appeal of the clear oil forced all processors to adopt some form of winterizing.

The process of winterizing evolved from practical experience at the refinery when it was found that storing the cottonseed oil in outdoor tanks exposed to low temperatures during the winter months allowed the higher melting glycerides to settle to the bottom of the tank leaving a top layer of clear oil. This top layer was decanted, deodorizied, bottled, and marketed as a salad oil. The process became known as "winterizing" and the clear oil produced as "winter oil." The bottom portion containing the high melting glycerides, palmitic and stearic acid fractions, (mainly dipalmitoolein and dipalmitolinolein) was used for shortening manufacture. With this "topping" process consistent results could not be obtained as it depended upon the weather. As demands grew, it became impractical to have so many storage tanks outside holding oil for the winterizing process; therefore, mechanical refrigeration or special winterizing plants were developed. This paper describes the present commercial practices of winterization from its inception.

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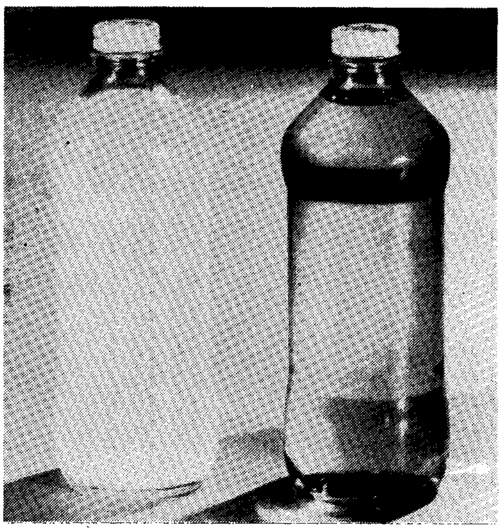

FIG. 1. Unwinterized and winterized cottonseed oil.

RESULTS AND DISCUSSION

Today the art and practice of winterizing vegetable oils is still very much the same as it was at the turn of the century, but the techniques and equipment have improved considerably. The early plants pumped the bleached oil into chilling or graining tanks in a cold refrigerated room. These tanks were rectangular and very narrow (as little as 2 or 3 ft wide), to facilitate the heat transfer of the cold air inside the room to the oil in the tank. Other processors used round horizontal storage tanks which would hold from 10 to 40 tons of oil. Separation of oil and stearine was accomplished by filtering. The filter press, usually a plate and frame or a recessed plate unit, was also located inside the same cold room or in an adjacent one. As capacity requirements increased, it became impractical to build a cold room large enough to house all the graining tanks. Therefore, they were moved out of the cold room, insulated, and provided with internal chilling equipment. More recently the tank type filter has been used in place of the plate and frame press, eliminating the need for a cold room completely. A flowsheet of a modern winterizing plant for cottonseed oil is shown in Figure 2.

The process starts with the bleached oil, which should be at a temperature of 30 to 35 C, being pumped into the graining tank. The temperature controller is then started. It regulates the amount of brine or propylene glycol slurry that is circulated through the cooling coils. The temperature differential between the brine and oil should not be large in order to avoid shock chilling of the oil. A satisfactory differential is about 13 C initially, but it diminishes to about 5 C when the oil cools to its final temperature. A slow rate of chilling is essential to produce a large crystal or flake. During the cooling the oil is stirred very slowly. This can be done by mechanical agitators or by bubbling cold dry air slowly through the oil.

Toward the end of the chilling cycle, which lasts from 48 to 60 hr, the rate of crystallization is sufficiently rapid to cause a slight rise in temperature of 1 C to 2 C, which then drops. At this point cooling is stopped, and the oil/crystal mixture is allowed to stand for 12 hr at 6 C. It is then ready for filtration. The filter cycle is time consuming

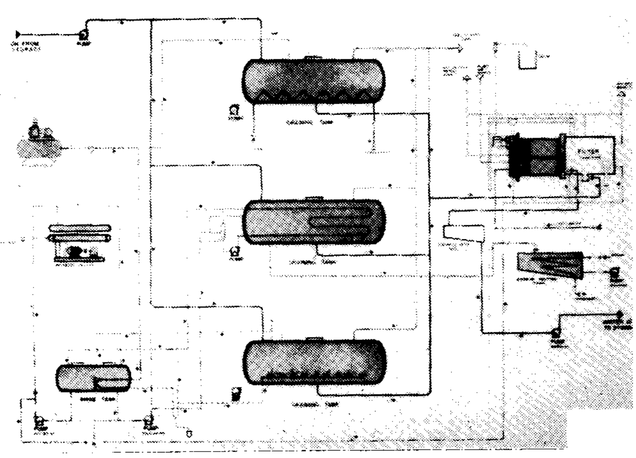

FIG. 2. Winterizing plant flowsheet.

