The all-round choice for starch equipment

Alfa Laval solutions for processing starch

More than half of the 60 million tons of starch produced each year throughout the world passes through Alfa Laval equipment and systems.

We are world-renowned specialists in the heat transfer, separation and fluid handling that are crucial to efficient processing and outstanding operating economics when producing starch.

This means that Alfa Laval is perfectly placed to help starch manufacturers open up important new market opportunities – and optimize the results you can achieve in existing ones.

Widely grown – widely used

All over the world
Starch is extracted from a wide range of agricultural products. These include maize, wheat, potatoes and cassava (also known as manioc in some regions) and to a lesser extent from rice, barley, sorghum and sago.

Starch provides almost three-quarters of the nutritional energy consumed by mankind. It is also widely used in pharmaceuticals, textiles, the paper industry, chemicals and many lesser-known but nevertheless crucial specialist applications throughout industry.

The product that emerges from the extraction process is known as native starch. This is used both in this form and as modified starch, or is processed still further into different kinds of sweeteners and for use in a wide range of fermentation processes.

Success based on disintegration
No matter which particular crop the starch is to be extracted from, the production processes involved are essentially the same. They are all based on making the raw material disintegrate (milling), followed by mechanically separating the different component parts.

Cereals such as maize and wheat are milled by grinding whereas tubers/roots such as potatoes and cassava/manioc are shredded using raspers.

The subsequent separation of the component elements is carried out either on the basis of their different sizes – using screens or filters – or different weights – using gravitational forces in centrifugal separators (decanter centrifuges, nozzle centrifuges or hydrocyclones).

With almost eighty years of experience in the starch industry behind us, Alfa Laval is the leading supplier of such process equipment and process lines to starch producers and processors throughout the world. Our leading position in our core technologies of heat transfer, separation and fluid handling makes it possible to bring our unparalleled know-how to all aspects of starch operations.

Starch – a worldwide opportunity

The worldwide starch market is currently in one of its most profound states of flux ever. This provides both challenges and opportunities.

Expansion
There are agricultural products grown all over the world that can be used in the production of starch. Colder climates favour potato growing and cassava is cultivated in the tropics, while grain varieties are grown all over the world. With supplies of sunlight and water as the prime determining factors, yields of up to fifteen tons of starch dry matter per hectare can be achieved.

In regions where these crops are only marginally utilized, their use in starch production can play an important role in boosting agricultural returns and in supporting the industrialization process.

Processing the starch makes it possible to move further up the value chain and gain access to world commodity markets for both nutritional and industrial products.

Modern techniques make it possible to extract starch from many different crops with high yield and extreme purity, making starch one of the most versatile raw materials available to the food and chemical industries.

Opportunities
On a worldwide scale, only about 25% of starch production now consists of basic native starch.

This is because the vast range of industrial uses for starch means that each customer requires starch that is tailored to meeting specific needs. A further 25% of production therefore undergoes physical or chemical treatment, and is known as modified starch.

The remaining 50% is hydrolysed into starch-based sweeteners for industrial use.

This constellation of requirements generates significant business opportunities for the starch industry.

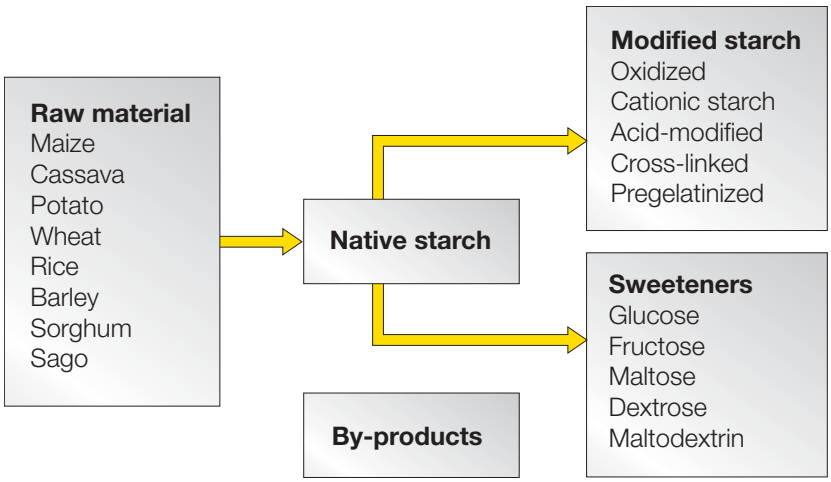
– and limitations
In some parts of the world, however, there are limitations. For example, EU quotas on potato starch production have placed a ceiling on production expansion.

