Processing Lines from GEA Westfalia Separator for the Edible Oil Industry

engineering for a better world

GEA Mechanical Equipment

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Oils and Fats Processing

Robust – reliable – efficient

Vegetable oil is one of the most important primary foods. The quality of the final product depends on the refining method and the nature of the crude oil. GEA Westfalia Separator offers a wide range of solutions designed to maximize value, ranging from a separator with a daily capacity of 10 tonnes for operators of small oil mills to separators with capacities of more than 1600 tonnes per day for large refineries.

The production processes and technologies used must be as varied as the different types of oil processed.

GEA Westfalia Separator designs and manufactures a customized solution which is tailored to meet the requirements of the specific application. The centrifuge is always found at the heart of the installation. Whether a self-cleaning separator with a maximum level of automation or a discontinuously operating system, every customer is able to find the best solution in economic and technological terms for thier specific production tasks. We not only supply the mechanical separation facility, but also supply all other components and systems necessary for an efficient and reliable production line.

Processing of oils including:
- Soybean oil
- Canola oil
- Sunflower oil
- Animal fat
- Cottonseed oil
- Corn oil
- Fish oil

Our core competence in edible oil refining:
- Press oil clarification
- Degumming
- Neutralization
- Dewaxing
- Fractionation
- Soapstock splitting

Special applications:
- Ni-catalyst removal
- Lecithin deoiling
- Bleaching earth deoiling
- Re-refining of used frying fats

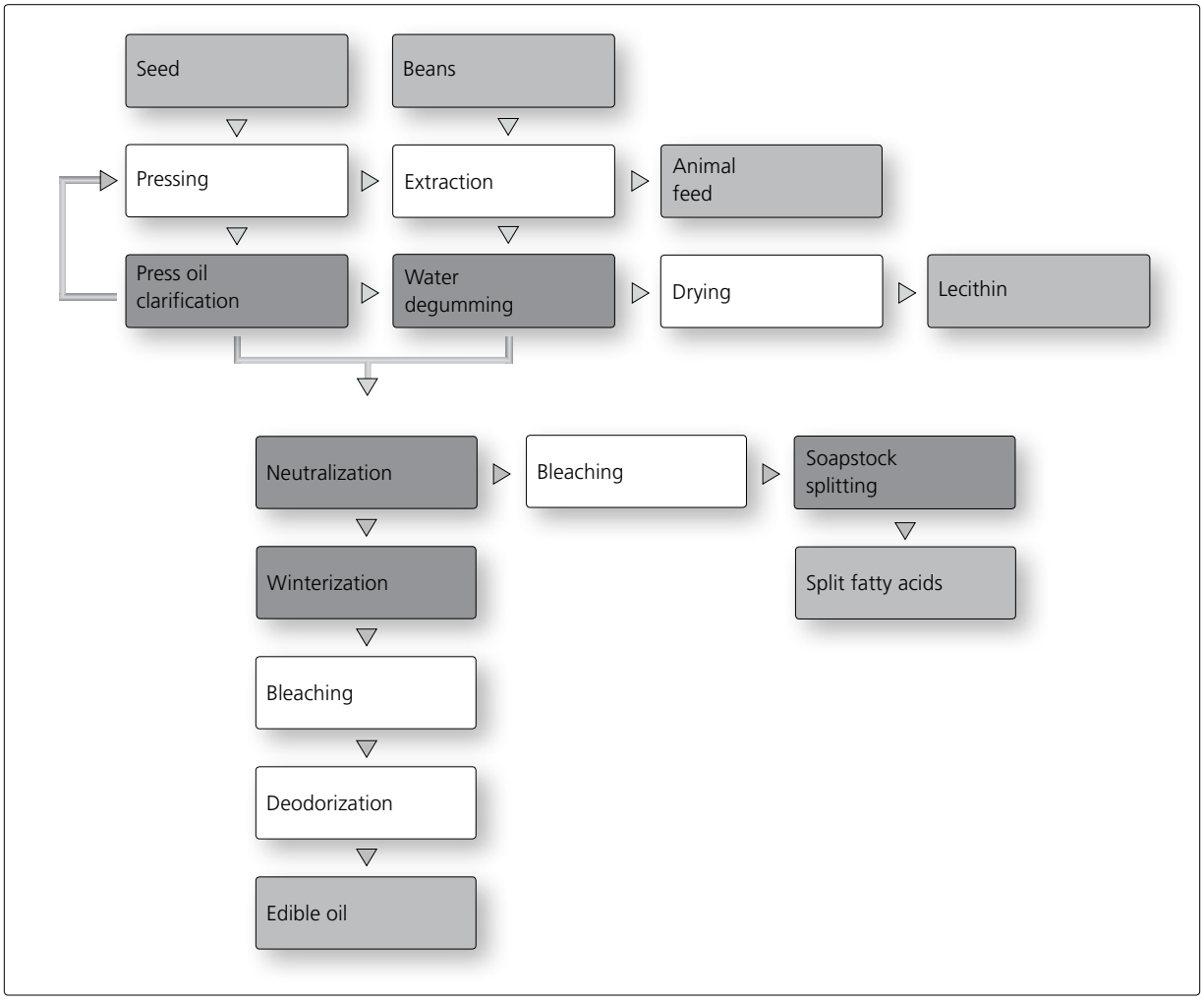
Our core competence in oleochemical applications:
- Transesterification (e.g., for making biodiesel)
- Epoxidized oils
- Mono-/diglycerides
- Fatty acids
- Glycerin
- Soap
- Fatty alcohols

Chemical Refining

Different Processes – One Solution

Two processes have been developed for refining edible oils and fats. The decision as to which process is to be used depends on the type and quality of crude oil to be processed.

Chemical refining is the traditional method, where the free fatty acids of the crude oils are neutralized with caustic soda. The resultant sodium soaps are separated by means of separators. The neutral oils are subsequently bleached and deodorized. This method can be used for reliably refining virtually all crude oils, including oils of low quality, with the exception of castor oil.

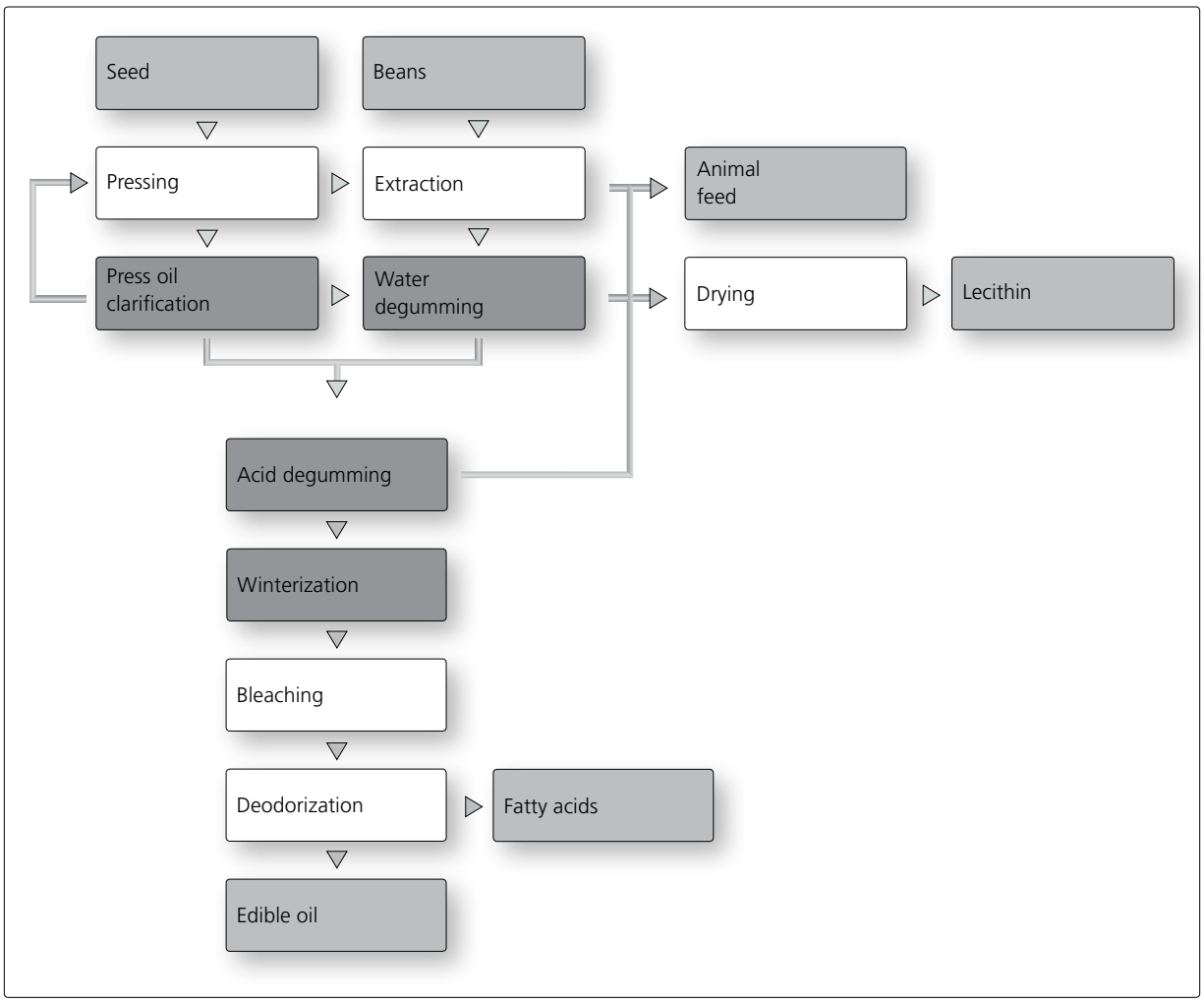


The fields highlighted in the dark color represent the core business of GEA Westfalia Separator and are highlighted in this brochure.

Physical Refining

In the alternative method of physical refining, the free fatty acids are removed by distillation in one stage during deodorizing. A fundamental criterion for using this method is that the crude oils should be degummed as effectively as possible. This is only possible to a limited extent with some crude oil types. Other oils, for instance cottonseed oil or fish oil, are fundamentally not suitable for physical refining.

GEA Westfalia Separator is able to supply suitable process lines for both processes; we have limited ourselves to the processes in which centrifuges are used, or which complement centrifuge lines.



The fields highlighted in the dark color represent the core business of GEA Westfalia Separator and are highlighted in this brochure.