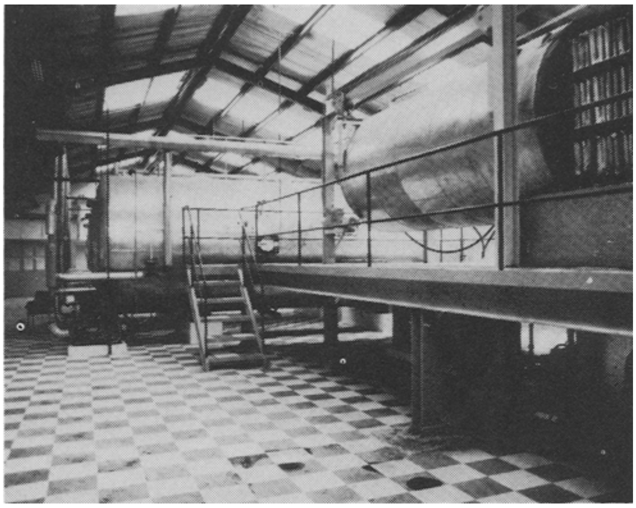

FIG. 3. Winterizing plant.

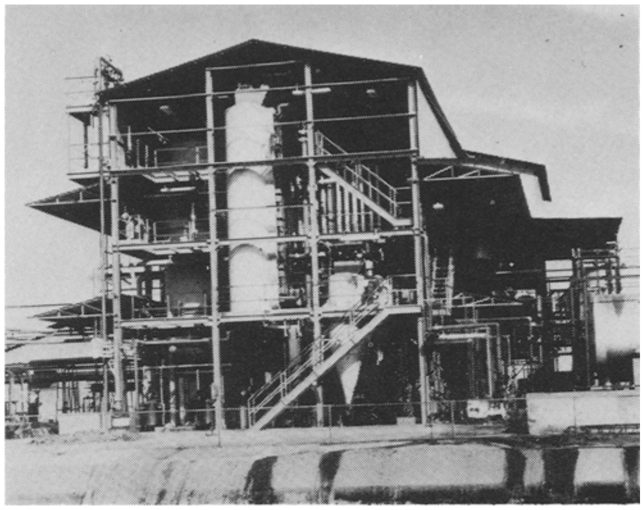

FIG. 4. Rancher's winterization plant.

due to the extremely low filtration rates that vary from 1 to 3½ lb of oil per square foot of filter surface per hour. In order to prevent flake compression with subsequent filter blinding, the amount of filtration pressure must be kept low, in the range of 5 to 20 psig. It is recommended that the oil drop by gravity and flow through the filter press at least for the first hour. Thereafter, low pressurization of the graining tanks pushes the oil/stearine mixture to the filter.

The filtration cycle normally takes 8 hr which includes time for opening, cleaning, and closing the filter unit. To avoid the need for excessively large filters, plants are designed for three filtration cycles per 24-hr period which is sufficient to filter one complete graining tank. While one graining tank is being filtered, the other two are in various stages of cooling. After each filtration cycle the filter cake is removed from the filter press cloths. This is done by circulating warm water or steam through the filter press coil. The stearine is discharged into a stearine melting tank and is pumped to shortening supply tanks.

Figure 3 shows a modern winterizing plant. The horizontal graining tanks are in the background. The tank type filter is mounted on a platform to allow the stearine to discharge into the stearine melt tank below.

Cottonseed winterizing normally yields 75-80% salad oil with an IV of 110 to 114. The standard AOCS winterizing test calls for the oil to remain clear for a minimum of 5½ hr at 0 C. However, the industry prefers oils to have a cold stability of 8 to 16 hr or more.

Cottonseed oil can be winterized while in a solvent miscella state using hexane or acetone. This results in a higher yield and a salad oil of better quality than can be expected from conventional winterization. The chilling and holding time required for this method is less thus making continuous operation practical. A continuous system operated by Ranchers Cotton Oil in California is shown in Figure 4.

