Technical News Feature

Winterization of Sunflower Oil

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ABSTRACT

The chemical composition and percentage of waxes in sunflower oil are presented in relation to the crude oil quality obtained from decorticated or undecorticated sunflower seed. Three methods of winterizing are described: the conventional method with separation by filters, crystallization with a wetting agent and separation by centrifuge and winterization in solvent. We also comment on methods for checking the quality of winterized sunflower oil.

Winterization is a separation process which allows the removal of higher melting point crystallized parts (waxes or triglycerides) that are responsible for the turbidity of some edible oils in the winter or after refrigeration. In the case of sunflower oil, this process can also be called 'dewaxing.'

Sunflower oil has a wax content which is an ester of fatty acids from C20 to C28 and of fatty alcohols from C22 to C30. The melting point of pure wax is 76-77 C. It is not only the waxes that are responsible for the turbidity but also the 7-8% saturated fatty acids (stearic and palmitic acids) which are present in the triglycerides (1).

According to the distribution in Table I, there is no tripalmitin and tristearin in sunflower oil. In the winterization process, it is also possible to remove, in addition to the waxes, glycerides in crystal form which are responsible for the turbidity. In the sunflower oil, only the stearo-diolein and palmito-diolein form crystals which can be efficiently separated only in β or β' form. β stearo-diolein has a melting point of 23 C and β palmito-diolein, 19 C. α stearo-diolein has a melting point of 8.6 C and α palmito-diolein, 2.5 C. By rapid cooling, an amorphous micro-crystalline, softish precipitate with poor filtration properties is obtained. This form will be transformed slowly into the metastable α form with micro-crystalline characteristics (2).

By the gradual cooling of the oil, macro crystals, the stable β and β' form, are obtained and can be separated easily from the liquid phase by filtration or other separating methods.

The following 3 methods can be used to winterize sunflower oil: (a) the conventional method, which consists of a gradual crystallization with special Kiselgur (Hyflo-supercell) maturation and separation by filters; (b) crystallization with water containing a wetting agent (it can be soap); after the necessary crystallization time, the water suspension is separated from the oil by centrifugation and (c) winterization (dewaxing) in solvent, which consists of mixing the oil with a fixed volume of solvent (hexane, isopropyl alcohol, etc.) and after chilling/crystallization, separating the solid part from the oil by filters, hermetic centrifuges or special decanters.

TABLE I

The Glyceride Composition of Normal Sunflower Oil

Glyceride type	%	Glyceride type	%
LOL or OLL	28.3	SPL or SLP	0.8
LLL	19.7	PPL or PLP	0.8
OLO or OOL	13.4	SOP or SPO or PSO	0.4
PLL or LPL	7.1	PPO or POP	0.3
POL or OPL or OLP	6.7	SLS or SSL	0.2
LLL or LSL	4.3	SOS or SSO	0.1
SOL or OLS or OSL	3.9	PPS or PSP	0.02
OOO	2.1	PPP	–
POO or OPO	1.4	SPS or PSS	0.01
SOO or OSO	0.9	SSS	–

The wax content of the oil depends on the oil content of the sunflower seed and the process technology. Generally, for sunflower seed with an oil content of at least 40%, the wax content is 0.65%-2.33%, when processing undecorticated seed, and 0.17-0.47% when processing decorticated seed (3). A good winterization process should also be able to dewax oil from undecorticated seed.

For good operation, it is necessary to remove the gums before winterization. The presence of gums in the oil influences the formation and stability of formed crystals. This also diminishes the filtration rate of the oil. For this reason, the winterization unit has to be installed after degumming-bleaching and before deodorization or deacidification.

Another factor in dewaxing is optimum oil temperature. For good crystallization and maturation, the oil is cooled to 6-7 C. The viscosity of the oil does not allow an acceptable filtration rate at this temperature. At 12-14 C, the filtration rate is about 60% higher. For this reason, we heat the oil for separation after crystallization. For sunflower oil to obtain β crystals, the gradual cooling must have a Δt of 4-10 C. In our systems, we cool to 6-7 C.

A flowsheet of a conventional winterizing plant is shown in Figure 1. After bleaching, the oil is pre-cooled from 60 C to 25-30 C in a heat exchanger with the cold oil after filtration. The next cooler cools the oil from 25-30 C to 10-15 C with brine. The last cooling takes place in the crystallizer where there is an automatic regulation system to ensure the temperature gradient needed.

The cooling and crystallization time, in the presence of Kiselgur, is 4 hr. The Kiselgur, mixed with a small part of oil, is pumped from a special mixer in the crystallizer. In this crystallizer, the oil is mixed very slowly and cooled to 6-7 C. From the crystallizer, the cooled oil is introduced into the maturator to form the filterable β crystals. The maturator (without cooling coils) also has a low-speed agitator. The recommended maturation time is 5-6 hr.

From maturation, the oil is pumped through an oil heater to the horizontal tank filters. The oil is heated from 7 C to 12-15 C. Before filtration, a precoating layer is introduced into the filter. Depending on the oil quality, the filtration rate in a horizontal tank filter can be calculated on the basis of 40-60 kg/m^2/hr (10-12 lbs/ft^2/hr).