Clarification of Press Oil

The oil which is discharged from expeller presses has various solid content levels depending on the oil seed type and the condition of the press. In order to remove particularly large solid particles, the oil is usually fed into a settling tank, which is used simultaneously as a buffer tank. In some installations, a vibrating screen is used for pre-cleaning. In others, the oil is taken directly from the press to the press oil clarification unit.

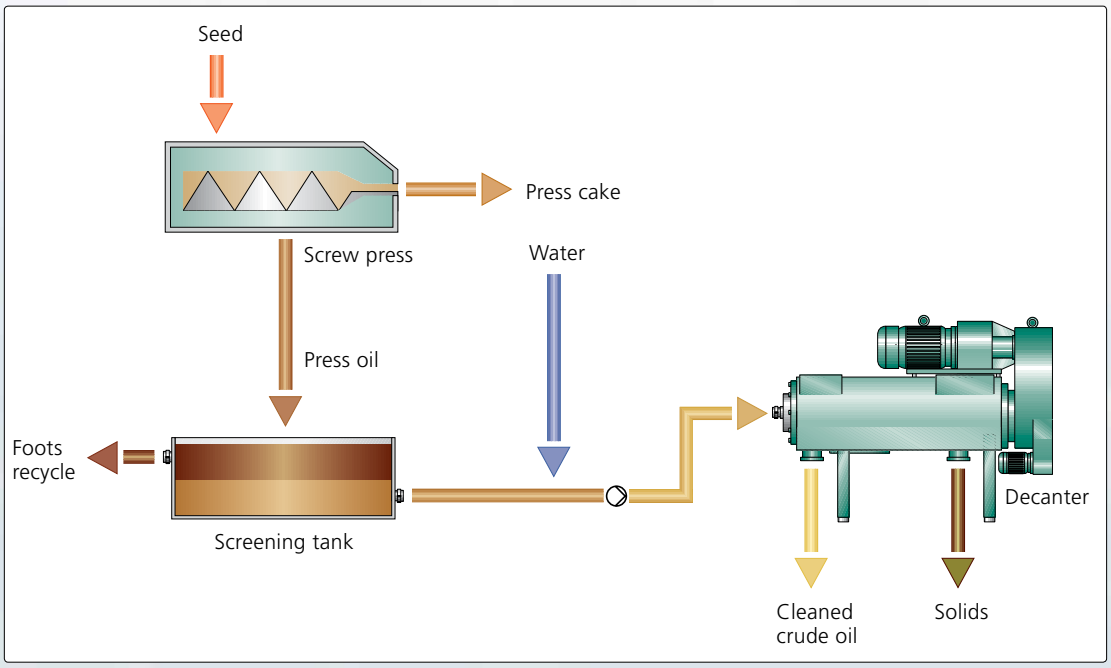
In order to support the separation process, the solids are wetted with hot water. A water quantity of 1% in relation to the oil quantity is normally adequate. The water is mixed with the oil in the decanter. The decanter – which is a horizontal scroll-type centrifuge – continuously separates the solids from the oil.

As a side effect of adding water, any phosphatides present are hydrated and then removed together with the solids.

In order to avoid oil losses, the solids are returned to the press. The purified oil is either processed directly or, if it is stored or sold, it should be dried in a vacuum.

Many features for your benefit

- Continuous solids separation
- Low cost of automation
- Lower space requirement
- Simultaneous degumming



Water Degumming

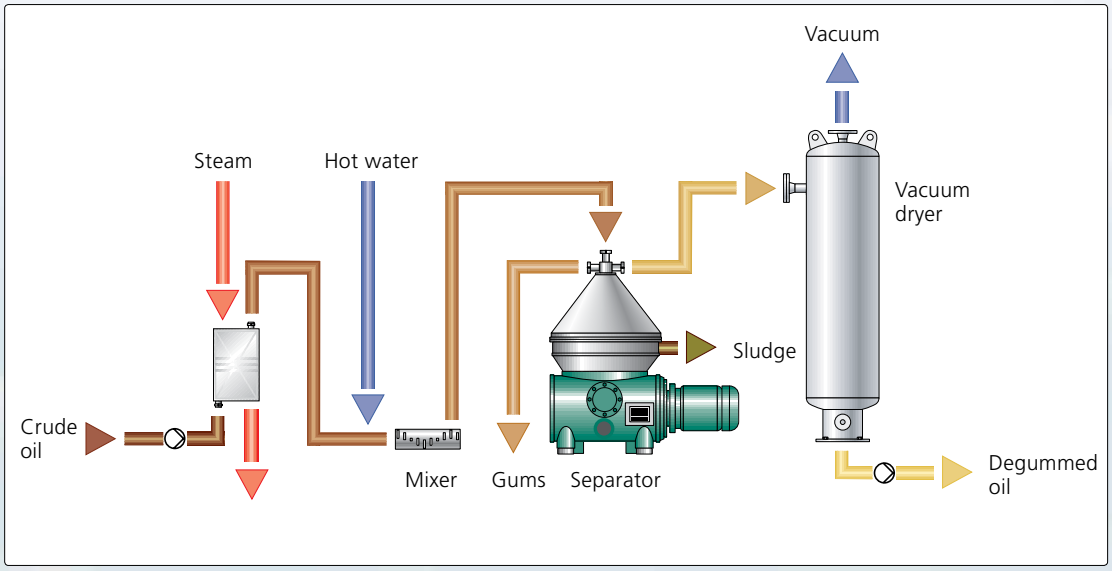
A smooth action pump is used for conveying the crude oil to a heat exchanger, which is used for heating the crude oil to the optimum process temperature. A quantity of hot water corresponding to the content of phosphatides in the crude oil is added to the oil and mixed intensively. A special centrifugal mixer, which simultaneously conveys the oil directly to the separator, is used for this purpose. The hydratable phosphatides swell immediately due to the particularly intensive mixing of oil and water, and no additional reaction time is necessary.

A separator is used to continuously separate the phosphatides which are insoluble in oil. They are either added directly to animal feed or dried in thin-film evaporators and sold in the form of lecithin. Lecithin is a valuable by-product, which is used as an emulsifier, e. g., in the food, animal feed, pharmaceutical and cosmetics industries.

The degummed oil is either conveyed directly to the refining stage, or it has to be dried in a vacuum if it is stored or sold.

Many features for your benefit

- Lecithin recovery
- Reduction of losses in the refining stages



Simple Acid Degumming

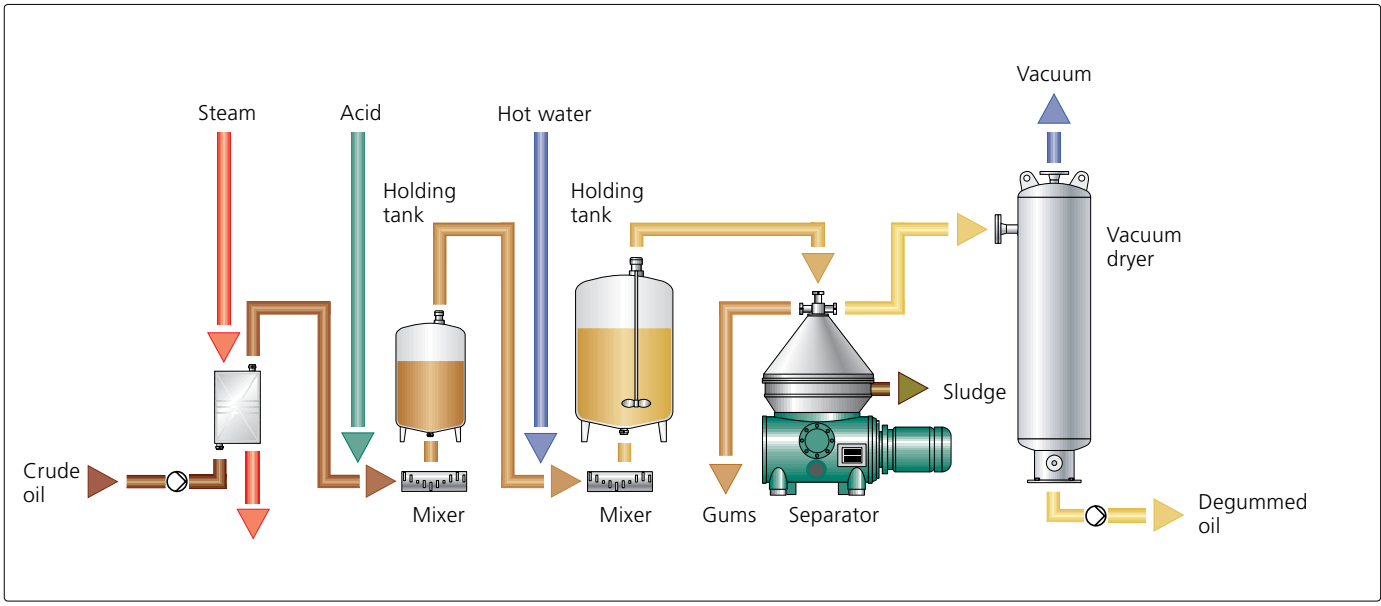
Simple acid degumming is suitable for pretreating palm oil, palm kernel oil, coconut and olive oil as well as animal fats. This method of degumming aims to reduce bleaching earth consumption in the physical refining process, making this an extremely economical method.

