From fruit to food - and beyond

Innovative, sustainable processing solutions for the palm oil industry

In response to challenges facing players in the competitive palm oil milling, refining and fats modification industry, Alfa Laval has developed a range of innovative solutions that offer sustainable alternatives to traditional technology. The solutions have one thing in common – they add value.


**CPO**

Kaohsiung

Palm oil supply chain: The innovative Alfa Laval way to sustainable, high yield palm oil extraction, refining, fats modification and biodiesel production

Leading the way and minimize negative impact on more efficient ways to increase yield production it is essential to find new, properties. To achieve growth in oil is constantly increasing due to Demand for palm oil and palm kernel thinks outside the box

Fruit handling

- Fruit preparation
- Enzyme with separation
- Reactor
- Solvent washing

Fruit oil with separation

**OPAD**

- Oil recovery
- Heat recovery
- Oil recovery
- Vacuum

**RPOD**

- Specialized with bleaching
-馄饨
- Defatting

**RBDPO/RBDPKO**

- Refined, bleached, deodorized palm oil/palm kernel oil
- BPO/BPKO: Bleached palm oil/bleached palm kernel oil

**PFAD**

- Advanced glycerol modification
- Sterilization

**Biofuel**

- Oil recovery
- Alcohol

**Oleochemicals**

- Epoxidation
- Maleination

**Micronutrients**

- Enrichment processes
- Hydrogenation

**Enzymes**

- TocoBoos

**Bioprocesses**

- Biofuel

**Performance Agreements**

- Our individually tailored service agreements offer more than just basic maintenance to complete process optimization. Alfa Laval keeps track of your equipment and all services you ordered in advance.

A Performance Agreement gives you peace of mind and full control over your service budget. Let us handle the preoccupation while you focus on your core business.

Challenge: Maximum uptime while consistently improving your processes

To keep your operation up and running a professional partner with the know-how to handle your equipment and end-product plus a reliable supply of spare parts are essential.

Purpose 24/7 service

Our service facilities for palm oil are situated close to the main palm oil istatistics. Our service facilities for palm oil are situated close to the main palm oil processing. Our service facilities for palm oil are situated close to the main palm oil processing.

Global services close to you

Your challenge is our inspiration. Owned by a team of skilled and trained engineers, we take care of your processing needs. Alfa Laval’s palm kernel oil processing

Leading the way with palm kernel oil and experience gained since the 1960’s, Alfa Laval takes care of your palm kernel oil processing needs. Alfa Laval’s palm kernel oil processing

Our well-proven, energy-efficient solutions with capacities from pilot scale to 3,000 t/d and beyond enable sustainable palm kernel oil production of high-quality, extra-pure seed oil. We design and deliver the machinery for these processes, so you get the most from your palm kernel oil.

Your versatile solutions provider at Alfa Laval are both process engineers and equipment designers. Our company has been and continues to be at the forefront of palm kernel oil processing innovation.

If it’s a complete plant we take responsibility for the overall solution. If it’s a competitive offer we build the equipment and systems plus a reliable supply of spare parts are essential.

Your service facilities for palm oil are situated close to the main palm oil processing. Our service facilities for palm oil are situated close to the main palm oil processing.

Global services close to you
Crude palm oil with maximum yield

Milling

For decades Alfa Laval has provided palm oil mills with efficient equipment to convert sterilized and pressed palm fruit into crude oil, playing a key part in shaping the design of today’s clarification room.

Challenge: To achieve maximum yield in a sustainable process

A growing number of industry players are now calling for a process that can recover more crude palm oil, minimize costs and optimize yield. It should also be simple to operate and sustainable.

Solution: D3 PRO, all-in-one clarification/purification

The Alfa Laval D3 PRO process is a combined 3-phase clarification/purification and oil recovery solution. It offers a profitable alternative to traditional settling tank technology that requires huge continuous clarification tanks for skimming pure oil and decanters/separators to recover oil from the underflow of the tank. D3 PRO can be configured as an automated system capable of operating 24 hours a day, with minimum maintenance or supervision.

After de-sanding, the pressed palm oil is fed to the 3-phase decanter. This is capable of high capacity separation with no need for dilution water, which means much less effluent for smaller, more manageable ponds.

The “ready to go” light phase oil can be sent directly to the vacuum dryer for final moisture removal before refining with no need for purification. This not only saves on equipment and maintenance, it also ensures consistent quality.

