



**Potato Starch Processing
Custom-Fit Solutions from GEA**

GEA, Committed to Perfect Solutions

engineering for a better world

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○ GEA companies worldwide

The GEA Group is one of the largest system providers of machines and process technology worldwide, especially in the food and energy industries, where it rates among market and technology leaders. The GEA Group focuses on demanding and sophisticated production processes and offers its customers efficient solutions.



Highest yields
Top quality products
Optimum energy usage
Innovation leadership
Minimum fresh water consumption
Minimum effluent streams

Turnkey projects
Excellent process know-how
Tailor-made solutions
Technology leadership
High quality equipment
Intelligent process design
High level of automation

Short reaction time
Global network for excellent support
Local process specialists
Customer focus
Fast and qualified local service support
Excellent spare-parts availability

Challenges of Today's Potato Starch Processing

GEA Westfalia Separator Group, in close partnership with other associated GEA companies, is a pioneer in potato starch and protein processing. Over many decades, we have continually supplied the potato starch industry with innovative solutions, from single machines up to the complete processes. By working closely with the industry, we have learned to understand the major challenges that the modern potato starch processors faces in today's market:

- Highly valued end products, demanding the highest quality
- High raw material prices, requiring maximum yield
- High energy costs, which requires energy efficient operations
- High fresh-water and water-discharge costs, which demands efficient water management
- Maximum uptime, requiring robust and reliable processes, low maintenance and easy operation
- High investment costs, demanding long equipment service life and optimal performance

- Responsibility for consistent quality and compliance with the hygiene of food ingredients regulations
- Making optimal use of invested capital, requiring multipurpose plants that process other raw materials between seasons
- Obtaining good service and support from a knowledgeable supplier

The trick is to find the best-fitting set of benefits and requirements for each customer, and to design the process accordingly. Different priorities translate into different process setups and the process design has to live up to several different, even conflicting demands. The challenge is to work with the customer to find the best compromise. GEA Westfalia Separator Group can provide all the key technologies used for potato starch and protein processing enabling customers to identify and achieve their most profitable process design.



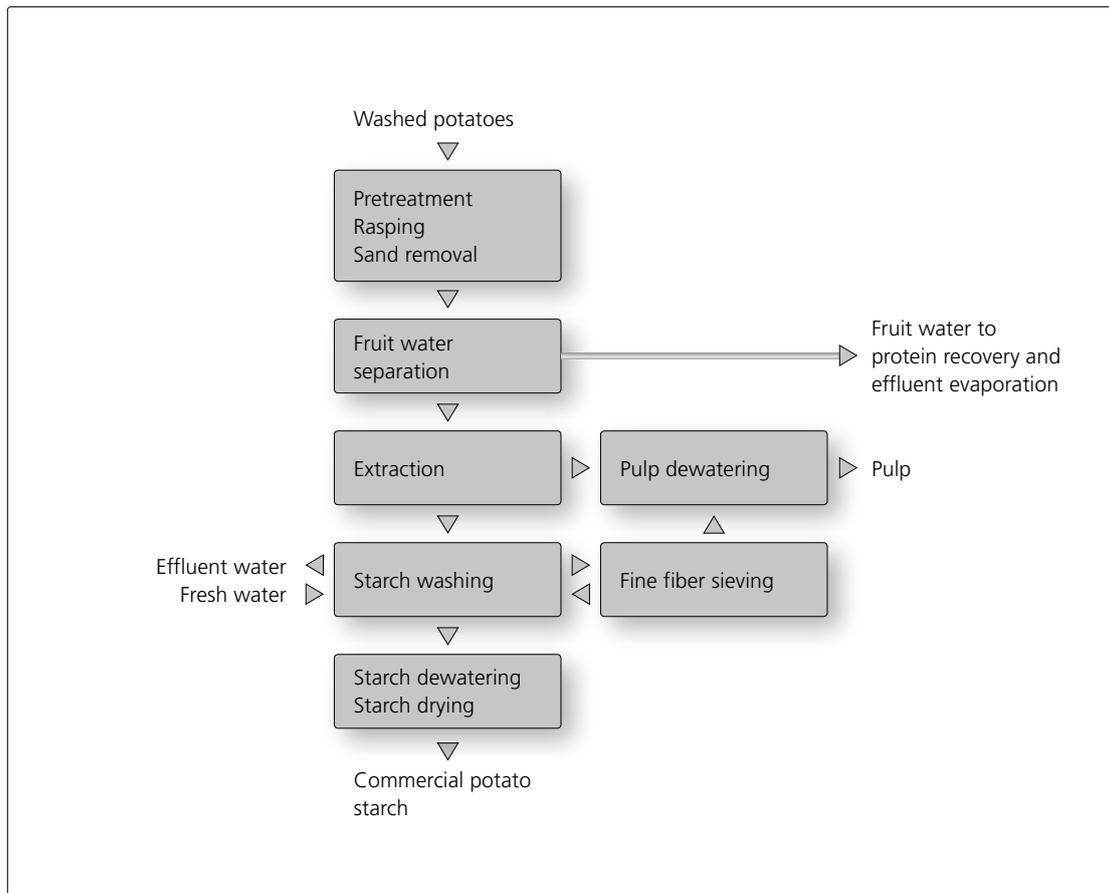
Whatever objectives are relevant: our solutions mean that success can be planned.
Agreed performances are attained reliably and permanently.