The emphasis here is therefore more on boosting the efficiency and profitability of starch modification and processing operations by developing larger-scale, more efficient equipment with lower operating costs.

From sugar to starch
Furthermore, the European sugar industry is currently undergoing significant structural change.

As result, some starch producers that specialize in the further conversion to sweeteners are reconsidering the options available. The production of starch-derived sweeteners provides them with a way to become more competitive in relation to the natural sugar industry.

At the same time, the natural sugar industry is also investing in starch-related sweetener production facilities, in order to counter this challenge.



From fossil fuels to starch
Starch is now in a position to replace crude oil as a source of carbohydrates in the manufacture of plastics and fuel products.

For example, bio-ethanol produced from maize has great potential in replacing petrol/gasoline, with considerable success already achieved in the Americas.

Similarly, biodegradable plastic based on starch is a field with considerable growth potential, especially as a replacement for conventional plastics in packaging material.

Energy-efficient crops
Energy-efficient crops are now increasingly coming into focus. Where today's process is limited to converting only the starch-bearing fraction into ethanol, in the future the whole plant will be converted, thus reducing production costs and boosting yield.

Nutrition
More and more starch is being used throughout the world, as part of the widespread move towards ready-made foods and meals that are sold as refined products with a longer shelf life than basic ingredients.

This growth in consumer demand can only benefit starch producers that are capable of developing starch-based products to meet food industry requirements.

Internationalization
The biggest challenges for the starch industry consist of maintaining the balance between consumption and production, and to maintain a stable price structure for both raw materials and finished products.

In light of the increasingly important role being played by Asia and Eastern Europe, it is likely that much starch production will be transferred to these areas. They have the advantages of the availability of a substantial surplus of raw material, labour costs are cheap and environmental restrictions are less stringent.

Efficiency makes the difference
For the starch industry, future prosperity depends on achieving economies of scale in production and on applying highly focused R&D work to develop new starch-derived end products that enable producers to move further up the value chain.

Extracting starch from maize

Almost 85% of the world demand for starch is met by growing maize (known as corn in the US), making it a crop that is crucial for the success and prosperity of the starch industry.

Extracting starch from maize begins with soaking the maize kernels in water, in a process known as steeping. Once the kernels are softened, the germ is separated after milling in hydrocylones and screens. After the germ has been removed, the fibre fraction is then separated and washed using screens. The germ is subsequently pressed to produce maize oil for human consumption.