At the same time the cake and heavy phase oil are separated and can be treated differently. The cake can be re-used, e.g. as fertilizer to generate other income sources. In the D3 PRO process, oil from the heavy phase can be further recovered using a nozzle separator.

Oil recovery from sterilizer condensate

Large amounts of water are used during sterilizing and pressing of palm fruit. With an Alfa Laval nozzle separator the residual oil can be recovered from the sterilizer condensate effluent.

Energy efficient drying and cooling

Centrifugal separation alone will not produce an oil sufficiently dry to be stored or to meet standard specifications from industry associations like PORAM. The amount of dissolved water present in the homogeneous oil phase depends on the amount of free fatty acid (FFA) in the oil and the temperature. The Alfa Laval vacuum dryer system utilizes vacuum to create a potential for the water to go over into the vapour phase.

With a temperature close to 90°C the oil leaving the dryer is more sensitive to oxidation and should be cooled before storage. An Alfa Laval Plate Heat Exchanger is ideally suitable for cooling as well as pre-heating before drying. An even more energy-efficient solution is heat recovery provided by an extra economizer – the capital cost is often recouped in a few months.

Larger scale production – with less water, energy and effluent

Palm oil mills and refineries are increasing in size to meet the growing demand in the world market. Hence, high capacity, high yield and energy efficient equipment is needed.

Alfa Laval has therefore extended its portfolio with new, very large and innovative separators and decanters.

For decades Alfa Laval has been clarifying and purifying crude palm oil at a Malaysian oil mill with a total capacity of 80 tons FFB/h.

Our self-cleaning separators can handle up to 18 m³/h of feed in the mill.

Separators for refining are available with capacities of up to 85 m³/h.

Our latest decanter technology for clarification and purification can handle a mill throughput of up to 90 tons fresh fruit bunches (FFB) per hour, and enables significantly reduced effluents and lower energy consumption.
Efficient effluent treatment

Challenge: To reduce effluent discharge from mills
The use of anaerobic digestion as a first-stage treatment of palm oil effluent results in a gradual accumulation of organic matter that silt s up the ponds. This makes it difficult to achieve the desired, increasingly stringent discharge parameters.

Solution: Sludge dewatering using decanters
Alfa Laval designs and supplies solutions based on decanters for dewatering palm oil mill effluent (POME) and de-sludging of anaerobic ponds.

The latest decanter technology for effluent dewatering, Aldec G2, has a new liquid outlet design that provides energy savings of up to 30% compared with its predecessor.

‘Plug-and-play’ module
The complete waste decanter module is equipped with a feed pump and a polymer dosing system. It can be commissioned quickly and easily on-site.

Located near the effluent ponds, the decanter removes up to 90% of the solids present by the addition of bio-degradable chemicals. Removing the solids decreases the organic loadings in the ponds, substantially reducing the biochemical oxygen demand (BOD) which, in turn, reduces silting. The module offers continuous operation with minimum supervision.

Challenge: Meeting final effluent discharge parameters
Increasingly stringent final discharge parameters stipulated by local environmental regulations are posing problems for many palm oil mills. Continuously adding effluent ponds is not a sustainable solution.

Solution: Effluent polishing with a Membrane Bioreactor (MBR)
Membrane Bioreactors are a very effective way to treat the effluent, and to ensure correct discharge values. It is one of the most advanced technologies within municipal and industrial wastewater treatment.

An Alfa Laval membrane filtration unit can be added to existing settling ponds for polishing of final effluent. Or it can be installed in a new plant and run as a MBR, where ponds are not needed, as the MBR is a simple yet effective combination of an activated sludge biological treatment process and membrane filtration. The membranes act as a physical barrier, allowing the passage of clean water, while trapping suspended solids, bacteria, pathogens and some viruses. The treatment is sufficient to produce a permeate quality that is low in BOD and total solids.

Saves space and construction costs
The MBR process supports a high biomass concentration and increases the removal of organic matter, thus reducing the size of biological tanks needed. This, together with a small footprint, reduces overall construction cost. The MBR process has low energy requirements, and does not require high chemical consumption or high pressure.

Up to 90% solids removed
An Aldec G2 decanter is used to dewater palm oil mill effluent (POME) and removes solids from the anaerobic ponds at an 80 t FFB/h palm oil mill in Malaysia. Thanks to automatic torque control, the decanter is able to deliver a consistent cake dryness.
Patum Vegetable Oil

Since 1985 Patum Vegetable Oil, one of Thailand’s largest producers of edible palm oil and biodiesel, has used Alfa Laval equipment to upgrade and extend its first physical refining plant for improved quality and reduced energy consumption. In 2012 a completely new 1,500 t/d refinery was put into operation, comprising the latest Alfa Laval innovations: Gum removal with high speed separator and pre-filtration prior to bleaching, plus all the newest features in continuous deodorization, such as flexible retention time, double scrubber, chilled water closed loop, VHE economizer (under vacuum and stripping) and CompaBloc plate heat exchangers.