The Potato Starch Process

Process overview for production of potato starch

Optimizing the potato starch production process can only take place when the overall process is taken into consideration. The GEA Westfalia Separator Group is unique, supplying top-class machines for potato

starch production as well as for protein recovery (see page 16). With our expert knowledge and local service and support staff we offer tailor-made processes to suit our customers' needs.



Process overview for production of potato starch



The Right Start for a Robust and Efficient Production Process

Pretreatment, rasping, and sand removal

In this stage the potatoes are treated to create a pulp containing fibers and as much free starch as possible. Process steps are pretreatment – where the potatoes are washed – rasping, and de-sanding.

Pretreatment

Washing the potatoes is necessary to avoid damage and to minimize wear of the equipment used later in the process. The last pretreatment step is crushing the potatoes with shredders to a size that can be fed smoothly to the rasper.

Rasping

This process step is essential, since the quality of the rasper determines the yield of the overall process. The starch granules are locked in the cells of the potato together with other constituents, and have to be released from this cell compound. The more thoroughly the cells are destroyed, the better the release of the granules – and thus the better the starch yield. GEA Hovex raspers are designed to rupture the cell walls so efficiently that the maximum amount of starch from the potatoes is released.

Benefits of GEA Hovex raspers

- Highest starch yield
- Long saw blade life
- Easy maintenance

De-sanding

For best protection and minimum wear of the overall process equipment, the pulp is then fed to de-sanding cyclones to remove sand and other coarse particles. Because of the especially highly erosive nature of sand, GEA Hovex cyclones are made of stainless steel with a ceramic body.

Benefits of GEA Hovex de-sanding cyclones

- Excellent de-sanding
- Increased life and uptime of components such as pumps, screens and cyclones
- Long life and low maintenance (full stainless steel construction, ceramic cyclone body)
- Easy operation (automatic solids discharge)
- No starch losses



GEA Hovex de-sanding cyclone



GEA Hovex rasper

Potato Protein for Additional Value

Fruit water separation

In this stage the fruit water, which contains the protein, is separated from the starch and the fiber pulp. Proteins have a sticky nature. When they are not removed properly, they clog sieves and form deposits on machine parts. This leads to increased downtime and maintenance. More importantly, potato protein is a valuable substance which can be used as animal feed for example. Thus, recovering the protein makes not only for additional value for the overall process. The subsequent fruitwater process also reduces the consumption of fresh water and the effluent load.