After filtration, the waxes and triglycerides, together with the Kiselgur, can be recuperated in another filter with liquid oil. The Kiselgur can be re-used for dewaxing and the oil, with waxes and separated triglycerides, sent to the hardening plant. The feasibility of recuperation depends on the size of the plant and the possibilities of using the removed oil. Other types of filters can be used in place of horizontal tank filters. When using filter-presses, the flow rate decreases to 15-20 kg/m^2/hr (5 lbs/ft^2/hr).

The possibility of introducing a horizontal automatic band filter working under vacuum has been checked re-

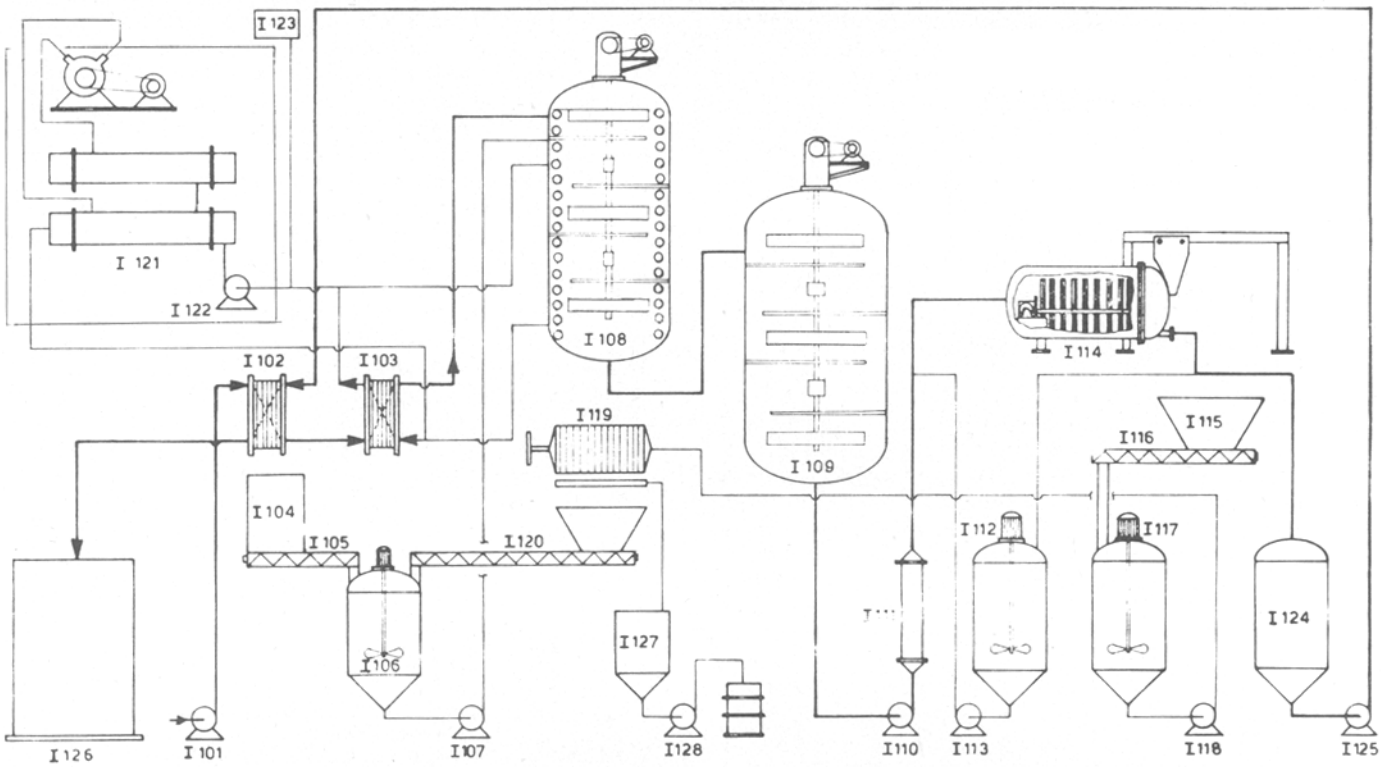

FIG. 1. Continuous dewaxing of sunflower oil with horizontal tank filters.