Refining - Degumming and bleaching

Challenge: Reduce use of bleaching earth, oil loss, waste and MCPD

Traditional removal of gum, colour pigments and solid impurities from crude oil using acid and bleaching earth followed by filtration results in large amounts of spent bleaching earth containing a lot of non-recoverable oil.

Solution: Gum removal with a separator and pre-filtration

To minimize waste and oil loss, Alfa Laval recommends using an energy-efficient high-speed separator to remove precipitated gum before the bleacher.

The reduced gum load to the bleacher enables less dosing of bleaching earth, and further increases final oil quality. Gums can be mixed with spent bleaching earth or recycled upstream to the mill.

Pre-filtration of acid-treated oil through an already used filter before bleaching is normally not viable as filter blocking, mainly by gum, allows only a small fraction of the oil to be pre-filtered. Gum separation now makes it possible to pre-filter the full oil flow, further reducing the bleaching earth consumption.

Mitigation of MCPD formation

A positive side effect of wet degumming with a separator is significantly reduced content of chlorine compounds, that during deodorization can contribute to the formation of the undesired contaminants MCPD (monochloropropene-diol) compounds and esters thereof.

Solution 1: VHE Economizer for cooling under vacuum

Some refiners prefer cooling under vacuum. Alfa Laval’s patented Vacuum Heat Exchanger Economizer (VHE ECO) has for many years set the standard for economizing in deodorization, where the cooling is conducted while stripping the oil in a shallow vacuum tray.

Our conventional VHE ECO is a double deck construction which facilitates very shallow liquid height during the joint cooling/stripping. To meet the demand for cost-effective processing, we have designed a single deck version, suitable for palm oil economizing at high capacities.

Solution 2: Pressurized economizing

Some choose to conduct the economizing under pressure, a more cost-efficient solution than using vacuum. The duty in VHE ECO is partially or fully replaced by an economizer type where a hot pump provides pressure which is utilized to create efficient turbulence on the hot side, thus enhancing the heat transfer. For this, Alfa Laval offers various types of heat exchangers including plate, spiral, fusion-bonded and compact heavy duty. Each equipment type has its own characteristics regarding efficiency, resistance to fouling, resistance to thermal fatigue etc. Our specialists advise you regarding the best choice for your specific application.
New trend in deodorization

Partners in innovation
Since 1989 when Sakonkom, Thailand, decided to expand from plantation to downstream processing, Alfa Laval has been their chosen technical partner. Total cost of ownership, flexibility and our ability to implement their ideas were key to the owners. Today, the plants of companies including Refining (500 t/d), dry distillate (900 t/d) and mixture blending (1,500 t/d) are manufactured at the site.

Challenge: Cost-effective continuous deacidification/deodorization

Removal of colour, pigments and volatile substances in a continuous deodorization process should be as gentle and energy-efficient as possible.

Alfa Laval’s well-proven modular concepts for continuous deodorization, with feeding and cooling under vacuum in separate vessels, offer a high degree of flexibility compared to all-in-one solutions. The structured packing based on counter-current technology ensure that stripping steam consumption and, thus, vacuum costs are minimized. It has therefore become the standard in the vegetable oil industry.

Solution 1: Packed Columns

This conventional deacidification/deodorization solution offers high production quality while consuming a minimum of utilities. Alfa Laval was the first to introduce structured packing into this field of operation based on the physical refining concept.

SoftColumn Dual-Strip benefits
- Enable production of oil with less FA (free fatty acids) compared to standard deacidification technologies
- Lower energy consumption
- Improved oil quality

Solution 2: SoftColumn for flexible operation

This flexible continuous deacidification/deodorization solution addresses challenges in a variety of solutions for combined technologies as a standard part of the product quality while consuming a minimum of utilities. Alfa Laval was the first to introduce structured packing into this field of operation based on the physical refining concept.

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Deodorization is a crucial part of all vegetable oil processing. Alfa Laval offers a variety of solutions for combined deacidification/deodorization in both continuous and semi-continuous mode with minimum stripping steam and the highest degree of heat recovery.