The miscella (45% by weight hexane) first passes through a refrigerated chilling unit cooling it to about -4 C. From there the miscella goes into a continuous vertical winterizing column which cools it in a series of agitated trays over a 40 to 60 min period. The final discharge temperature is as low as -20 C. From the continuous winterizer the miscella goes to a Sharples continuous solids discharge centrifuge where solid stearine/liquid miscella separation is made. This eliminates the need for a conventional filter press. The miscella goes from the centrifuge to a solvent evaporator system, and the solvent-free oil goes to a deodorizer for further processing. The salad oil produced meets a cold test of 15 hr or more.

The solid discharge from the centrifuge drops into a stearine surge tank feeding a self-cleaning pressure leaf filter which is used for polishing the stearine to remove extraneous matter. It is then sent to a solvent evaporator system to remove the remaining 10-15% hexane. The solvent-free stearine is then pumped to storage for further processing.

Today soybean oil as a liquid or salad oil is consumed in even greater quantities than cottonseed oil. The oil is first partially hydrogenated to 115 IV or less. The stearine is removed by winterization. The resulting liquid phase is a more stable oil less subject to reversion.

The winterization step of soy oil is very similar to that of cottonseed except that the chilling can be done in 24 hr plus a 6 to 8 hr retention time. The filtration rates are higher than cottonseed because the soy stearine flakes produced are sturdier. The filtration rate is about 75 to 100 lb per square foot of filter area per hour. The yield of salad oil is in the order of 75-85%.

The winterization of cottonseed and soybean oils is so very similar that identical winterizing equipment can be used. However, if only soy oil is to be processed a continuous filter can be utilized because of the durable nature of the flakes. The key to the process is the continuous drum type vacuum filter. This unit, such as a Komline-Sanderson type, has a filtration rate of ca. 50 to 60 lb an hour per square foot of filtering surface. The vacuum filter is normally installed in a cold room with a temperature of about 10 C.

The continuous filtration process using a vacuum filter is shown in the flowsheet (Fig. 5). Oil is discharged from the graining tanks preferably by gravity and enters the side of the filter vat. An agitator in the vat prevents settling. The vacuum draws the oil through the rotating filter belt and through an automatic filter valve which adjusts to each section of the filter drum as it rotates. The oil, and some air, passes into the vacuum receiver at 5-10 in. vacuum where the air is separated while the filtrate (winterized oil) is pumped to the storage tank. The drying of the caked stearine occurs when the belt leaves the vat. To accomplish this, a separate and larger vacuum system is used to draw air through the cake. Any remaining free oil flows with the air stream to a separator for recovery. The cake continues to travel on the belt until it reaches the discharge roll and falls into a hopper equipped with a screw conveyor or directly into a remelt tank.

The vacuum filter unit is equipped with a spray pipe for cleaning the cloth. This is done by pumping winterized oil at 40 C back to the spray pipe when necessary. Under normal operation the spray pipe is not used.

Because of the increasing demand for salad oil, other oils have entered the market. They also must either be winter-

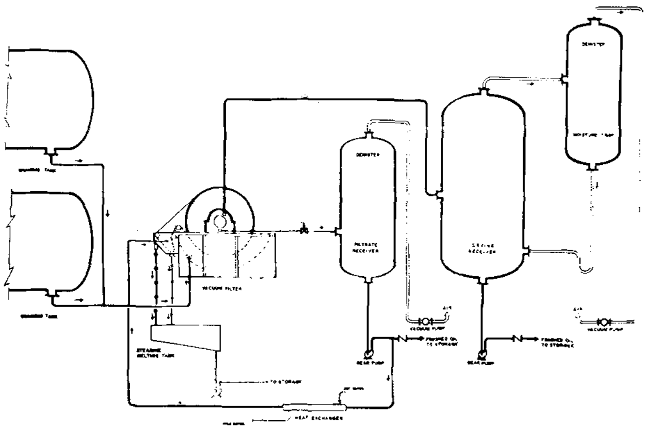

FIG. 5. Continuous filtration flowsheet.