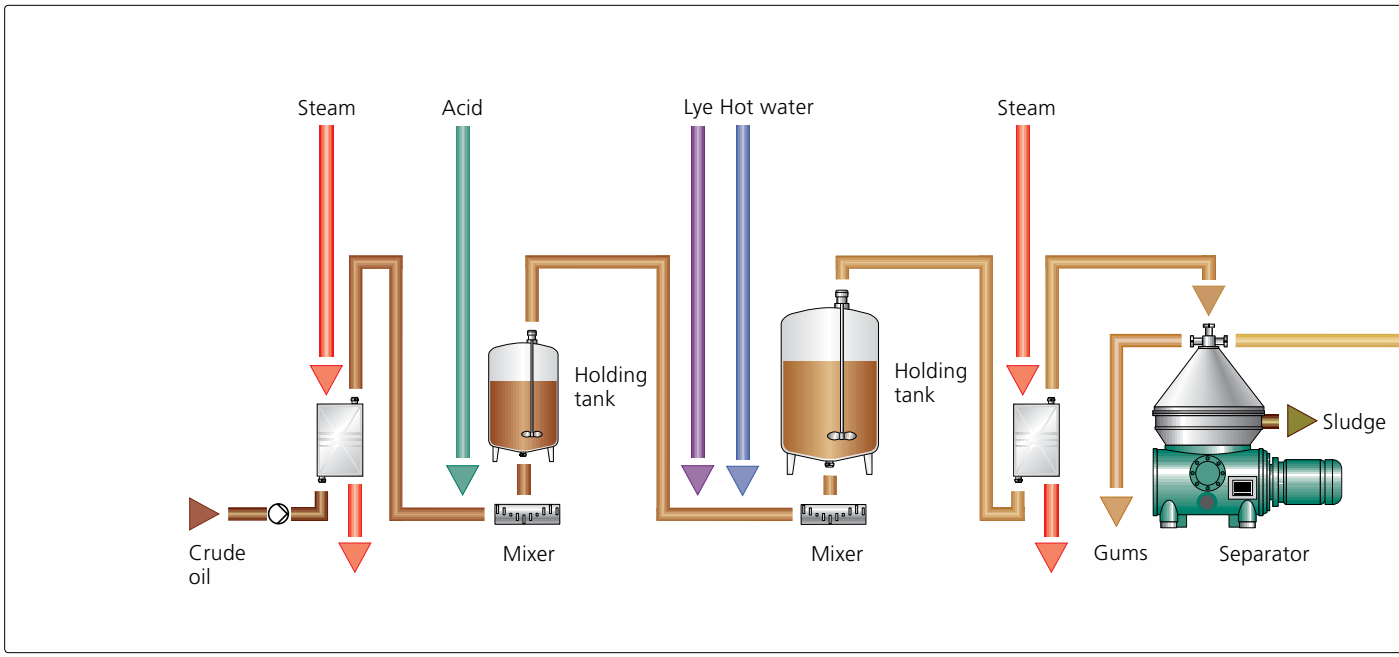
The crude oil is initially heated to the optimum process temperature in a heat exchanger. A metering unit is used for adding a small quantity of phosphoric or citric acid, which is mixed intensively with the oil in a centrifugal mixer. After a brief reaction time, hot water is added and mixed.

The heavy phase which contains phosphatides, proteins, pigments and other impurities is then separated. The oil which is treated in this way is generally sent directly to the bleaching stage and deacidified by means of distillation.

Many features for your benefit

- Reduction of bleaching earth consumption
- Better end product quality
- Less fouling of downstream equipment

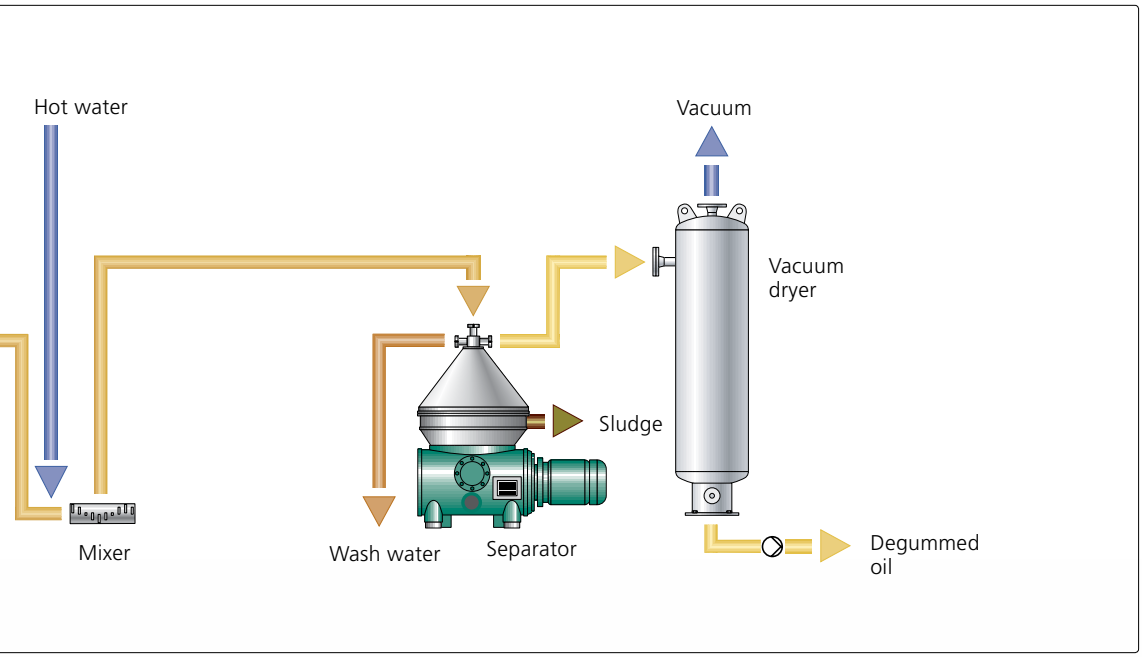

Steam
Acid
Hot water
Holding tank
Holding tank
Vacuum
Vacuum dryer
Crude oil
Mixer
Mixer
Gums
Separator
Sludge
Degummed oil



Special Degumming

This degumming method can be carried out with slightly modified neutralization lines. Depending on the quality of the crude oil, it is possible to decide whether the oil can be refined by chemical or physical means. However, with respect to the residual gum content, it is necessary to accept a compromise in comparison with the more demanding acid degumming methods described below.

The crude or water-degummed oil is initially heated to the optimum hydration temperature. A small amount of phosphoric or citric acid is then added and intensively mixed in the centrifugal mixer. After an appropriate reaction time, some of this acid is neutralized with very diluted caustic soda and a sufficient amount of water is simultaneously added for hydration of the phosphatides. The caustic soda and water are also mixed together with the oil in the next centrifugal mixer. The mixer conveys the oil through a hydration reactor to the next heat exchanger, which heats the product to the corresponding separation temperature. Phase separation then takes place in a separator to produce gums and oil. The residual phosphatide content which can be achieved in this way may be adequate for some applications. In most cases, however, further reduction is recommended by means of washing the oil.



If this is the case, a certain quantity of hot water is added to the oil. They are then mixed and conveyed to a second separator which continuously separates the wash water.

The oil which is virtually degummed is then either conveyed directly to the bleaching stage, or it is dried in a vacuum if it is to be sold or stored.

Many features for your benefit

- This process line can also be used for neutralization (flexibility)

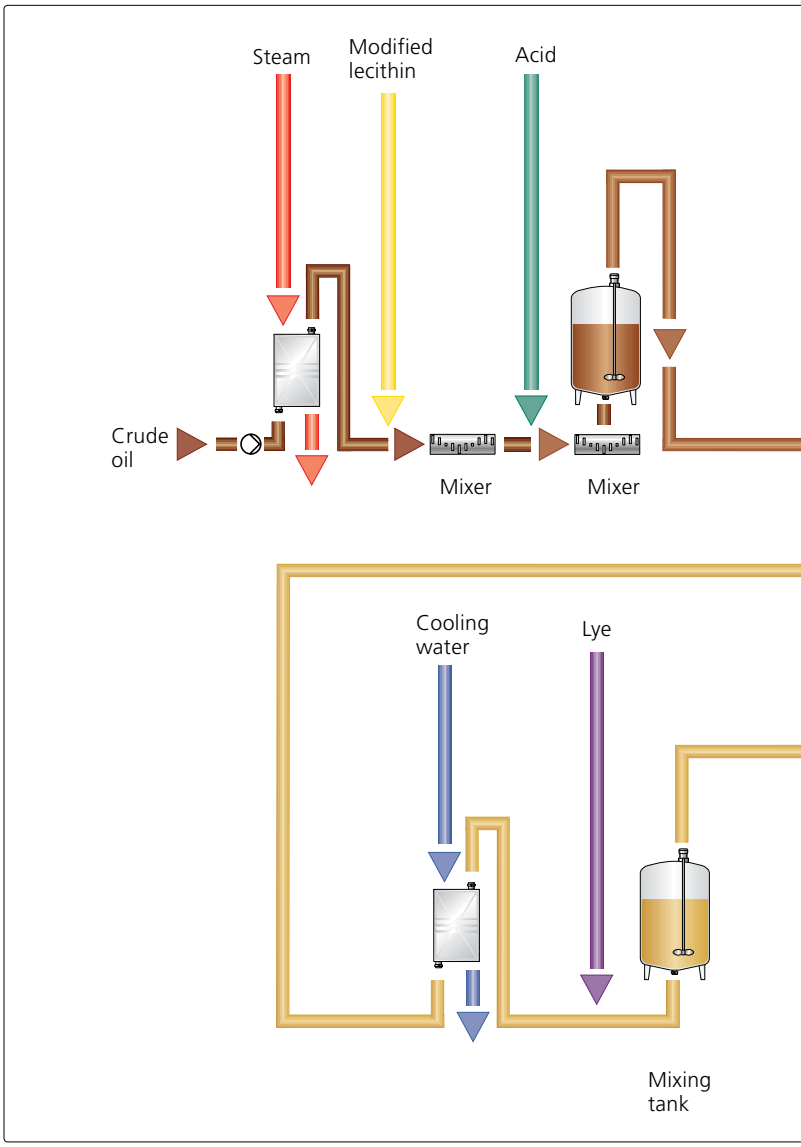
Super- / Uni-Degumming

After the crude oil has been heated, specially modified phosphatides which subsequently facilitate phosphatide hydration can be added. However, this is only necessary in exceptional cases. Under normal conditions, a small quantity of citric acid is added to the crude oil and mixed very intensively with the oil. After a certain reaction time, the oil is cooled and the necessary quantity of water is added for hydrating the phosphatides. After more reaction time in an agitator tank, the oil is heated to separating temperature and the gums are separated from the oil in a separator.

This concludes the super-degumming stage. However, depending on how the oil is to be subsequently treated, it may be necessary to remove the phosphatides more efficiently, as extremely fine particles cannot be separated. A further process stage, the uni-degumming method, has been developed for this purpose.