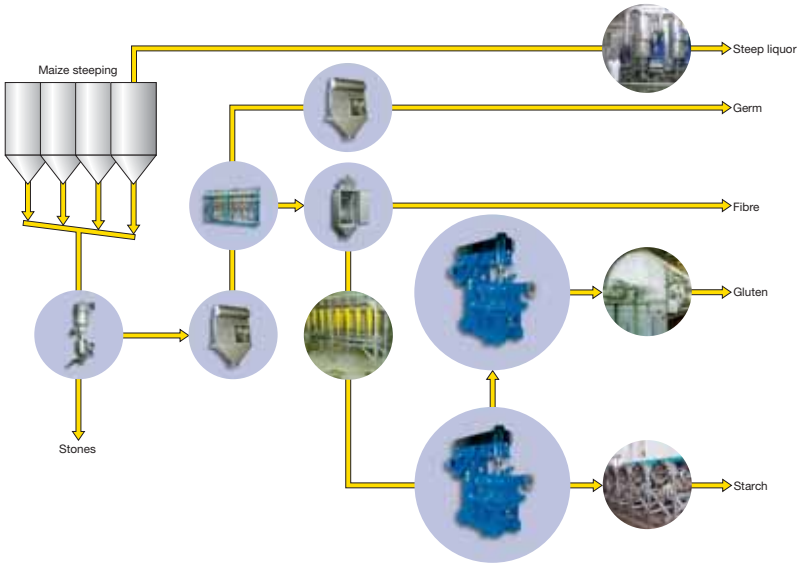


Diagram of typical installation for extracting starch from maize

Starch and protein (gluten) are then separated in two steps. First, the main protein fraction is separated using nozzle centrifuges, in a process known as primary separation. This is followed by washing with fresh water in hydrocyclones to separate out the remaining proteins and other impurities.

The protein separated in the nozzle centrifuge is then pre-dewatered in another nozzle centrifuge, followed by final dewatering using vacuum filters. Water recovered from the protein is used as process water for washing the fibres and germ and in the steeping process.

During steeping, solubles leach out from the maize and end up in the steep water. To recover this valuable component of maize, the steep water is processed in an evaporator, where these soluble solids are concentrated by evaporating part of the water.

In most plants, these solubles are subsequently mixed with the fibre fraction before the fibres are dried. This dried product is often called ”gluten feed” and is widely used as a raw material in animal feed.

Protein after drying is called gluten meal. With its high protein content (approx. 65%), it is widely used as feed for fish and poultry.

Fitting in well
The maize starch factory at Aschach in Austria, owned by AGRANA Beteiligungs-AG, has continuously extended its processing capacity, to the current 1000 tons daily. Alfa Laval has supplied the know-how and most of the processing and control equipment for this.

Alfa Laval and maize starch extraction
With its acquisition of the Dorr-Oliver starch activities, Alfa Laval became the company with the largest installed base in the maize starch industry, with a vast body of know-how focused on all kinds of separation equipment used in the maize starch extraction process.

Alfa Laval's unique experience is based on the design and construction of more than 100 maize starch plants throughout the world.

Alfa Laval Merco centrifuge
Unlike other nozzle centrifuge products, which are multi-purpose, the Alfa Laval Merco centrifuge design is specially developed to meet maize starch processing requirements. These involve high solids loads and continuous discharge, yet a minimum of blockages of the nozzles is crucial.

The Alfa Laval Merco design is unique in making it possible to adjust production settings while in operation, by varying the nozzle draw-off. It is also world-renowned for its sturdy construction, which ensures dependable, non-stop high-volume production.

To achieve concentration and separation with maximum efficiency, Merco centrifuges feature oversized nozzles and larger openings between the discs. The Merco design uses a special recirculation system, with a return flow that is a uniquely effective

way to control the separation and/or concentration process, via the underflow draw-off valve.

This allows the operator to change the split and the concentration by a simple adjustment of the underflow draw-off valve in the discharge line.

To reduce maintenance costs and minimize repair downtime, the bowl is supported by an overhead bearing cartridge that is distinctive for its extended service life and rapid, easy replacement.

The Alfa Laval Merco nozzle centrifuge is therefore widely used in the maize starch industry for mill stream thickening, primary separation, gluten thickening and the clarification of middlings.

Different Merco models are available, with capacities of up to 1,000 tons per day. Actual throughput depends on variables such as particle size distribution, duty, temperature and the required separation result.

Extracting starch from wheat

Wheat is a popular source of starch throughout the world, since it is readily available in milder climates and contains a valuable protein fraction called vital gluten. This is widely used for human consumption.