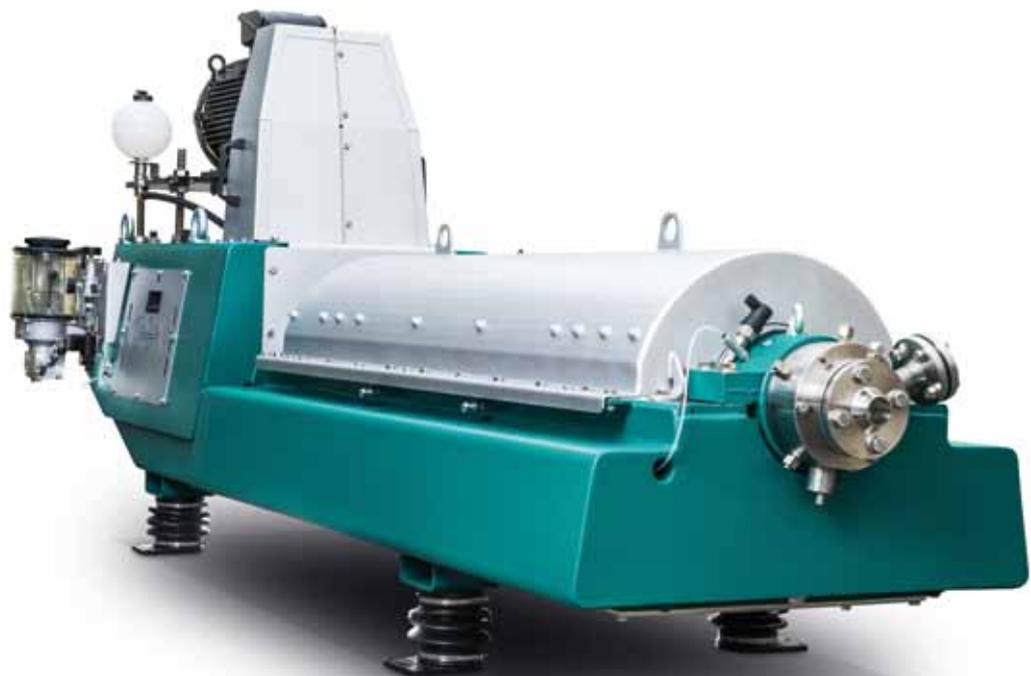
Advantages of removing the proteins early in the process

- Higher starch yield (starch can be more easily separated from the fibers)
- Higher end-product quality (less impurities in washing water)
- Reduced water consumption (less fresh water needed because of fewer impurities)
- Less effluent load
- Recovery of additional by-products for additional value

Decanters, with their high centrifugal force, offer the best performance in separating the fruit water and proteins. The fruit water is sent to protein recovery.

Benefits of decanters from GEA Westfalia Separator Group

- Outstanding throughput capacity and separation efficiency due to high g-volumes, high speeds, and full torque at all times
- Automatic optimization of torque and differential speed for maximum dry matter at all times, independent of feed conditions
- Reliable and robust technology with high-protection lubrication systems, external gears, and high-quality wear protection
- Energy-efficient operation: minimum conversion losses in the drive system



GEA Westfalia Separator **eco**force decanter

Extracting the Maximum Amount of Starch

Extraction of free starch and separation of fibers

In this stage the starch is separated from the pulp. The key parameter is the maximum recovery of starch. Process steps in this stage are multi-stage extraction using centrifugal sieves and de-sanding of crude starch milk.

Multi-stage extraction process

The starch is extracted by centrifugal sieving. The pulp is placed on a rotating sieve which is designed in such a way that starch can pass but fibers cannot. During the sieving process, water is added to wash the maximum amount of starch out of the pulp.

Benefits of GEA solutions

GEA Hovex centrifugal extraction sieves are designed to generate the maximum possible starch yield with the following benefits:

- Highest starch yield (optimal sieve configuration)
- Sieves with long service life
- Easy and stable operation (automatic feed pressure regulation)

- Easy maintenance: unique opening system for fast access to inner part of machine, and fast exchange of worn parts.
- Low maintenance (vibration free, robust design)
- Minimum cleaning downtime: self-cleaning sieve cone and CIP design (clean-in-place)
- Low-energy use: direct drive or belt drive
- High production capacity: greater than 40 m³/h per sieve

De-sanding

Some sand is extracted with the starch in the extraction process. This sand will cause excessive wear to pumps and other equipment, leading to increased downtime and more maintenance. For more information on de-sanding cyclones, see page 7. GEA Westfalia Separator Group advises the installation of a rotary brush strainer to avoid blockages of the separator nozzles in the following washing stage.



Centrifugal extraction sieves with direct drives from GEA Hovex



Upgrading Crude Starch to High-Quality Starch

Starch washing

The quality and value of the final starch product is largely determined by the washing of the crude starch. White high-quality potato starch can be obtained only if fiber fragments, lipids, proteins, dissolved substances are washed out efficiently. Process steps in this stage are a multi-stage washing process, fine fiber separation, and starch recovery from wash water.