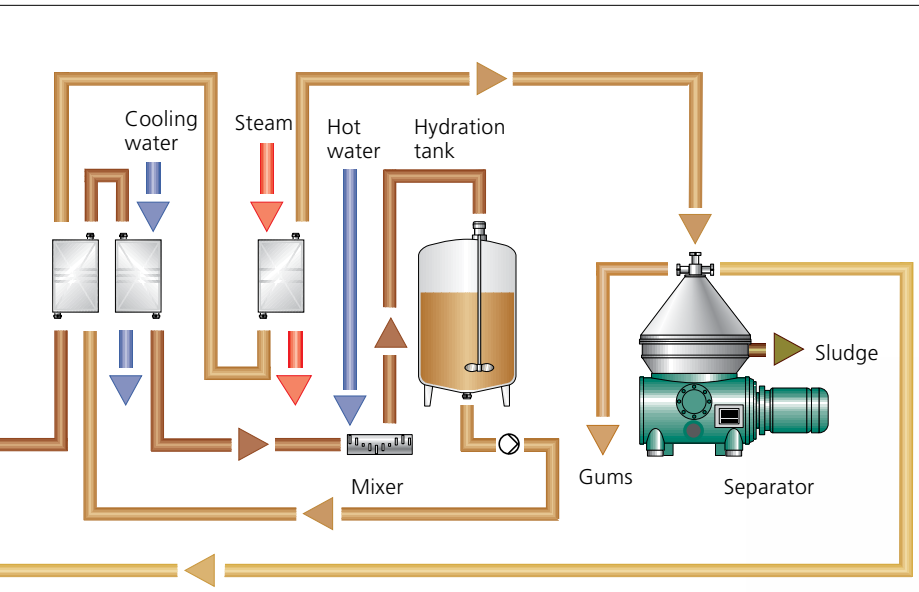
The oil is cooled for a second time and a small amount of caustic soda is added. Mixing of the caustic with the oil in a special mixing tank is followed by further reaction time in an agitator tank, during which the fine phosphatide particles agglomerate to form larger particles. These can be separated in a clarifier after the oil has been heated. The oil is subsequently dried in a vacuum.

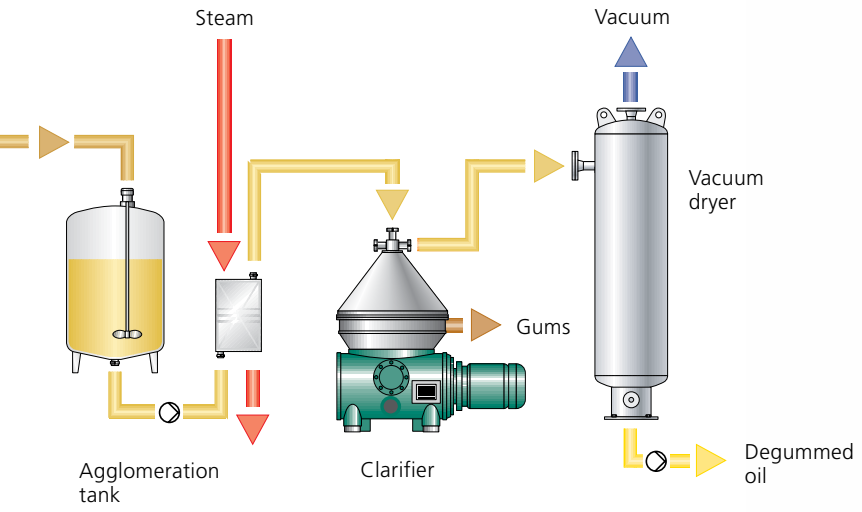
The hydration and agglomeration of phosphatides at low temperature produces a positive side effect for wax-containing oils (e. g., sunflower oil and corn oil). Some of the wax crystallizes and is separated together with the gums. This produces a considerable advantage in the subsequent refining process of these oils.



Many features for your benefit

- P-content < 10 ppm possible
- Can be combined with partial dewaxing

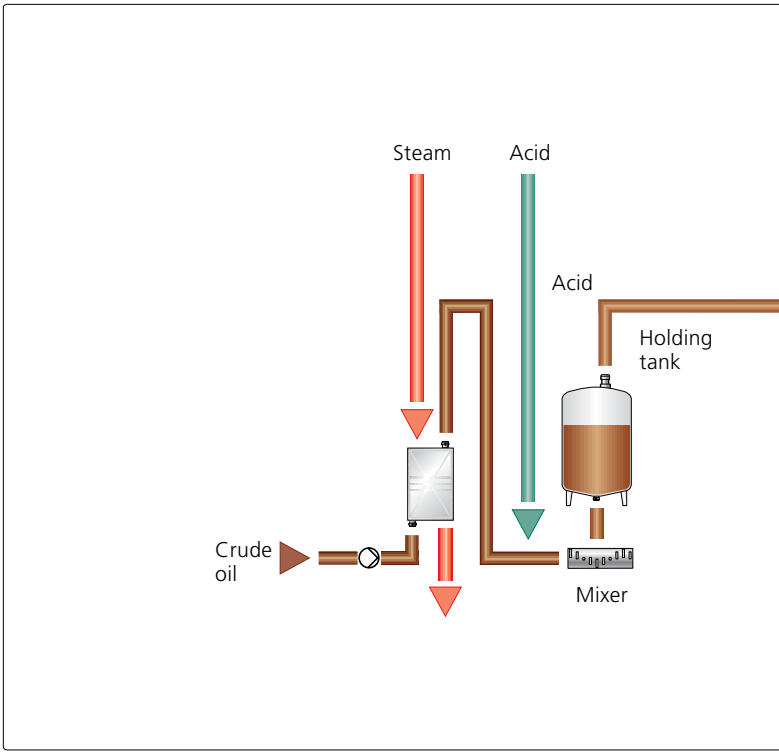

Cooling water
Steam
Hot water
Hydration tank
Mixer
Sludge
Gums
Separator


Steam
Vacuum
Vacuum dryer
Gums
Agglomeration tank
Clarifier
Degummed oil

TOP-Degumming

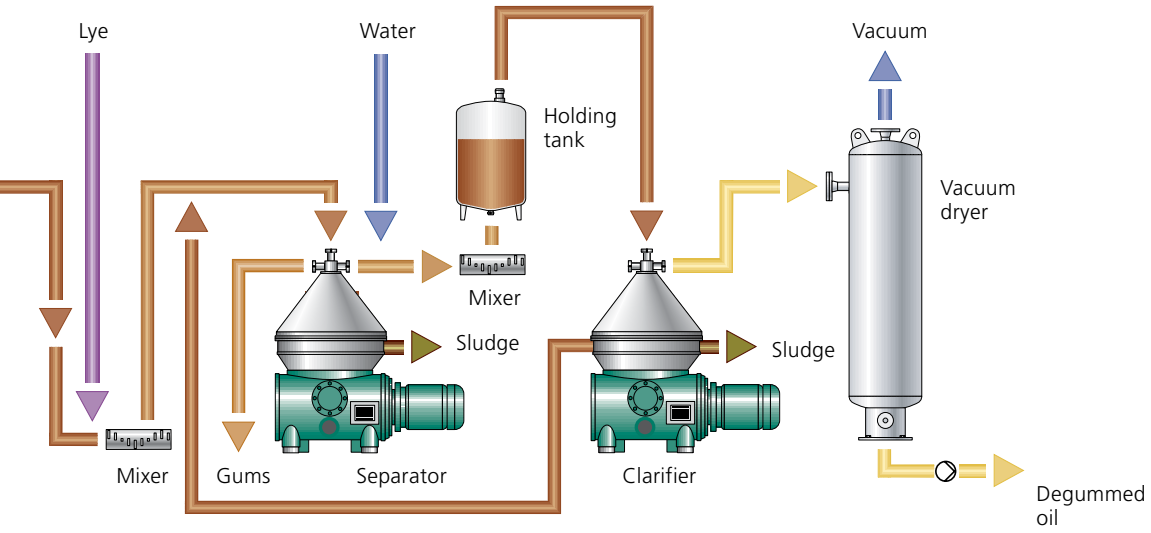
The crude oil is initially heated to the optimum process temperature and a small quantity of acid is added. Following intensive mixing and a brief reaction time, some of the acid is neutralized with diluted caustic soda. After mixing in a centrifugal mixer, the gums are separated from the oil in a separator.

Because very fine phosphatide particles cannot be separated, a certain amount of water is again added to the oil. Following a brief reaction time, the mixture is conveyed to a high-performance clarifier which is able to generate an extremely high g-force. This enables the fine particles to be continuously separated with the water. In order to avoid oil losses, this phase is recycled into the feed of the first centrifuge, where the fine gum particles are separated together with most of the phosphatides. The oil which is degummed in this way is subsequently dried.



Many features for your benefit

- P-content < 10 ppm possible
- Short retention times
- Very compact installation


Lye
Water
Vacuum
Holding tank
Vacuum dryer
Mixer
Sludge
Sludge
Mixer
Gums
Separator
Clarifier
Degummed oil

Standard Neutralization

This method is suitable for neutralizing pre-degummed edible oils or oils which originally only have a low phosphatide content. The free fatty acids are saponified with caustic soda, and the sodium soap is separated.

The oil is initially heated to the optimum process temperature. In order to condition the non-hydratable phosphatides, a small quantity of concentrated phosphoric acid is added and intensively mixed with the oil. Following a brief reaction time, diluted caustic soda is added in order to neutralize the free fatty acid and the phosphoric acid. After mixing with the oil, the mixture is either conveyed directly to the first separator or it passes through a further reaction tank. The latter is recommended only for oils with a relatively high phosphatide content. Self-cleaning separators are mostly used for separating the sodium soap. However, the residual soap content in the neutral oil is still too high for the subsequent process stages and it must be further reduced by one or two washings. For this purpose, hot water is added to the oil and intensively mixed. The soapy wash water is removed in a further separator.