In order to extract the starch, the wheat is first milled to obtain wheat flour. This is mixed with water to form a dough, which is then subjected to a brief maturing process.

More water is then added, forming a slurry that is subsequently separated into its different fractions using a three-phase decanter centrifuge.

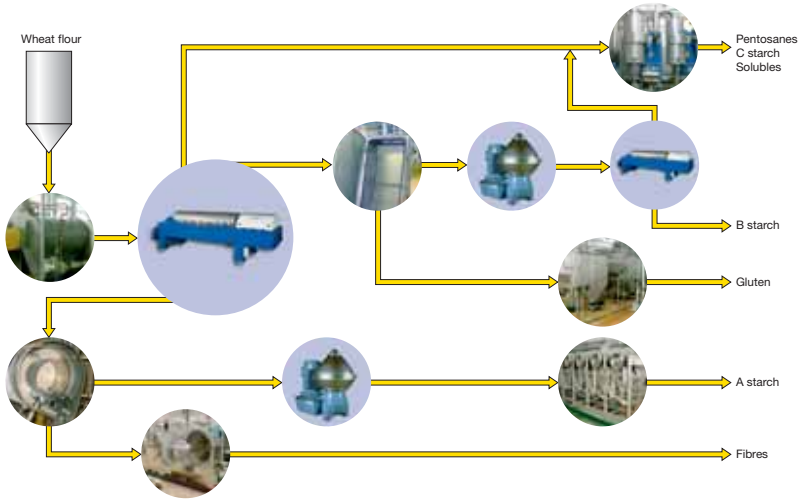


Diagram of typical installation for extracting starch from wheat

In this process, the first – and heaviest – fraction is the prime A starch.

The second fraction consists of B starch and vital gluten.
The third fraction consists of the solubles, some very fine starch particles (C starch) and pentosanes.

After the fibres have been removed using screens, the A starch is concentrated using nozzle centrifuges and finally washed in hydrocyclones, using fresh water.

Separating B starch and gluten
The mixture of B starch and gluten is initially separated using screens. The gluten is then washed using washing drums, and dried. After drying the gluten is milled. This so-called vital gluten is used for human consumption and as a general food additive – for example as a dough improver in bread-making.

B starch is concentrated using nozzle centrifuges. B starch is mixed with the A starch for conversion into glucose. This B starch can also be dewatered in a decanter centrifuge, and then dried and sold as secondary starch.

The light phase from the three-phase decanter centrifuge, which contains the pentosane fraction present in the wheat flour, is then treated with enzymes and concentrated using an evaporator.

Setting the standard
The Syral SARL wheat and maize starch plant at Marckolsheim in France is one of the most modern plants of its kind in Europe.

The wheat starch plant was built to meet the constantly growing demand for starch to provide various types of starch-based sweeteners. Alfa Laval supplied and installed starch processing equipment, featuring three-phase decanter centrifuges for wheat splitting.

This plant is now acknowledged as a benchmark installation for the extraction of starch from wheat.

Alfa Laval and wheat starch extraction
Alfa Laval has worldwide experience in conjunction with wheat starch production.

Among our many references are complete turnkey plants both in France and China. These installations also included all the required key equipment, such as decanter centrifuges, nozzle centrifuges, hydrocyclones and screens.

Alfa Laval STNX 944 three-phase decanter centrifuge
Alfa Laval has developed the special STNX 944 three-phase decanter centrifuge for use in wheat starch separation. This design makes it possible to achieve the most efficient separation of starch, gluten and pentosanes.

This is the largest three-phase decanter centrifuge available for wheat flour splitting, and is distinctive for using overflow weirs rather than paring discs. This ensures optimum recovery of the most valuable fractions with no operator adjustments needed, even under varying process conditions, and provides the greatest possible capacity.

Accurate splitting means that this process involves very little recycling and no recovery step. This reduces the installed power required, which reduces energy costs. It also limits the temperature increase in the process, thus ensuring lower bacterial activity. This in turn makes it possible to boost product quality and reduce downtime for cleaning.