Multi-stage washing process

The starch is washed by concentrating the diluted starch in suspension and diluting it again with clearer water. In this way, contaminants are removed.

By using a counter-current flow principle, the amount of fresh water used is small. After this multi-stage process, almost all contaminants are washed out. Nozzle separators and hydrocyclones are used in the washing stage.

GEA Westfalia Separator Group offers three process configurations for the washing process:

- Nozzle separator system
- Hydrocyclone system
- Hybrid system with a combination of nozzle separators and hydro cyclones

Process	Starch yield	Maintenance costs	Energy consumption	Water consumption	Investment	Ease of operation
Separator system	++	+	++	++	+	+
Hydrocyclone system	+	++	++	++	++	++
Hybrid system	++	++	++	++	++	++

Performance difference between washing systems

+ good performance ++ excellent performance

Nozzle separators and hydrocyclones are both based on the same mechanism. They concentrate the starch milk by centrifugal force. The centrifugal forces are higher in separators than in hydrocyclones.

Nozzle separator washing stage

High-yield washing with nozzle separators is advised for optimizing the starch yield (this means that more starch is captured due to higher centrifugal force). Since these machines can process many different starch types, they are recommended for use in multi-purpose plants.

2-phase nozzle separators

The 2-phase nozzle separators separate the crude starch milk into a washed starch suspension and a clear phase consisting of water, fine fibers and small-granule starch.

3-phase nozzle separators

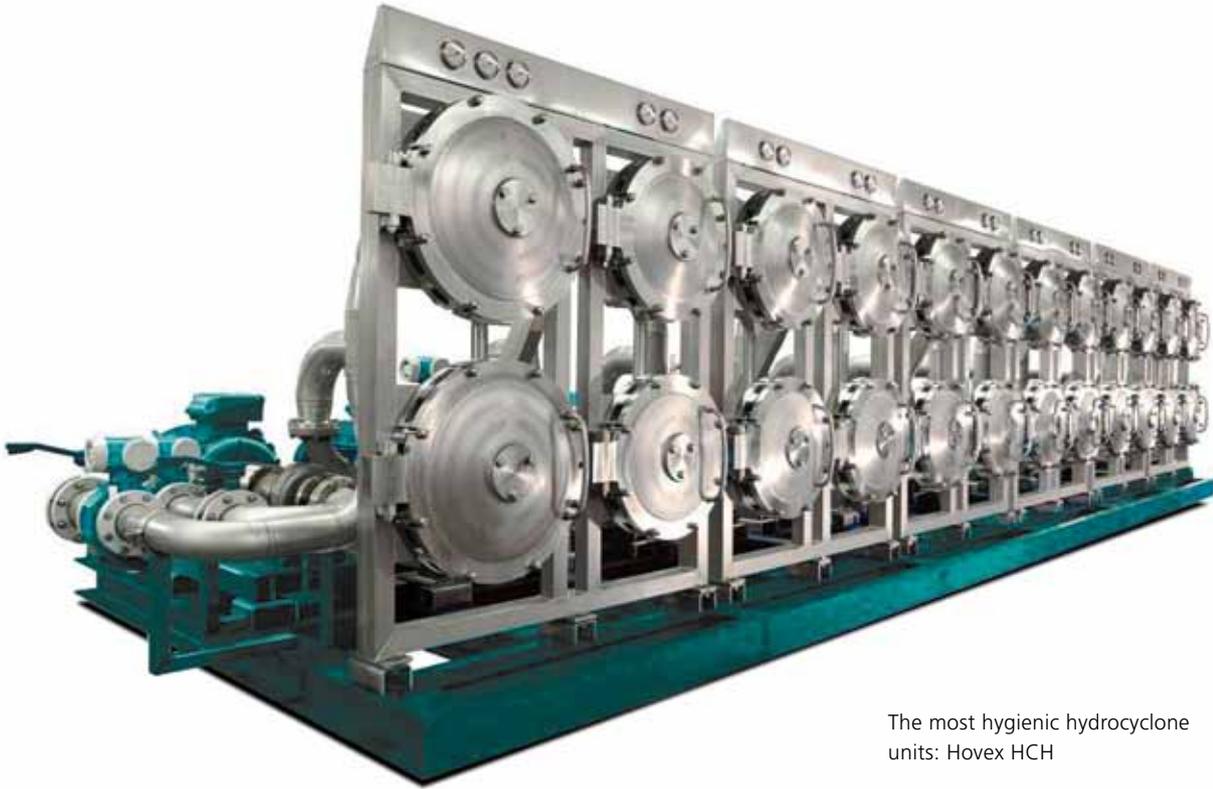
The 3-phase nozzle separators separate the crude starch milk into a washed starch suspension, fine-fiber fraction and clear-water fraction.