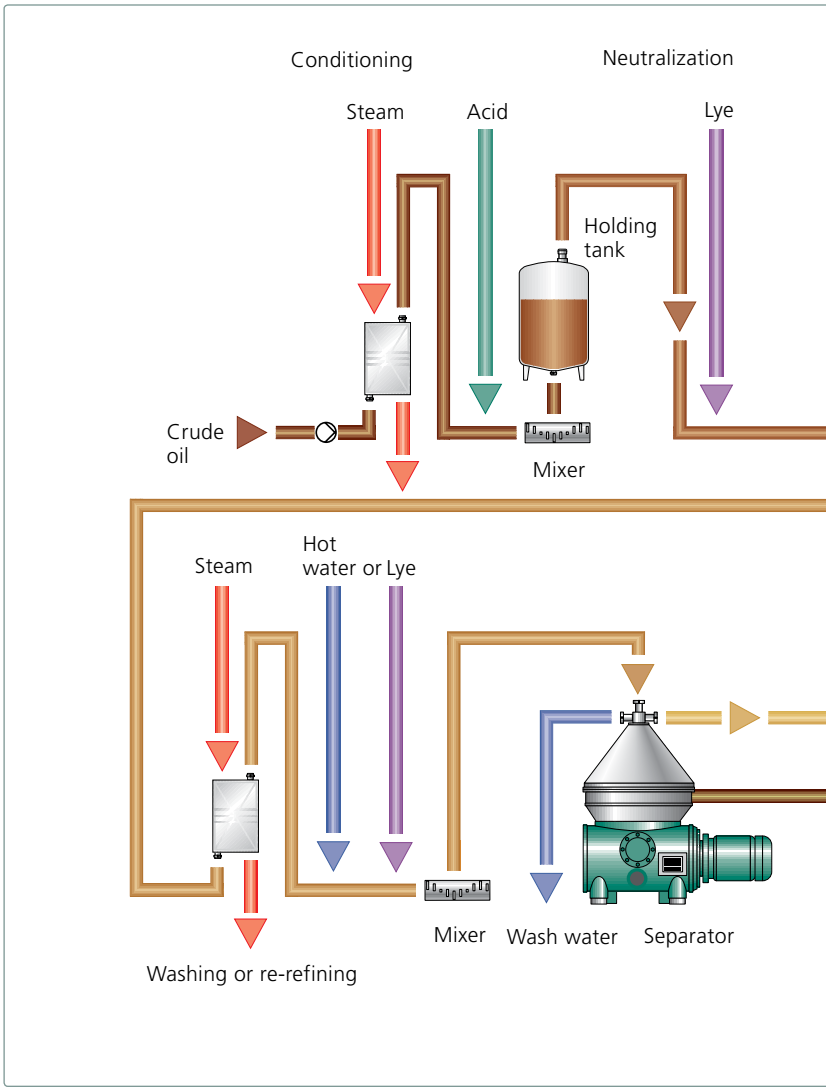
In general, one wash stage is adequate. A second washing is only necessary if very low residual soap contents are required. However, a low residual soap content can also be achieved by acidifying the wash water with citric or phosphoric acid.

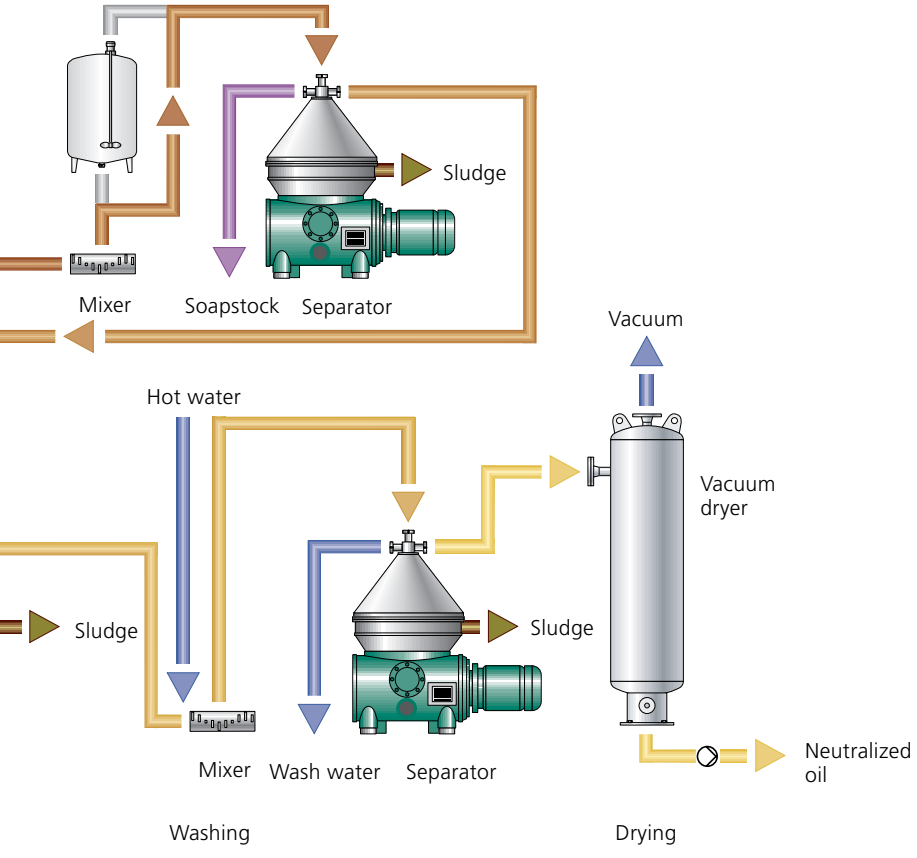
A second caustic treatment of the neutral oils is only advisable in exceptional cases. This mainly applies to cottonseed oil, so most of the gossypol is removed. This oil should always be neutralized in 3-stage installations.

Depending on the subsequent bleaching method, the neutralized and washed oil is subsequently vacuum-dried.

Many features for your benefit

- Very reliable process, e. g., for poor-quality crude oils
- High product quality guaranteed
- All oils can be processed




Sludge
Mixer
Soapstock
Separator
Vacuum
Hot water
Vacuum dryer
Sludge
Sludge
Mixer
Wash water
Separator
Neutralized oil
Washing
Drying

Neutralization of Undegummed Oils

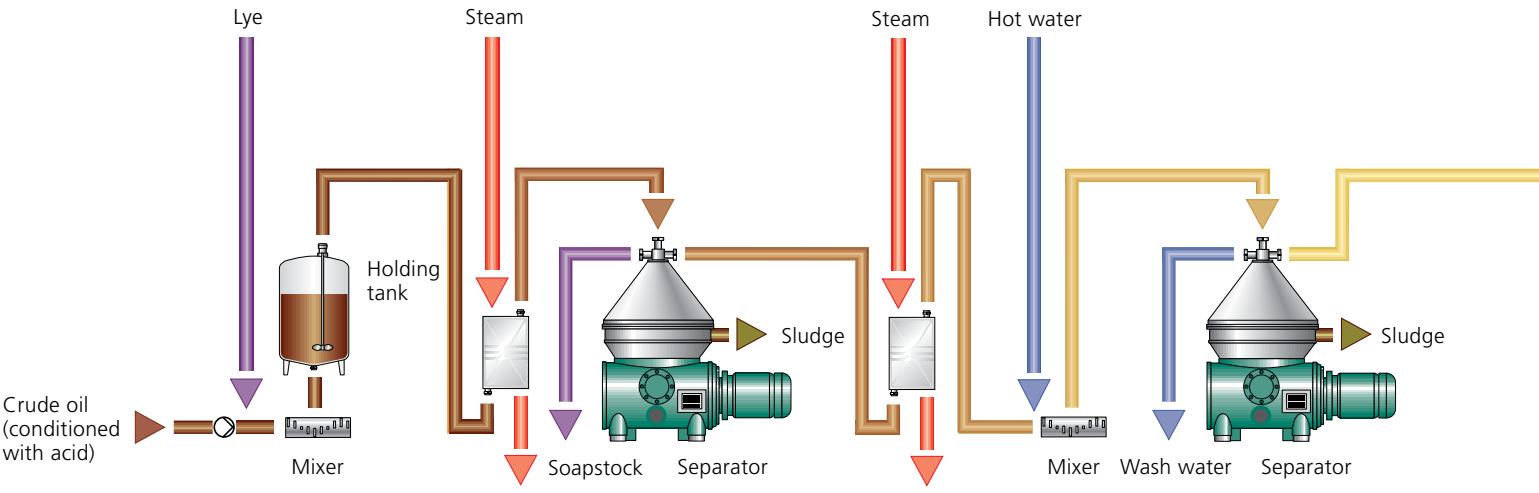
This method has become established mainly in the USA for refining soybean oil. The process is a combination of degumming and neutralization.

For conditioning the non-hydratable phosphatides, a small quantity of phosphoric or citric acid is added to the crude undegummed oil. In some cases, the acid is added in the feed tank with an agitator upstream of the installation. This involves several hours of reaction time. However, a more effective method is to add the acid upstream of a centrifugal mixer. The intensive mixing enables the reaction time to be reduced to a few minutes. Diluted caustic soda is then added in order to neutralize the free fatty acids. Adequate water must be present with the caustic in order to hydrate the phosphatides. Following a reaction time of several minutes in special retention mixers, the oil is heated and added directly to the first separator in order to separate the soapstock.

The neutral oil is washed in order to further reduce the residual soap content. For this purpose, a certain quantity of hot water is added to the oil, mixed in a centrifuge and separated into wash water and oil in a separator. The residual humidity of the oil is further reduced in a vacuum drier.

Many features for your benefit

- Prior water degumming not necessary
- High end product quality



Miscella Refining

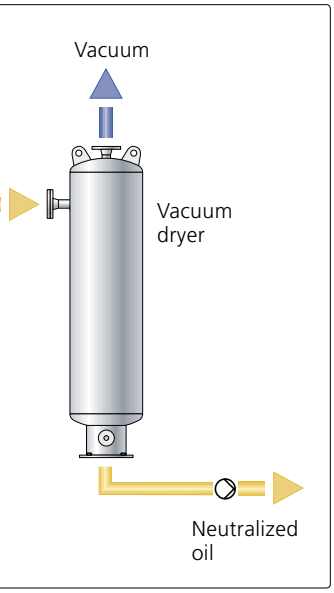
This method was originally developed for neutralizing cottonseed oil. It enables most of the gossypol to be removed with simultaneously low neutralization losses.