Solution 3: SoftColumn Dual-Strip for high-capacity, mass-rock

Offering higher capacity with lower costs, our latest innovation SoftColumn Dual-Strip is a cost-effective continuous deodorization solution with post-stripping.

The Deodorizer plant divides the stripping action into two or more stripping sections. The SoftColumn Dual-Strip process uses this concept to offer a high degree of flexibility compared to all-in-one solutions. SoftColumn can handle 2-3 stock changes per day.

Reduction of vacuum effluent

Steam consumption for the deodorizer’s vacuum system and amount of vacuum effluent can be halved using chilled water. Ice condensing system can further cut them by up to 40%.

SoftFlex benefits
- Fast, automated stock changes with no loss of production time
- Minimum cross-contamination between batches
- Reduced energy consumption and lower fuel costs.

Challenges: Physical refining with frequent stock changes

Minimizing process contamination between batches and achieving lowest possible operating costs.

Solution: SoftFlex semi-continuous process

The patented Alfa Laval SoftFlex semi-continuous deacidification and deodorization technology comprises a structured packing section inside the batch-wise flow mode. SoftFlex is therefore especially suitable for extremely large capacities (more than 4,000 t/d), where the required vessel diameter (using single stripping) can exceed 4,000 t/d. SoftFlex offers solutions where organic matter is separated from the process vapour before condensing. SoftFlex offers a flexible process design that can be adapted to suit the specific requirements of the customer.

Comparison of vacuum system and vacuum effluent for different vacuum solutions

Reduction of vacuum effluent

The deodorizer’s vacuum system is in its standard configuration, i.e., a 4-stage steam ejector system with receiver by lowering costs, producing significantly amounts of effluent slightly contaminated with organic matter. Alfa Laval offers a number of options, which can significantly reduce the amount of vacuum effluent.

Closed loop cooling

A chilled water cooling system can be installed, thus avoiding operating in “TR”/cooling tower.

Chilled water

Using chilled water as a substitute for water in cooling towers is a sensible approach. They provide up to 30% higher heat transfer area in same space, resulting in less final heating requirement by high pressure steam.

Slurry separator never used in chilled water cooling system. The same unique Fluid-Flexing design is used in the SoftColumn design.

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Recovery of distillate

The distillate is a valuable product. Alfa Laval offers solutions where the process vapour is cooled and collected either via a venturi, or glycol loop, cooled by refrigeration plant.

Table of processing

| Consumption figures for 1,000 t/day deodorizer. Vacuum system based on steam ejectors. |
|---|---|---|---|
| Effluent (kg/h) | Motive steam (kg/h) | El power (kW) | Cooling water (m³/h) |
| 1029 | 2200 | 775 | 310 190 |
| 550 | 340 | 295 | 245 145 |

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Reap the added value from PFAD
Palm oil is a valuable by-product (PFAD) which is enriched in unsaponifiable components such as tocopherols, sterols and sterol esters. The ongoing hunt for these valuable products has increased refiners’ interest in separating PFAD to meet the growing demand for these valuable oleochemicals. It is also possible to produce high-purity sterols and tocotrienols using a double scrubber.

Today it is quite common to recover these in high concentrations. Alfa Laval offers several solutions to this production challenge.

We design and specify the most suitable key components, such as crystallizers, membrane filters, pumps and instruments to ensure a reliable and efficient production. All the equipment is practical and easy to install, operate and maintain.

Process options include slurry type for low viscosity feedstock or the preparative or industrial type, where more controlled outcomes are required. Another option is interesterification, an alternative to partial hydrogenation to modify triglyceride molecules. It can be used to produce healthy fats and can be made by adding more crystallizers and extending filter capacity.

The flexibility to expand is another factor of the system. The modular design makes it possible to increase production capacity to keep pace with demand by adding more crystallizers and extending filter capacity.

Contact us to learn more about these.

Beyond tocopherols

Natural palm oil E-vitamins, tocotrienols and tocopherols, typically used in dietary supplements, health and beauty products, have high market prices. The ongoing hunt for tocopherols and tocotrienols in palm oil is even more intense as these are more potent antioxidants than tocopherols and have a beneficial effect on a variety of medical conditions.