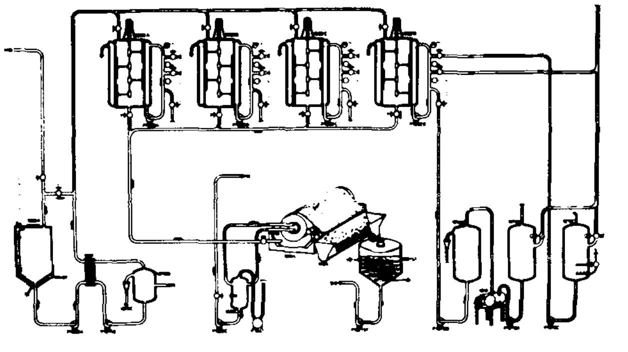

FIG. 6. De Smet semicontinuous oil fractionation with continuous filtration.

ized or dewaxed in order to have a clear oil at refrigerated temperatures. The dewaxing process is very similar to winterization. For example, sunflowerseed oil may contain from 0.2% to 3% high melting point wax (cerylcerotate) which has been extracted with the oil from the outer hull. This wax crystallizes when the refined oil cools. To remedy the cloudy appearance, the bleached oil must be pumped through a water-cooled heat exchanger to arrive at the crystallization or graining tanks at 10 C. The oil is held in these insulated tanks for 24 hr. At this point the oil contains finely interspersed crystals and is pumped, at a low pressure, through a filter press or tank type filter. The use of a filter aid is required for all dewaxing operations. The sunflower oil leaving the filter is wax-free and ready for deodorization. It is essential that the oil be kept completely free of water or it will cloud, giving the false impression that wax is present. Properly dewaxed sunflower oil will withstand cold tests of 50 hr or more.

Some processors chill the sunflowerseed oil, add caustic, and then remove the wax in the refining step. It is essential that neutralization take place at a temperature just below the point at which the wax material becomes soluble in oil usually below 20 C. A recent U.S. patent issued in March, 1976, to Herbert T. Young and assigned to P & G covers a somewhat similar process for refining and dewaxing crude vegetable oil in a one separation step.

In the case of corn oil the process is similar to that used for sunflower seed oil. The bleached oil is passed through heat exchangers to a final cooling and chilling tank to bring the oil to 10-12 C. This cooling can be continuous with no retention time required. From this tank the oil is pumped to a surge or filter supply tank to which filter aid is added, and the mixture is pumped through a standard type filter. Filtration takes place at a temperature of 10 C but not over 16.5 C. The wax removed can vary from 1/2-1%. The oil can normally stand a cold test of 98 hr or more.

Safflower seed oil which is very high in polyunsaturates does not require any winterization, but it does have wax (ca. 1/2%) which should be removed. This is done in a manner similar to corn oil.

Another oil that is ideal for salad or table use is sesame seed oil. This oil also contains waxes and can be handled in the same manner as sunflowerseed oil. The filtration rate is ca. 15-20 lb per square foot of filtering area per hour.

Peanut oil has many desirable properties for a salad oil. However, it is virtually impossible to winterize as the entire oil forms a gelatinous material even when chilled slowly.

Rapeseed is another salad oil source. This oil does not require winterization, but in practice the incoming rapeseed oils are tested and those lots which withstand the longest cold test of ca. 20 hr or more are normally designated for salad oil.

Fractionation of vegetable oils is a form of winterization which has developed considerable importance recently in the treatment of palm oil and fish oil.

Fractionation plants can be either batch or semicontinuous. A typical semicontinuous plant such as that designed by De Smet of Belgium for palm oil is shown in Figure 6. The bleached warm palm oil is cooled to a temperature of 30-35 C and the pumped to graining or crystallizing tanks for further cooling to about 20-25 C. These crystallizing tanks are different from those normally used in the cottonseed or soy winterizing process in that they are vertical tubular units with scraped surface slow speed agitators to insure efficient heat transfer. Crystallization time is 2 to 4 hr in each crystallizer, depending on products desired. Continuous filtration is done by means of a vacuum drum type filter. Fractionation can also be done in the miscella stage using hexane, acetone or, in the case of the Anadik system, using a mixture of isopropyl alcohol and acetone. Similar fractionating systems are being used in processing fish oil for the purpose of increasing stability. It is first partially hydrogenated and then fractionated so that the liquid fraction may be used in a salad oil mixture.

Crystal inhibitors are used to increase the size of the stearine crystal resulting in better filtration and improved cold test. An inhibitor containing up to 25% oxystearine is added in a range of .01% to 0.5%. The cost of such an additive has to be balanced against the saving in process time or the benefit of a longer cold test. Inhibitors are not effective on all oils.

The trend for both winterizing and dewaxing of vegetable oils is toward continuous systems wherever possible. In the near future the use of electrostatic filters for the removal of wax may be a possibility. Test work in this area is now being done.

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