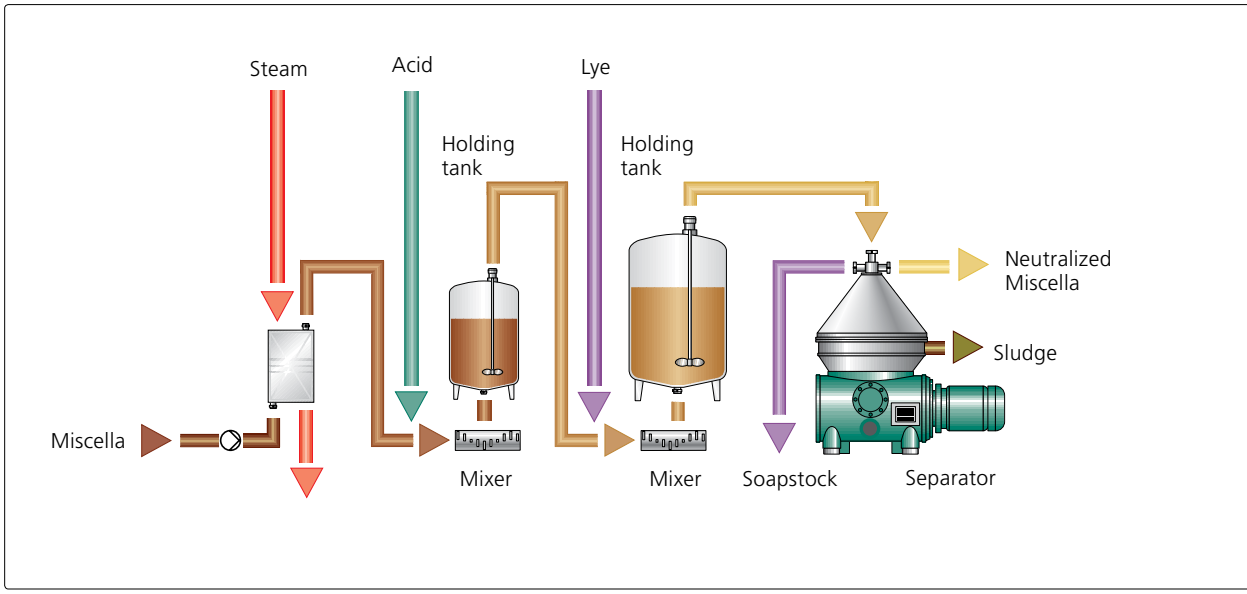
The miscella which discharges from the oil seed extraction stage is pre-concentrated either by adding the press oil or during the first stage of hexane evaporation. The miscella temperature is then briefly set below the evaporation point, and the necessary quantity of caustic soda is added in order to neutralize the free fatty acids. Mixing is followed by a reaction time in special retention mixers. The soapstock is separated in the separator. Because of the high specific density difference between miscella and soapstock, the separating efficiency is at its optimum level and it is not necessary to wash the oil after hexane evaporation. If it is necessary to treat oils with a higher phosphatide content, it is recommended that an acid is added before the caustic.

Because of the risk of explosion posed by hexane, all installation parts, and in particular the centrifuge, are explosion-proof. Due to special safety considerations, the centrifuge is blanketed with inert gas.

Many features for your benefit

- Low losses
- Good gossypol removal for cottonseed oil
- No wastewater if the soapstock is added to extraction meal
- Less fouling of hexane evaporation columns





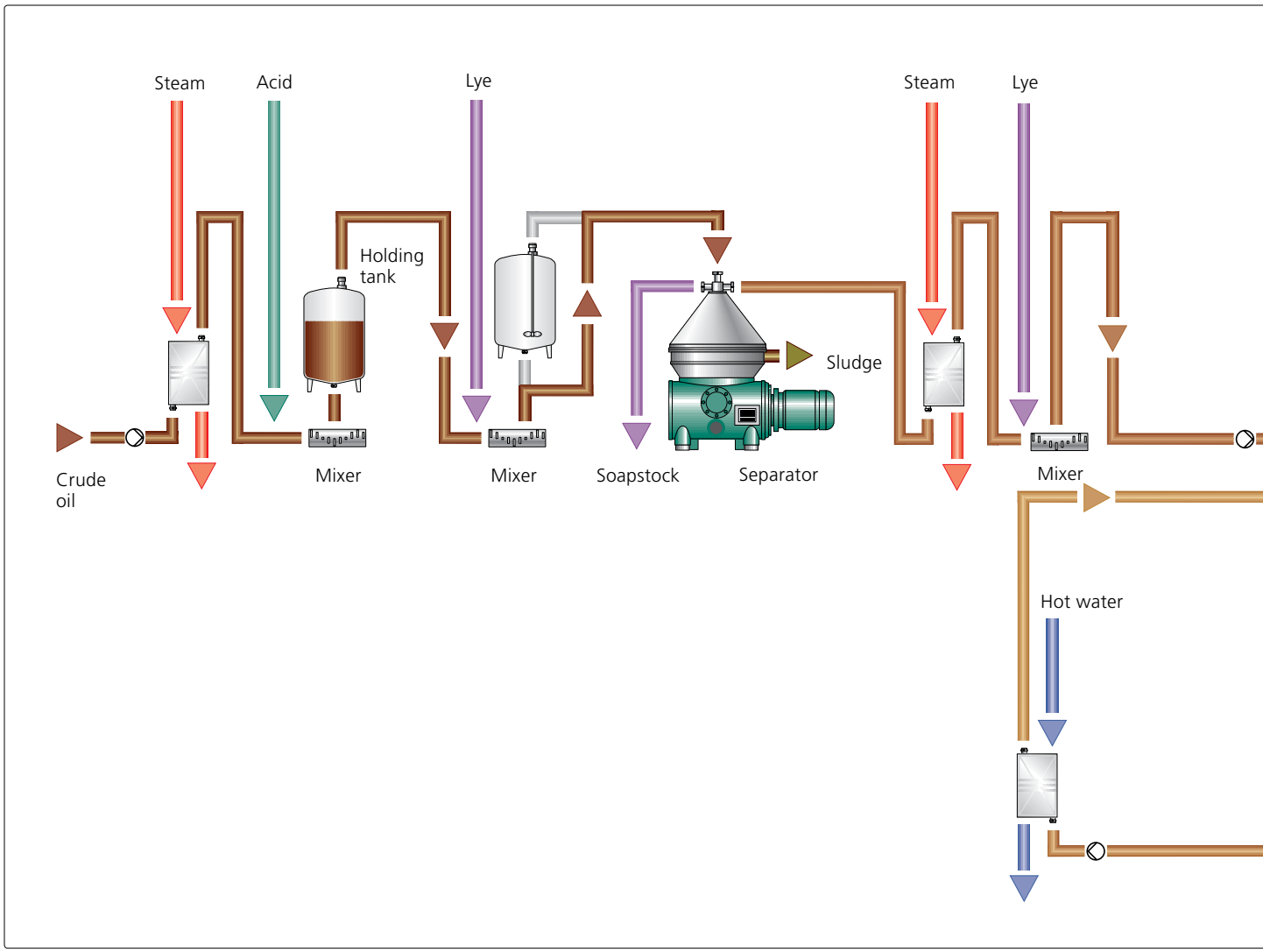
Wet Dewaxing

Winterization

Some vegetable oils, such as sunflower or corn oil, contain waxes (long-chained fatty alcohols or fatty acid esters), which crystallize at lower temperatures and result in turbidity in the oil. Wet winterization in combination with neutralization is suitable for removing these waxes.

The crude oil is initially neutralized, meaning that in order to condition the gums, an acid is initially added and the free fatty acids are then neutralized with caustic soda. After the soapstock is separated in the first separator, the oil is conveyed to the actual winterizing stage.

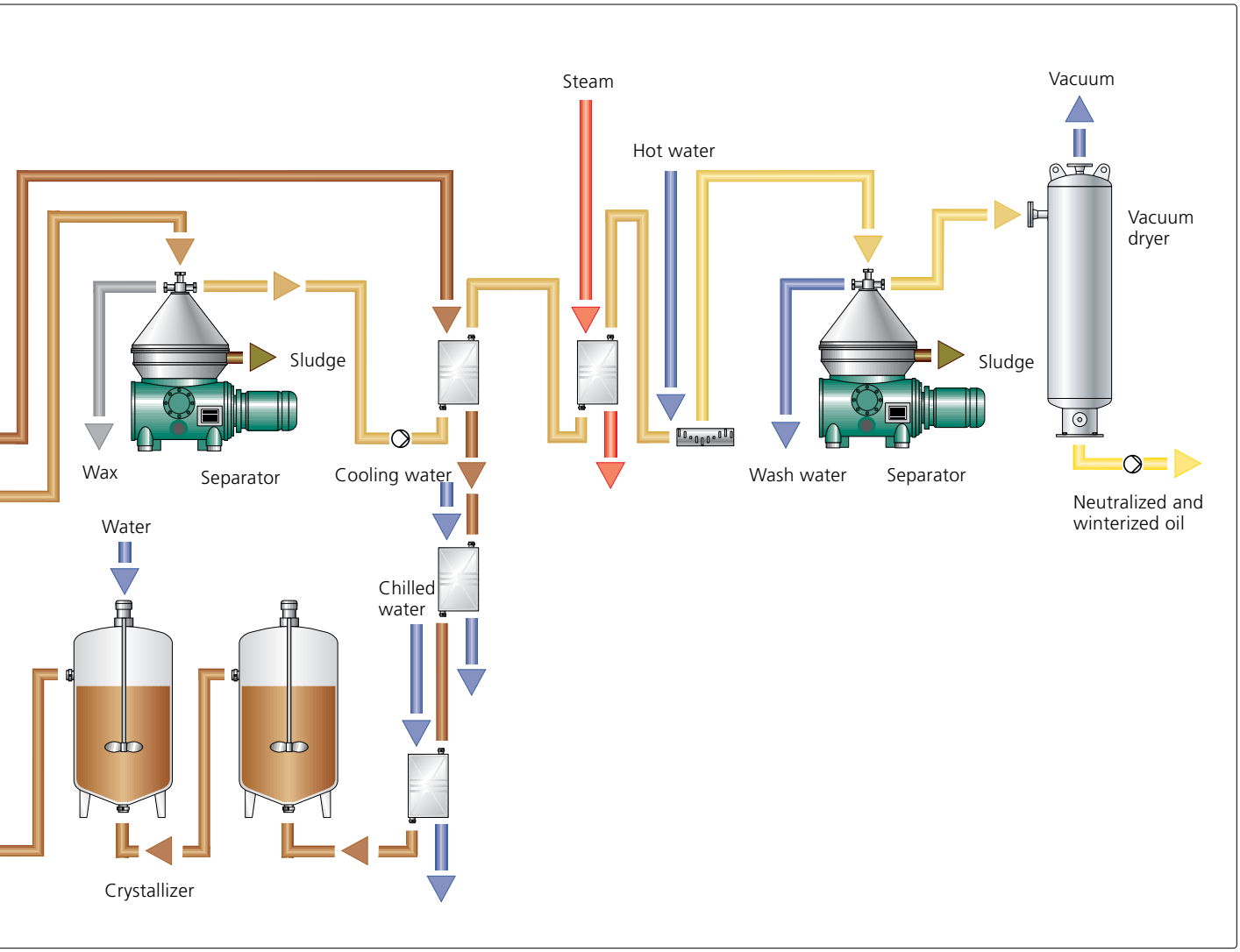
A small quantity of caustic soda is again added in order to set a specific residual soap content in the oil. This soap is subsequently required as a wetting agent during crystallization in order to bind the waxes to water. After mixing of caustic and oil, the product is cooled to the crystallization temperature. Wax crystals form in two to four crystallization tanks connected in series.