Today it is quite common to recover tocotrienols in high concentrations. Alfa Laval has developed the TocoBoost system to produce tocopherols, tocotrienols and sterols.

enriched in unsaponifiable components

Sterols

Tocoldehydes

Other fats modification processes

Fats modification

It is possible to modify fats using a variety of processes, including:

• Hydrogenation, hardening of soft oils or shortenings
• Partial esterification: Partial esterification and deodorization of hydrogenated oil and fats
• Chemical or enzymatic interesterification, an alternative to partial hydrogenation to modify triglyceride molecules and feedstock for the fats modification systems' application

The traditional way of melting left-over crystals inside the crystallizer by filling it with hot oil is very time and energy consuming. Crystallization can be carried out in place much better using the innovative Alfa Laval Iso-Mix rotary jet head technology. Installed inside the crystallizer unit, it enables internal surface to be washed using hot oil to melt away crystals left over from the previous batch. This allows most of the RBD oil to be recovered externally before feeding it into the crystallizer. This shortens the cycle time of each crystallizer considerably, thus increasing capacity by 15%. It also enables the cooling tower water circuit and chilled water closed circuit to be kept fully separated, so coils will have a longer lifetime. And cooling costs can be reduced by approx. 15% by lowering temperature using external plate heat exchanger with tower cooling to maintain temperature of oil in service so as to not exceed 65°C/90°C.

Move up the value chain

Palm oil processing

Yield up, waste down

Palm oil processing

Table: Concentration of tocotrienols with TocoBoost

<table>
<thead>
<tr>
<th>Concentration of tocotrienols with TocoBoost</th>
<th>Price levels at different toc levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>5% Toco</td>
<td>4% Toco</td>
</tr>
<tr>
<td>0.1%</td>
<td>0.2%</td>
</tr>
<tr>
<td>1000</td>
<td>2000</td>
</tr>
</tbody>
</table>

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11.6 Palm oil processing
12 Palm oil processing
13 Palm oil processing
Discover new palm oil applications

Oil from palm fruit and kernels is a wonderful source of food and a variety of other essential everyday products that improve the quality of our lives. Its nutritional and health value plus other inherent properties have been recognized and exploited for centuries. New applications are still being discovered.

Collaboration between all players

Refined and modified palm oil and palm kernel oil can be further processed in many different ways and turned into a wide variety of end-products – for nutritional as well as other purposes.

Alfa Laval’s dedicated palm oil teams see it as our mission to support the industry in making the most of the potential of this unique, natural raw material – in the most feasible, profitable and sustainable way. In close collaboration with upstream and downstream players as well as universities and scientists we continuously develop new, innovative processing solutions that pave the way for new applications and end-products.

Tap into our decades of experience from thousands of vegetable oil installations worldwide, and let us move up your value chain together.

From fruit to food - and beyond

End-products

Food and food ingredients

Margarine
Shortenings
Mayonnaise
Sauce/dressing
Frying/kailaid oil
Filling fats
Vegetable cheese
Vegetable whipped cream
Coffee creamer
Infant milk formulas (mother’s milk substitute)
Ingredients in cocoa butter equivalents (CBE)
Cocoa butter substitutes (CBS)
Emulsifiers (ingredients in food and non-food)

Health care
Pharmaceuticals
Cosmetics
Soap and detergents
Car tyres
Biofuel.

Non-food

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Biofuel

Continuous biodiesel plant

The state-owned petroleum company ALUR in Uruguay has purchased two Alfa Laval Ageratec transesterification plants: Stage 1 (US) for 16,000 TPY and stage 2 (US) for 55,000 TPY. The feedstock is RBD oil with a provision for re-commissioning to low grade animal fat.

An AGT system gives the freedom to select any appropriate output, and to sell the oil directly after upgrading. It delivers treated oil as mono- di- and triglycerides ready for mixing as heavy fuel oil. It can also be traded as an oleochemical, or forwarded to off-site biodiesel producers.

Solution 2: Ageratec “multi-feedstock” technology for biodiesel batch processing lines

Ageratec esterification batch plants make it possible to produce biodiesel with significantly less environmental impact, close to feedstock supply or diesel consumers. Intended for medium-scale production, each complete process line includes acid esterification, alkaline transesterification and our energy and cost saving wash process.

Ageratec continuous lines

– benefits
  • Directly applicable for traditional, refined feedstock
  • Attractive alternative to today’s elderly plant design
  • Savings in project development/site assembly

Ageratec batch processing lines

– benefits
  • Enables use of feedsstocks with up to 10% FFA
  • Front-end acid esterification for direct conversion of any free fatty acids (FFA) into methyl esters.
  • Plant logistics free from water and effluent

AGT pretreatment process

– benefits
  • Adds significant value to existing “waste products”
  • Enables the producer to move into new, high-value product segments available within the field of biofining.
  • Reduces the environmental impact of plant operations.