Alfa Laval starch decanter centrifuges feature a hydraulic back drive with automatic torque control for optimum performance and low repair cost.

Extracting starch from tubers

Starch can also be extracted from a wide range of tubers, including the potato, cassava and manioc.

Starch from tubers

Potato starch processing facilities only operate seasonally for the simple reason that the potatoes must be processed within a limited time frame after harvesting.

Fresh tubers are cleaned and then disintegrated on raspers. These are rapidly rotating drums fitted with rasping blades on the outer periphery. This process releases the starch granules from the fibrous matrix in which they are embedded.

The proteins in the tubers are soluble and in large potato starch facilities the first step is to separate these proteins using decanter centrifuges. In all other starch processing factories, these proteins are separated later in the process and end up in the wastewater flow.

The next stage is to remove the fibre pulp, using screens. After it has been dewatered using decanter centrifuges, this pulp is normally sold to the agricultural sector as livestock feed.

The starch is concentrated and washed using hydrocyclones and/or nozzle centrifuges.

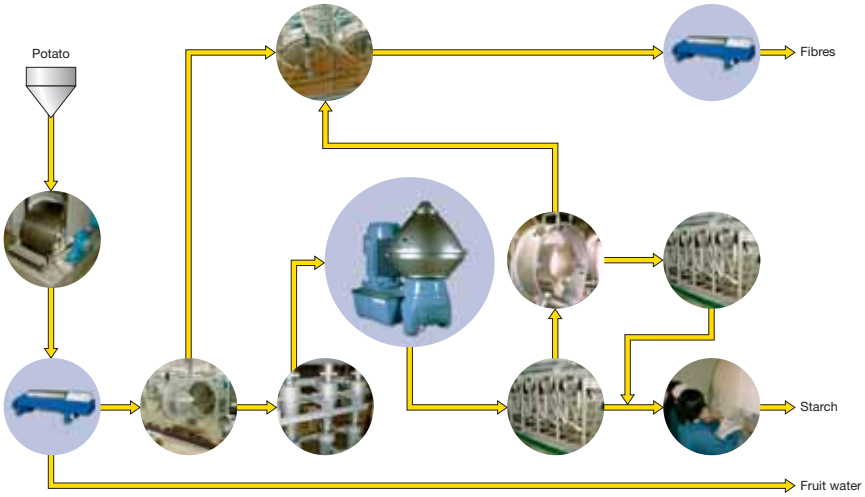


Diagram of typical installation for extracting starch from potatoes/tubers

In larger plants, the valuable soluble protein that has been separated after rasping is recovered. This is done in a two-step process using decanter centrifuges. The soluble protein is first converted into insoluble protein by means of heat and pH adjustment.

The precipitated proteins that result are then separated and dewatered using a decanter centrifuge followed by a drier. The non-precipitated proteins (approx. 50%) are finally concentrated using an evaporator.

Working together for best results
In 2000–2005, Alfa Laval installed separation equipment for three potato starch processing lines for the Chinese companies Lixue Fine Starch Co. Ltd. and Wohua Potato Products Co. Ltd.

Alfa Laval also provided a wide range of assistance and consultancy services to help develop potato starch processing in China.

A spokesperson noted “We are extremely satisfied with the Alfa Laval equipment, which is easy to operate and requires a minimum of maintenance. It also helps us to produce starch of a very high quality.”

Alfa Laval and extracting starch from tubers
Alfa Laval has a substantial installed base in the potato and cassava industries in Europe and South-East Asia.

For example, Alfa Laval has a very strong position and the largest installed base for cassava processing in Thailand, the world’s major source of cassava-based starch.

As a result of the acquisition of Dorr-Oliver, Alfa Laval is also the largest supplier of potato starch processing lines in China.