Due to the soap in the oil, these wax crystals bind to the water, which is added to the crystallizers. In order to reduce the viscosity, the oil is carefully heated and conveyed to a separator which continuously separates the waxy water. The oil is washed again in order to further reduce the residual soap content. For this purpose, the oil is heated and a corresponding quantity of hot water is added. After intensive mixing, it is separated in a further separator. Vacuum drying then takes place.

Many features for your benefit

- Integration of winterizing in neutralization
- Fully continuous operation
- Removal of very high wax amounts possible



Cold Refining

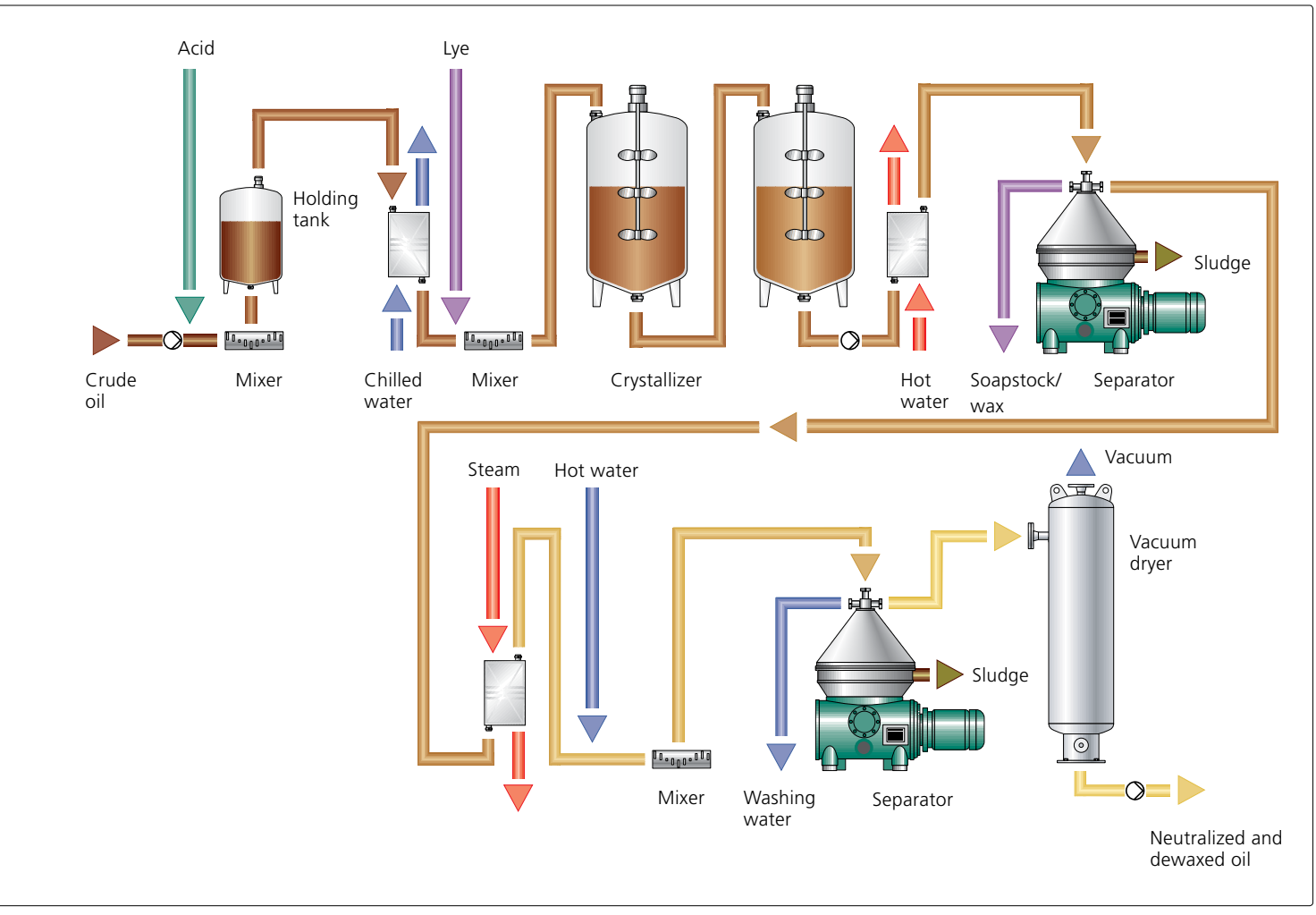
Winterization

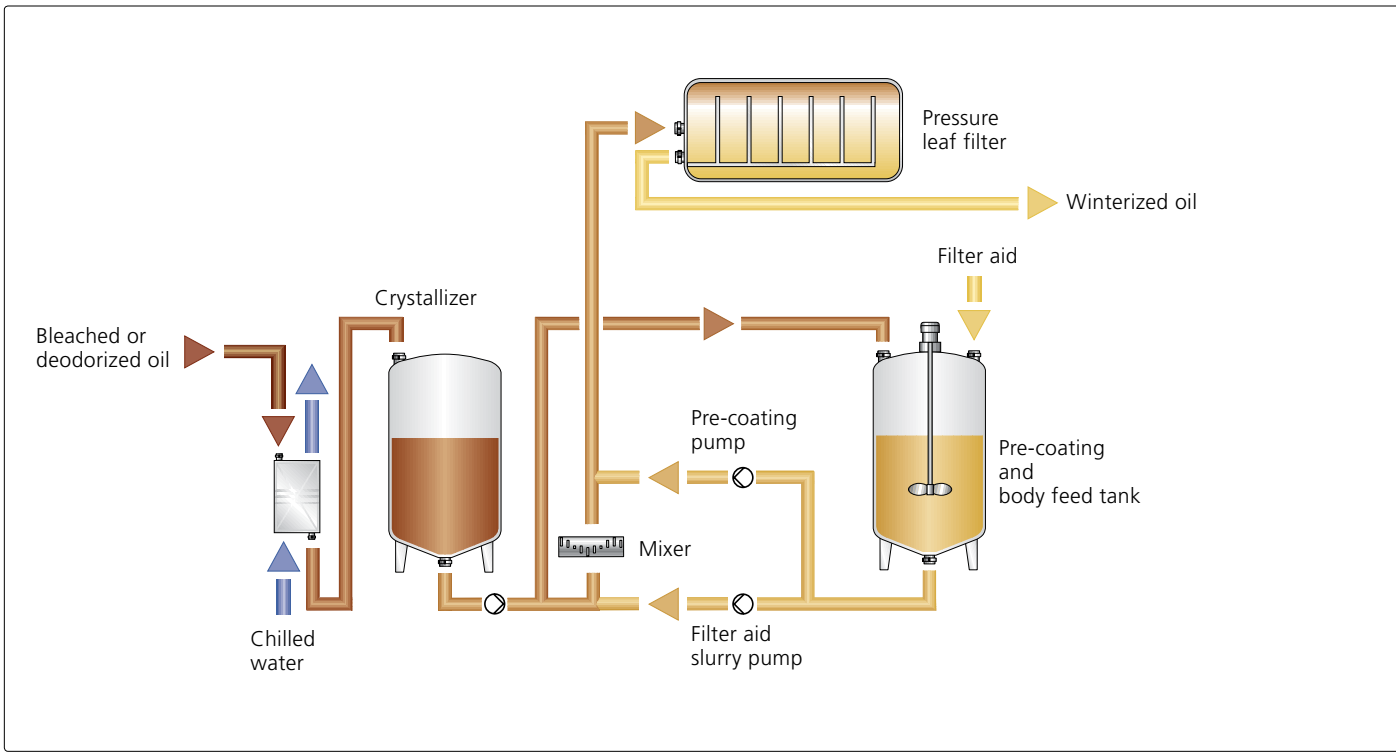
This process is an alternative to winterization preceded by neutralization. However, use of the process is confined to oils with a relatively low free fatty acid content as the oil losses are otherwise too high. Sunflower oil is therefore an ideal product for this application.

A small amount of acid is added to the crude oil without prior heating. After thorough mixing and a short retention time, the oil is cooled. The caustic quantity required for neutralizing the free fatty acids is admixed with the oil. The oil then flows through crystallizers with a residence time of several hours. The oil is gently heated to reduce the viscosity before the soapstock is separated in a centrifuge along with the waxes. The dewaxed neutral oil has to be washed to reduce the soap content. It is first heated, the required wash water quantity is added and, after thorough mixing with the oil, it is separated again in a second centrifuge. Finally, the oil is dried in a vacuum dryer.

Many features for your benefit

- Compact installation
- Effective wax removal





Polishing Filtration

Winterization

The wet winterizing method previously described does not guarantee that 100% of all waxes are always removed. If particularly strict process guarantees are applicable, additional polishing filtration is necessary for cold-stable oils. This further filtration process is carried out either after bleaching or after deodorizing.

For this purpose, the oil is cooled again and allowed to crystallize for several hours. It is then filtered using filter aid. Despite this additional filtration, the entire winterizing method offers economical advantages in comparison with methods which only use filtration. The major advantage is that much less filter aid is used and longer filter cycles are achieved.