Benefits of a nozzle separator

- High yield and counter-current washing resulting from high centrifugal force
- High-purity starch produced by counter-current washing
- Top quality achieved by the closed feed and discharge design, with no oxidation possible
- The small number of washing stages
- Minimum fresh-water consumption due to the recycling of separated process water
- Top flexibility: no conversion necessary for different starch types
- State-of-the-art drive concepts for high energy efficiency and low maintenance

Nozzle separators from GEA Westfalia Separator Group accomplish high starch yields in best quality at little water consumption.





The most hygienic hydrocyclone units: Hovex HCH

Hydrocyclone washing units

GEA Hovex offers a broad range of hydrocyclones to match every situation and customer demand. The HCH cyclone unit is the most hygienic hydrocyclone on the market. The washing water is sensitive to microbiological growth which can cause the failure of the washing equipment, increased downtime, and a contaminated end product. Using the HCH hygienic hydrocyclone minimizes the risk of this harmful microbiological growth. In case hygiene is of less importance, the HCC cyclone units are advised.

Benefits of GEA Hovex hydrocyclones

- Highly efficient washing and no internal leakage
- Easy and simple operation
- Easy maintenance: the equipment can be opened quickly and easily
- Low energy consumption
- Low water consumption

Making a High-Quality Fiber-Free Final Product

Fine fiber sieving: to remove fine fibers

The final wash water and the water from the extraction contains fine fibers. These fine fibers have to be removed to prevent them accumulating in the water system, which degrades the quality of the final starch.

The fine fibers are removed by centrifugal sieves. The screen of these sieves is designed to capture the maximum amount of fine fibers. For more information on the sieving process, please see page 9.

Stabilizing the Pulp and Making It Suitable for Other Uses

Pulp dewatering

GEA Westfalia Separator Group has tailor-made solutions for every situation. Depending on the final use of the fibers, the pulp coming from the extraction stage has to be dewatered to a certain extent. The highest dry solids are reached with a decanter (see page 8). If lower dry solids contents are sufficient, centrifugal sieves (see page 9) are a cost-effective solution.

Extra benefits with decanters

- Clean overflow which can be used as process water, less fresh water consumption and less effluent
- High dry solids fiber cake

Taking Water Out of the Final Starch Slurry and Preparing It for Drying

Starch dewatering

In this stage, the amount of water is reduced mechanically, either by centrifugal force (peeler centrifuge) or by filtration (vacuum filter or filter press). Peeler centrifuges dewater the starch to provide high dry solids. A disadvantage is the batchwise operation and intensive maintenance. Filter presses create high dry solids but in a continuous process. Generally, this equipment is expensive and requires intensive maintenance.

Vacuum filters are generally preferred for their continuous operation, easy control, and simple maintenance.

Benefits of GEA Hovex vacuum filters

- Low consumption of electrical energy and no peak currents
- Easy operation
- Easy maintenance



Vacuum drum filter



Drying, Milling, Cooling and Packing of Starch

Starch drying

The single pass Flash dryer is ideal for products that dry rapidly, due to the easy removal of free moisture. This makes the process suitable for most types of starches. Wet material is introduced into a stream of heated air where moisture is removed quickly without heat damage. High rates of heat and mass transfer are achieved as the material passes through the system. The design also has the advantage of being simple and easy to maintain. Continuous development of this technology ensures that GEA Barr-Rosin can offer the most effective pneumatic drying and conveying system. High quality modified starches benefit from drying in the P-Type Ring dryer. This enhanced design of the Flash dryer recycles wet and heavy modified starch particles into the low temperature region of the system, facilitating gentle drying with prolonged residence times and high product quality with precise control of particulate moisture.