Alfa Laval nozzle centrifuges
When processing different kinds of tubers as the raw materials for extracting starch, the use of Alfa Laval nozzle centrifuges as a preconcentrator or refining separator is crucial for the best results. These are available in a wide range of different sizes and configurations for tackling specific separation tasks.

Alfa Laval nozzle centrifuges have numerous distinctive features.

- Continuous discharge of starch or protein concentrate.
- A hollow main shaft to introduce wash water directly into the nozzle area of the bowl via special tubes, for maximum washing efficiency.
- Recirculation of nozzle discharge to provide greater concentration and better control.
- Filler pieces between the nozzles prevent clogging and make it easier to clean the bowl.
- Built-in paring disc for the pressurized discharge of overflow. External pump installations are therefore unnecessary.
- The disc stack cartridge can be lifted out in one piece for easy cleaning and maintenance.

Each Alfa Laval nozzle centrifuge can be delivered as a complete unit including all the required valve modules for process liquid and wash water, and a special starter and control system.

Downstream process optimization

Starch is produced from many different raw materials, and production methods vary accordingly. Whatever the processes involved, the starch must be washed free from impurities, and then concentrated.

Downstream process equipment
The processes that follow on from starch extraction are called downstream processes, and normally involve the production of modified starches, hydrolysates and liquid sugars in many different forms.

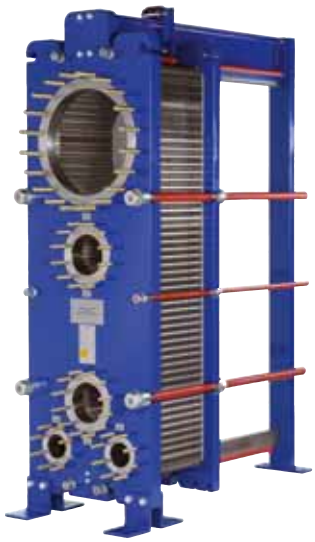
AlfaCond and AlfaVap plate condensers and evaporators dovetail perfectly into these downstream flows. Typical uses are for the evaporation of water and for concentrating glucose, fructose and sorbitol by evaporating excess water content.

Alfa Laval is also an important supplier of the hydrocylone batteries that the starch industry uses for washing salts left over from the chemical treatment of the starch. Designing and configuring such equipment requires considerable specialist experience and knowhow – which Alfa Laval is ideally placed to supply.

Optimize your performance
AlfaVap evaporators are ideal for use in all starch-related applications including
- glucose and fructose
- maltodextrine
- sorbitol
- corn steep liquor
- salty wastewater.

AlfaCond is the world's first and only tailor-made plate condenser, developed specifically for condensing low-pressure vapours.

Compared to conventional shell-and-tube evaporators and condensers, AlfaVap and AlfaCond work magic on operating costs. They not only save



expensive space because their compactness requires less floor area, but also substantially reduce investment cost and minimize maintenance – without sacrificing reliability or safety.

Starch from other crops

Rice
Rice is one of the most common starch-bearing crops, globally speaking, and as such is widely available. However, rice is used only very little to produce starch. This is because the extraction of rice starch is complicated on account of the very small size of the starch kernels.

Barley and oats
Barley and oats are grown in the northern hemisphere and are important for the dietary fibre they provide for human nutrition. Extracting starch from barley and oats is very similar to the wheat starch process, requiring enzymes to treat the beta glucanen to reduce viscosity.



Low installation costs
The compact, versatile design of the AlfaVap and AlfaCond means that erection and installation costs are drastically reduced compared to conventional equipment.

Flexible capacity
AlfaVap and AlfaCond make it easy to adjust capacity to meet changing needs, simply by adding or removing plates, while retaining the existing frame.

Multi-effect, MVR, TVR
AlfaVap evaporators can be used in multi-effect configurations and with Thermo Compressor (TVR). With surging energy prices, a combination of AlfaVap with Mechanical Vapour Recompression (MVR) provides increasing benefits.