Many features for your benefit

- Minimizing consumption of filter aids
- Higher filtration speed
- Longer filter cycles

Dry Fractionation

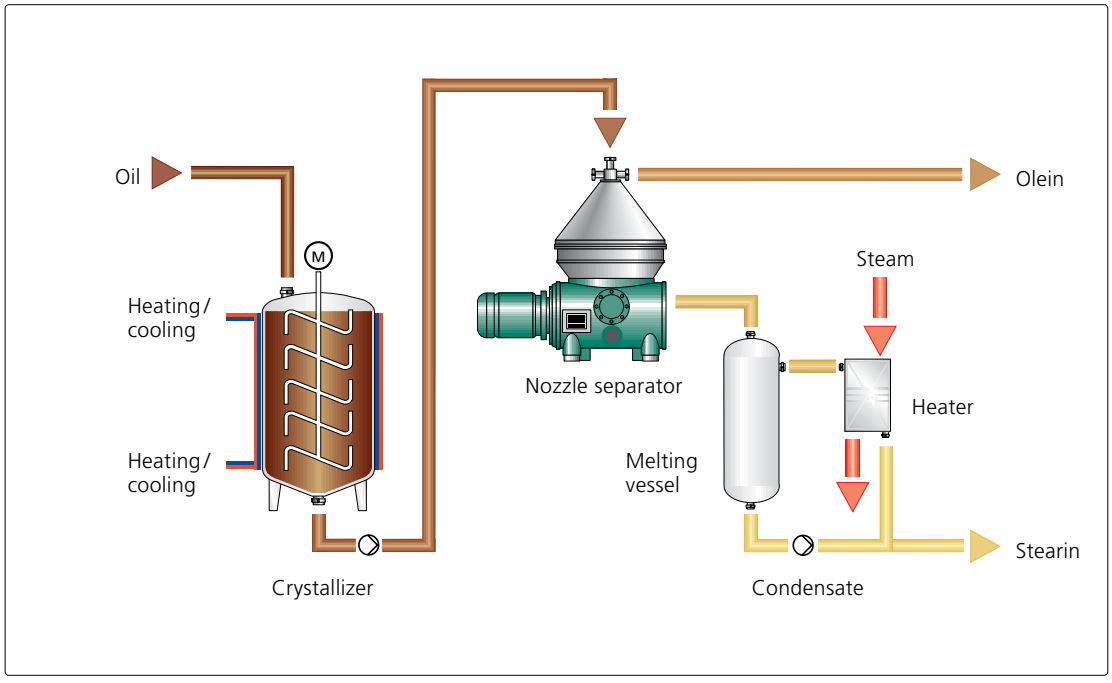
Oils and fats are a mixture of different triacylglycerols. If these mixtures contain a higher amount of saturated fatty acids, the products tend to partly crystallize at ambient temperature. Fractionation is a process to split fats and oils into a liquid part, the olein, and a solid fraction, the stearin.

The fractionation process consists of two stages, the crystallization and the separation of the olein and stearin. The crystallization is a batch process where the oil/fat is first heated above the melting point. Then a slow, controlled cooling takes place, following a specific cooling curve adapted to the kind of oil/fat. The aim is to produce stearin crystals which can be separated from the liquid olein phase. The process is called dry fractionation because there is no detergent or solvent added to the product, as is the case in some other known processes.

This separation is done with a specially designed nozzle separator. The stearin crystals, having slightly higher density, are discharged continuously through nozzles in the periphery of the bowl. The lighter olein is clarified in the disc stack of the bowl and continuously discharged from the centrifuge under pressure. The stearin slides down into a melting tank, where it is liquefied and pumped to further processing or storage.

Many features for your benefit

- Fully continuous stearin /olein separation
- Adjustable stearin and olein quality during separation
- Low installation and maintenance costs
- Hermetically closed system
- No cooled room for separator required


Oil
Heating/
cooling
Heating/
cooling
M
Crystallizer
Nozzle separator
Olein
Steam
Heater
Melting
vessel
Condensate
Stearin

Soapstock Splitting

Processing of by-products

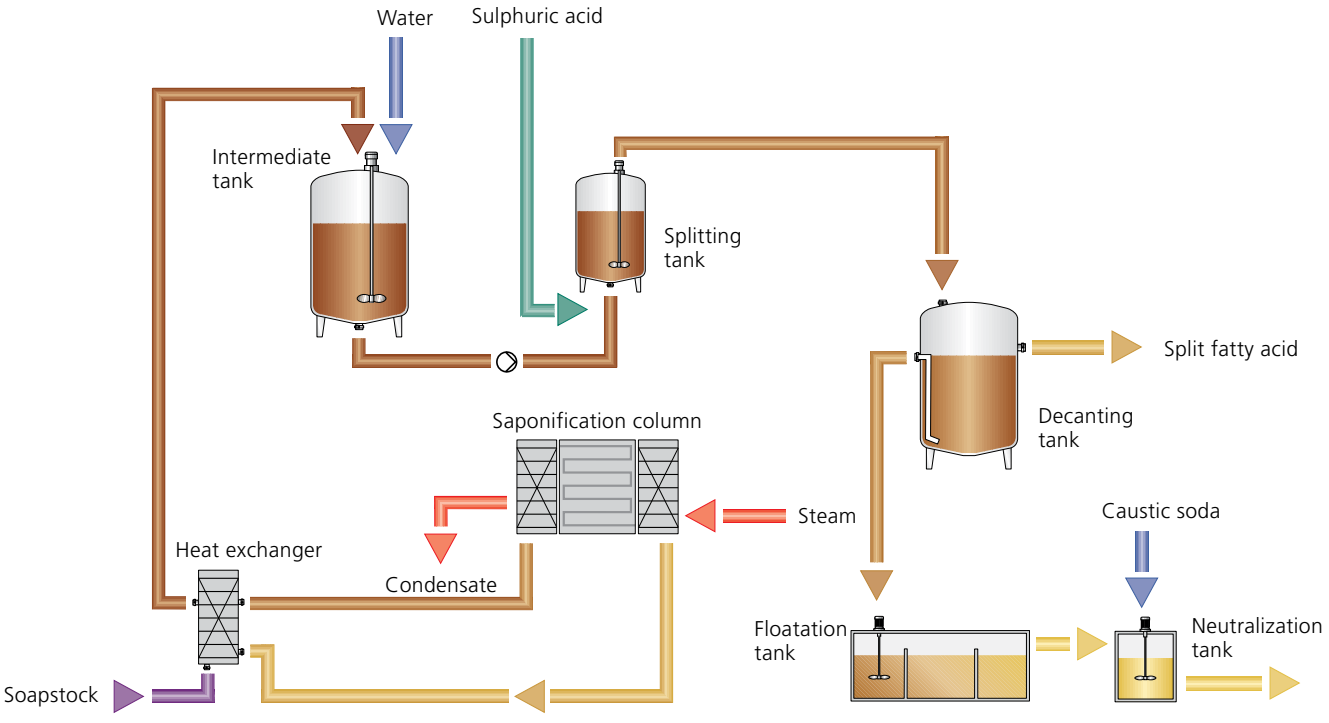
During the chemical neutralization of oils and fats, soapstock (sodium soaps of the free fatty acids) is obtained as a by-product. This can be split into fatty acids and water by means of acidification with strong acids (sulfuric or hydrochloric acid). Fatty acids are a valuable product in the animal feed, soap and oleochemical industries.

The phosphatides, separated together with the sodium soaps during the neutralization process, frequently have a significant effect on the splitting process during the formation of stable emulsions during phase separation. This can be prevented to a large extent by means of secondary saponification.

For this purpose, the soapstock is exposed to higher temperatures and pressures. During a reaction time under these conditions, part of the phosphatides and the neutral oil in the soapstock saponify. After saponification, dilution water can be added in an intermediate tank before the soapstock is conveyed to the actual splitting process. In the splitting tank, the pH value is reduced by adding a strong acid. The soapstock breaks down into fatty acid and water, which are then separated continuously in a static decanting vessel. The split fatty acid can be directly processed. The acid water is conveyed to a fat separator with an upstream flotation chamber. The de-fatted water is subsequently neutralized with caustic soda.

Many features for your benefit

- Fully continuous operation
- Lower level of emulsion



Available Drives for Edible Oil Separators

Gear drive

The conventional drive concept of the separators is the worm wheel gear, fluid clutch and standard motor with direct switching. The toothing of the worm wheel gear was optimized in order to reduce the noise level.

Advantages of the gear drive

- No requirement for the frequency converter
- Reliable design
- Suitable design for small machines

RSE 60 with gear drive

Flat belt drive

Flat belt drive can be used for the heavy bowls of larger machines. The power transmission from the torque-controlled motor to the bowl spindle is via a single flat belt without an intermediary clutch. The design is very simple and maintenance-friendly. The spindle can be removed together with the complete bearing assembly and can be serviced outside the machine. This considerably reduces downtime required for maintenance.

Advantages of the flat belt drive

- Longer oil change interval
- Longer maintenance intervals
- Lower maintenance cost
- Reduced noise level

RSE 220 with flat belt drive

Direct drive

Direct drive is the intelligent simplification of separation technology. Direct drive is used in applications where the upper limit for gear loads has been reached or when a belt drive is undesirable. Direct drive separators drive with virtually loss-free power transmission. Less energy consumption, lower maintenance and less space requirements mean increased performance for production.

Advantages of the direct drive

- Lower space requirement
- Lower maintenance requirement
- Lower energy costs
- Fewer wearing parts
- Further reduction of noise level compared to the flat belt drive
- The direct drive meets all explosion proof requirements

RSE 300 with direct drive



Ensuring Maximum Process Efficiency, Availability and Budget Security with serv&**care** from GEA Westfalia Separator

Wherever separating technology tasks have to be carried out, our serv&**care** program assures comprehensive services right from the very beginning. In close cooperation with our customers, solutions are developed to meet specific needs.

The customers benefit not only from traditional services such as inspection, maintenance, original spare parts and repair work provided by the original manufacturer, but also from pro-active solutions which avoid risk, e.g., online and offline monitoring with our GEA Westfalia Separator we**watch**®.

Modernization or upgrading to state-of-the-art technology also provides the opportunity to boost services as required.

Training provided on site or in the modern training center of GEA Westfalia Separator ensures that our customer‘s employees receive training in the proper handling of high-tech installations. This provides additional safety.

Our serv&**care** program provides for maximum process efficiency and installation availability as well as budget security. And these benefits are provided throughout the entire life cycle of the entire installation.

Services performed by specialists

When normal equipment use results in wear and tear, we stand behind the quality of our repair services. GEA Westfalia Separator has trained mechanics on staff that have the proprietary knowledge to make the necessary repairs. In true emergencies, a response team can be quickly deployed to your facility. Spare bowl and scroll assemblies are readily available for your use, so process/production lines are not idle while repairs are underway. And when equipment needs to be repaired off-site, we offer two full service locations here in North America. Our facility in Patterson, California was specifically developed to service customers based in the United States and Canada. Here, decanter and separators of all sizes can be repaired. There is also a large parts inventory and a specially designed training facility.

Service from the original manufacturer

- Service engineers move quickly to the site
- Extensive service network
- Risk avoided by service provided by the original manufacturer
- Pro-active solutions which avoid risk
- Upgrading to boost performance
- Staff training

serv&care

We live our values.

Excellence • Passion • Integrity • Responsibility • GEA-versity

GEA Group is a global engineering company with multi-billion euro sales and operations in more than 50 countries. Founded in 1881, the company is one of the largest providers of innovative equipment and process technology. GEA Group is listed in the STOXX® Europe 600 Index.

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