At the end of the drying process, the well-proven GEA Barr-Rosin suction discharge system achieves excellent atmospheric emission levels and often eliminates the requirement for wet scrubbers and bag filters. This system also minimizes dependence on mechanical handling equipment, significantly reducing maintenance requirements whilst largely avoiding product cross-contamination.

GEA Barr-Rosin includes engineering and supply of specialist classifying milling systems as part of its scope. The aspirated vertical grinding mill incorporates an internal classifying wheel with independent drive.



Flash dryer from GEA Barr-Rosin

By varying the speed of this wheel, oversize particles are deflected back into the mill for further grinding. This combination gives fine control of the particle size and ensures the highest product quality without heat damage.

A complete system can be supplied to include transport, storage, and packing. Packing systems can range from semi-automatic to fully automatic bagging units.



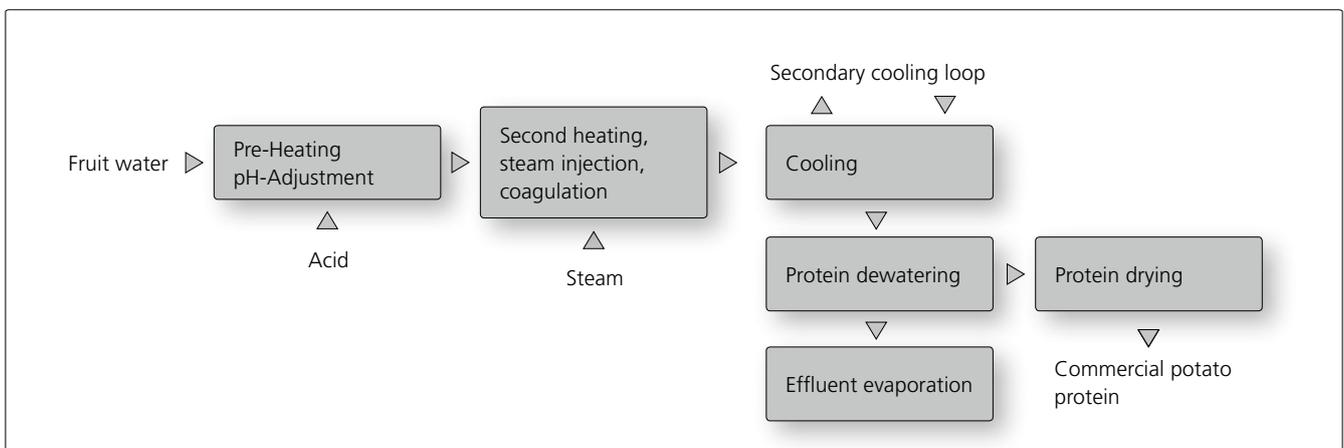


The Potato Protein Process

Process overview for recovering potato protein

Potato fruitwater contains high-quality and thus valuable protein. The recovery of this protein creates additional value to the overall process. Moreover, the fruitwater process considerably reduces the effluent load. The quality of fruitwater separation in the upstream starch recovery process is extremely important for the benefit of the protein installation. The better the fruitwater separation the more protein can be obtained. Up to 95 percent of potato fruitwater can be separated in starch installations from GEA Westfalia Separator Group.

The process design depends on the protein's purpose. For human food the protein is washed and dewatered prior to drying in a Ring Dryer which produces extremely fine powdered protein. If the protein is destined for animal feed GEA Barr-Rosin offers a simpler flash drying system.



Production process for production of potato protein



Coagulation

Heating, cooling, pH-adjustment

Pre- and second heating: two heat exchanger stages heat the fruit water from 20 to more than 100 °C, acid is added to adjust the pH-value to the isoelectric point as well as direct steam. This is essential to ensure optimum precipitation of the protein. The mixture is then injected with direct steam before it is allowed to rest and cool. This is where the actual flocculation process takes place, and also where the flocculant stabilizes. For optimum use of energy, the coagulated fruitwater is then recycled via a counter-current arrangement to the second heating stage.