Better product quality
The extremely low hold-up volume is a big advantage for heat sensitive products. It also permits rapid start up and shut down, with only minimal waste.

Hydrocyclones
Hydrocyclones were originally developed in the 1950s by the Dutch coal mining industry as a cheap alternative to centrifugal separation. This know-how and technology subsequently became part of Alfa Laval, and led to the development of special cyclones for separating germ from the milled maize slurry and for the purification of starch.

Batteries of hydrocylones are widely used to reduce the quantities of protein and other impurities in native starch and to reduce the salts present in modified starches.

Alfa Laval hydrocyclones are popular for this due to their uncomplicated design and low cost. This makes it feasible to install several washing stages in series, resulting in better washing results while using less water.

Sorghum
Sorghum – also known as milo maize – is a plant that is basically of the same genus as maize, which is actually a hybrid of milo maize. Sorghum kernels are substantially smaller than their maize counterparts, which makes them more difficult to handle.

Sorghum grows mainly in the tropics and is one of the larger crops in Africa. Extracting starch from sorghum is identical to the maize process, except that the split of the different fractions is more complicated than with maize. This results in lower yield and less pure starch and starch by-products.

Sago
Sago starch comes from the trunk of the sago palm tree and is only processed in small local starch factories. Most of these still use simple settling tables for the separation and purification of the starch.

Alfa Laval – a partner to the starch industry

Partnership benefits from experience
Alfa Laval is a long-term partner to the starch processing industry throughout the world. This partnership is based on our know-how about starch production involving all possible raw materials, combined with Alfa Laval's unparalleled experience in applying its core technologies to starch processing requirements.

We have the ability and resources to serve as your technical partner in all aspects of starch production, right from handling the raw material to final treatment of the end product. Our specialist process and engineering teams can handle everything from a simple component enquiry to the de-bottlenecking or expansion of an existing plant, and to the feasibility, design and construction of a green-field factory.

Alfa Laval provides the equipment and systems that make this possible, focusing on

- evaporation and condensation
- screening and filtration
- centrifugal separation
- membrane filtration
- heating and cooling.

Evaporation and condensation
Alfa Laval's broad range of plate evaporators, including the compact AlfaCond and AlfaVap units, provides the most cost-effective solution for your evaporation needs for wastewater (native and modified starch waste) and sweetener concentration. Their high thermal efficiency also means substantially smaller size, which in turn means less material and lower installation costs than for traditional shell-and-tube technology. The low retention time also improves temperature-sensitive end products.

Screening and filtration
In the world of starch processing, Alfa Laval bent screens are used extensively for separating and purifying germ and fibres from the starch slurry.

Decanter centrifuges are normally used when higher solid concentrations are required in the solid discharge.

Nozzle centrifuges, on the other hand, are ideal for separation tasks that involve lower solids concentrations and smaller particle sizes.

Hydrocylones are extremely efficient for removing grit and sand from the starch slurry and for separating out the germ, as well as for concentrating and purifying the final starch product.

Later in the process, Alfa Laval rotary drum filters are used for dewatering the concentrated gluten and for purifying starch-based sweeteners.
In wheat starch production, Alfa Laval rotating and bar screens are extensively used to remove fibre from A starch after washing, for separating gluten from the B starch and for washing the gluten.

Centrifugal separation
Separating solids from liquids plays a key role in countless industrial, food and treatment processes. Alfa Laval decanter centrifuges, nozzle centrifuges and hydrocyclones perform this crucial function exceptionally well.

Alfa Laval – a partner to the starch industry

Membrane filtration
Our customers in the starch, sweeteners and sugar industries face increasingly stringent environmental and quality standards.

Alfa Laval is uniquely positioned to address these needs using the entire spectrum of cross-flow filtration technologies, from microfiltration, ultrafiltration and nanofiltration to reverse osmosis.