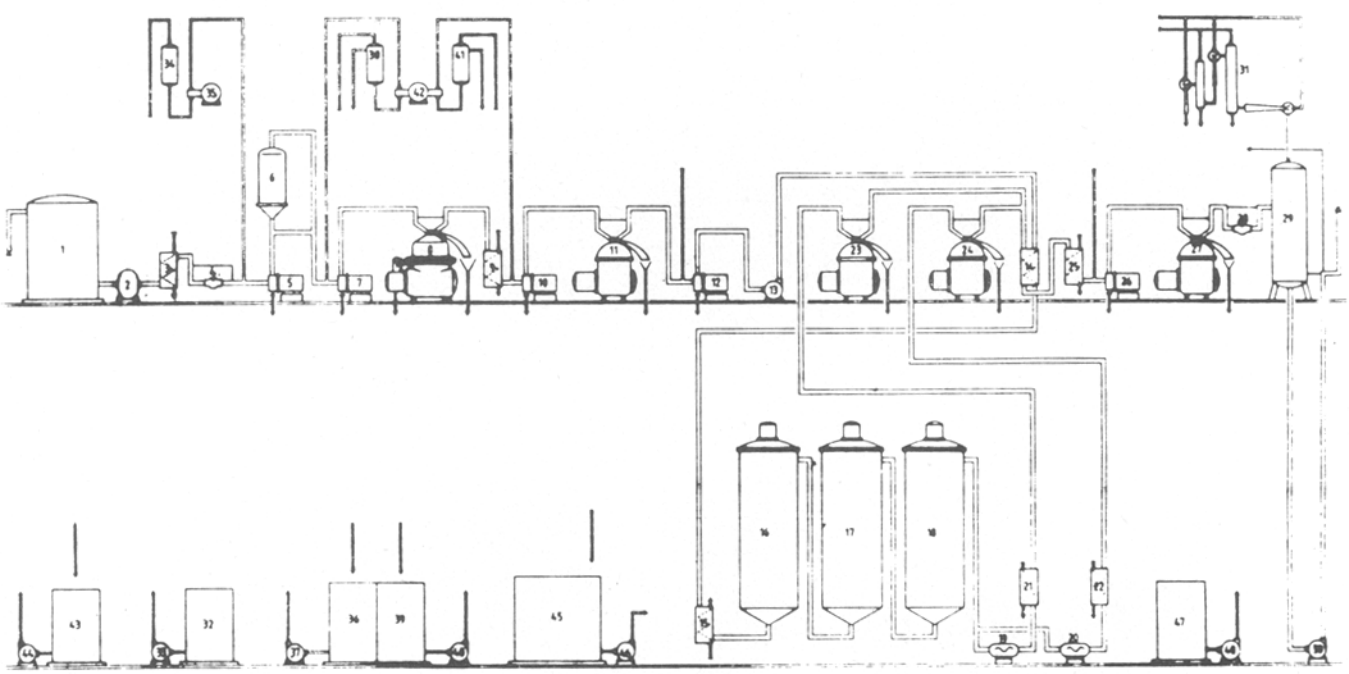

FIG. 2. Continuous refining and winterizing of sunflower oil with a wetting agent. Flowsheet of a Westfalia plant.

cently. This type of filter works more efficiently but there has not been enough experience to recommend it.

The second method used for winterization is with a wetting agent. The agent wets the fat crystals which migrate to the aqueous phase and are washed free of adherent oil. The water suspension of fat crystals is then separated from the liquid oil phase by centrifugation. This method makes it possible to separate smaller crystals which reduces the crystallization time to 2-6 hr. After the fat crystals are separated, they are melted and the phases again separated by centrifugation. The aqueous phase with the surfactant is recycled to the process. This method, known as the Lipofrac Process, was developed by Alfa-Laval (4).

Westfalia (5) has developed the Continuous Neutralizing and Winterizing Process, OERWS, as shown in Figure 2. In this system, the oil is degummed by acid treatment and then neutralized in 2 stages. First, the oil is neutralized with a stachiometric quantity of caustic soda and then with a solution required for the re-refining. The oil with a high soap content (3000 ppm) is introduced into a mixer where it is mixed with the correct amount of water (3-4%) to bind and discharge the waxes and saturated triglycerides into the crystallization tank. Here, the oil is cooled to 5 C after also passing through heat exchangers. The crystallization time in this case is 6-8 hr.

Separation takes place at 12-15 C. After the centrifugal separators have been running for 8 hr, they have to be flushed with hot water for 15 min and only once in 2 weeks do they have to be dismantled for cleaning. After this stage, the oil has to be washed with 6-10% water and separated again. The soap content in oil after washing can be kept to below 50 ppm. After washing, the oil should be dried.

H.L.S. Ltd. has also developed a winterizing, dewaxing and fractionating method in solvent-isopropyl alcohol. Crystallization takes place in a continuous crystallizer where crystal nuclei are always present and adequate crystals are formed and float upward in the liquid medium. A special continuous decantation system separates the crystals. The drawback of this method is its high energy consumption due to the evaporation of solvent.

The classical standard for checking winterized sunflower oil was the cold test OC for 5½ hr. Oil which remains brilliant for 5½ hr generally remains so for 24 hr at 0 C. However, the oil can become opaque after several hours at room temperature due to the reappearance of waxes as well as glycerides. This is typical in sunflower oil obtained from undecorticated seed. In practice, the following cold test has proved satisfactory: the oil remains absolutely clear after 24 hr at 0 C and after 72 hr at room temperature. To obtain this result, in the case of winterization with a wetting agent, the supplier of this method recommends filtration after deodorizing at 14-18 C using 0.1% filter aid.

The main differences in the winterization methods we have described above are that the conventional method with filters can be used with classic refining (caustic soda) and also with physical refining, a method which is being used more and more for oils with low acidity, whereas the wetting agent method can be used with soda neutralizing only and the solvent method has the drawback of a high energy consumption and the need for explosion-proof equipment.

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