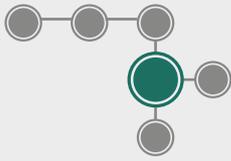
GEA PHE Systems offers tailor-made plate heat exchanger solutions with plate heat exchangers (PHEs) individually tailored to their heat exchanging processes: the size of their heat transfer areas, the selection of the plate materials, their surface profiles and flow control properties. The wide range of gasket and connection variants create an almost unlimited modular system for tailor-made heat exchanger solutions. For media containing solids and pulp like in the starch and protein industry the FA Free Flow plate heat exchangers are ideally suited. With their low investment and operating costs these are a viable alternative to shell-and-tube and spiral heat exchangers. Their special feature is the constant flow gap width between the individual plates and the coarse corrugation of the actual plates. The gap between the plates can be up to 12 mm. Moreover, they have service-friendly adhesive-free gaskets which can be replaced quickly and easily.

Benefits of plate heat exchangers from GEA PHE:

- Blockage-free operation with a constant gap width
- Wide variety of different types
- Maximum heat transfer, minimum investment
- High pressure resistance
- Fast and reliable gasket replacement
- NBR and EPDM gasket material available
- Blockage-free operation with a constant gap width



Plate heat exchangers from GEA PHE



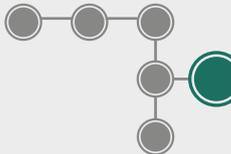
STEPS OF PRODUCTION PROCESS

Protein Dewatering

Fine-tuning for maximum dewatering

The quality of fruit water separation in the upstream recovery process is extremely important for the benefit of the protein installation. With decanters from GEA Westfalia Separator Group up to 95 percent of potato fruit water can be separated and thus used in the subsequent protein recovery. After heating, flocculation and cooling a high performance decanter separates the protein from the residual fruit water. GEA Westfalia Separator Group has designed this decanter specifically for this application so that the coagulate can be maximally dewatered while the residual effluent is efficiently clarified.

- Outstanding throughput capacity and separation efficiency due to high g-Volumes, high speeds and always full torque
- Automatic optimization of torque and differential speed for always maximum dry matter independent of feed conditions
- GEA Westfalia Separator **varipond®** for optimum adjustment of the pond depth to increase the relative clarifying area; this means that extremely small protein particles can be separated resulting in excellent separation efficiency
- Reliable and robust technology with high protection lubrication systems, external gears, high quality wear protection
- Energy efficient operation: no conversion losses of the drive system
- Closed feed and discharge: no oxidation and sanitary processing
- CIP capability to meet hygiene requirements



STEPS OF PRODUCTION PROCESS

Drying

High valuable protein

For human food the protein is washed and dewatered prior to drying in a Ring Dryer. GEA Barr Rosin has specially designed this dryer to dry protein based materials without causing thermal damage. It produces fine powdered protein which is suitable for adding to food products to increase protein levels without affecting the taste. This dryer can be used after the potato processing campaign for drying other proteins such as spent brewer's yeast or vital wheat gluten.

For protein destined for animal feed GEA Barr Rosin offers a simpler flash drying system which produces a coarser particle size. This type of dryer is lower in capital and produces a product suitable for animal feed.



Evaporation plant for the concentration of potato fruit water, consisting of two identical lines; each line with a single-effect falling film evaporator as pre-evaporator, heated by a mechanical vapour recompressor, as well as a 3-effect falling film forced circulation finisher, heated by a thermal vapour recompressor. Overall evaporation rate: 152,000 kg/h.

Evaporation

Minimize the energy footprint

The residual effluent from the protein dewatering still contains a high portion of valuable nutrients. To recover these nutrients, the effluent is concentrated in evaporation plants to 50 – 60 percent.

GEA Wiegand delivers tailor-made plant concepts meeting their individual requirements of the customers.

For an economic design of the evaporation plant, the investment costs and operating costs, i.e. overall energy costs, have to be taken into account. GEA Wiegand is

experienced in offering energy-saving concepts such as multi-effect evaporation or mechanical vapor recompression (MVR).

However, to find the optimal solution, the individual situation of the whole starch plant has to be considered. GEA Wiegand is able to design a fully energy integrated solution to minimize the energy footprint and to find the right balance between energy saving and investment cost.



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.

GEA Mechanical Equipment

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