The Alfa Laval range of spiral-wound and plate-and-frame membrane filtration modules are ideal for use with high temperatures and high viscosities over the full pH range.

Alfa Laval is a reliable partner in providing membrane filtration solutions to companies in the starch, sweetener and sugar industries, and we are constantly involved in working with our customers to develop highly effective new applications for this technology.

Current focus includes
- monosaccharide purification
- treatment of sugar decolourization, resin regeneration, effluent concentration and the recovery of sugar water
- colour removal (sugar)
- production of high-fructose corn syrup
- concentration of sweeteners.

Heating and cooling
Our starch process expertise makes Alfa Laval the ideal long-term partner to meet your heat exchanger needs in starch processing.

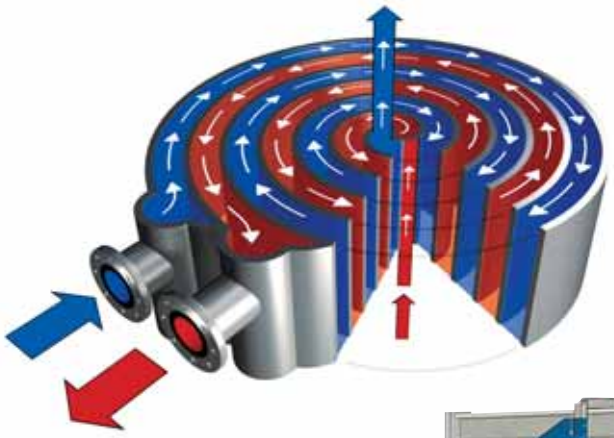
Alfa Laval plate heat exchangers are designed to optimize heat transfer, because the corrugated plates provide the largest possible surface area through which the heat can be passed from one gas or liquid to the other. Plate heat exchangers have the advantage that this substantial heat transfer area is available within a relatively compact footprint.

The design of the channels also ensures maximum turbulence as each fluid passes through. This results in maximum efficiency in transferring heat from one medium to the other.

Alfa Laval plate heat exchangers also have the added advantage that completely standard units are normally capable of handling all requirements within the starch industry, as the range covers both standard heat exchangers and wide-gap heat exchangers that are ideal for fluids that contain solids, fibres or particles.

Spiral Heat Exchanger
Spiral-shaped heat exchangers are not a new idea but Alfa Laval has perfected the design.

The single-channel arrangement is excellent for fouling duties and provides a self-cleaning effect. This unique feature makes the Alfa Laval spiral heat exchanger the most reliable choice for critical fouling duties such as dealing with slurries in which both sides contain suspended solids that settle very easily.



Nonstop Performance

Service counts
In modern starch processing, efficient, well-planned service plays an important part in maintaining profitable operations.

Full control
Alfa Laval operates with a highly sophisticated Nonstop Performance concept made possible by our worldwide network of service and spare parts distribution centres in more than fifty countries throughout the world.

Alfa Laval has full control over the entire supply chain, which means that we can provide customers with response times, availability and lead times that are second to none.

Service when it fits in
The service requirements for Alfa Laval starch processing equipment are minimal, and planned preventive maintenance is the key to making sure this always remains the case.
Alfa Laval's worldwide service capabilities and vast experience with the contract maintenance and service of decanter centrifuges ensure that any service work required involves the absolute minimum of disturbance to operations.

Alfa Laval in brief

Alfa Laval is a leading global provider of specialized products and engineered solutions. Our equipment, systems and services are dedicated to helping customers to optimize the performance of their processes. Time and time again.

We help our customers to heat, cool, separate and transport products such as oil, water, chemicals, beverages, foodstuffs, starch and pharmaceuticals. Our worldwide organization works closely with customers in almost 100 countries to help them stay ahead.

How to contact Alfa Laval

Up-to-date Alfa Laval contact details for all countries are always available on our website at www.alfalaval.com

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