MEMBRANE FILTRATION IN THE FOOD INDUSTRY

Working with GEA means partnering with a dedicated global team of experienced engineers and process experts.

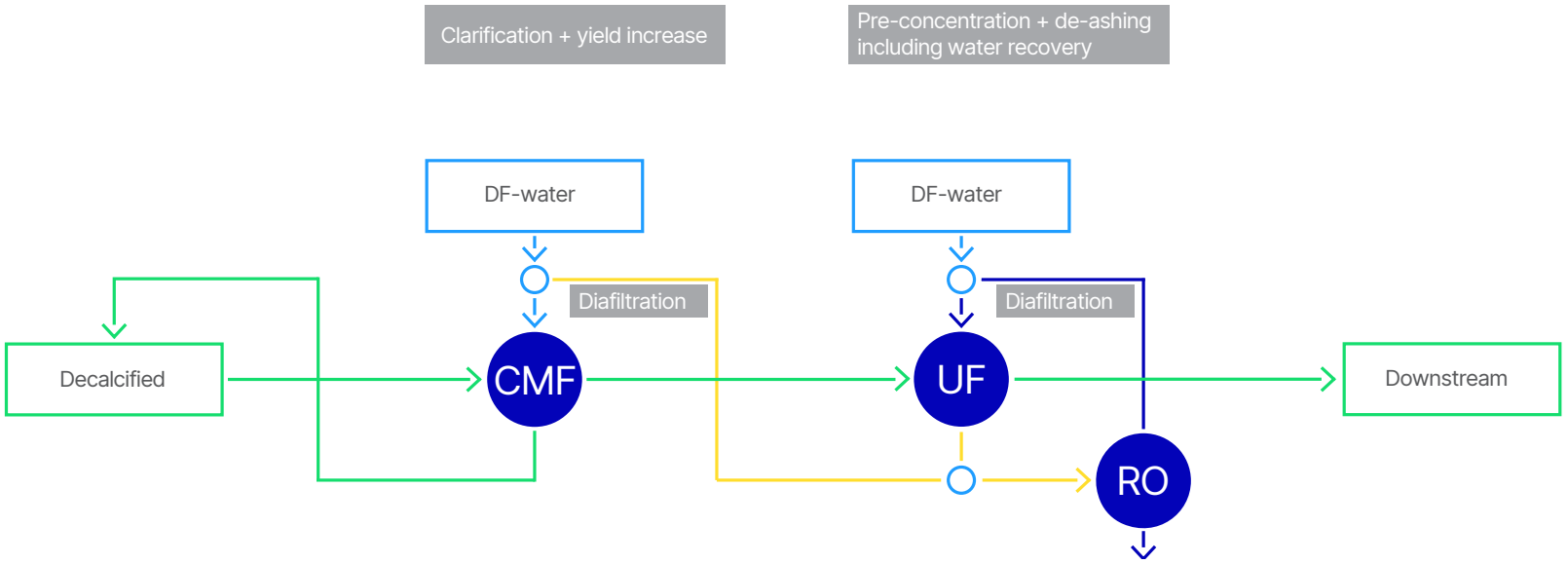
GEA Engineering for a better world.

GEA.com

Solutions to support your business
GEA designs and engineers customer-orientated membrane filtration solutions for the food industry. GEA is a leader in filtration technology providing membrane filtration plants for microfiltration, ultrafiltration, nanofiltration and reverse osmosis, and is known worldwide for its design of the most advanced cross-flow membrane filtration systems available. GEA is uniquely positioned to provide both customized membrane filtration plants as well as complete process lines, specifically tailored to the food industry to meet your requirements.

Contents

Membrane technology overview



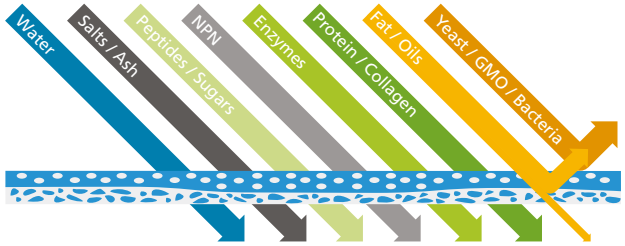
Membrane filtration is a separation process which separates a liquid into two streams by means of a semi-permeable membrane.

The two streams are referred to as retentate and permeate. By using membranes with different pore sizes, it is possible to separate specific components of protein and peptides Depending on the application in question, the specified components are either concentrated or removed/reduced.

Membrane filtration can basically be divided into four main technologies.

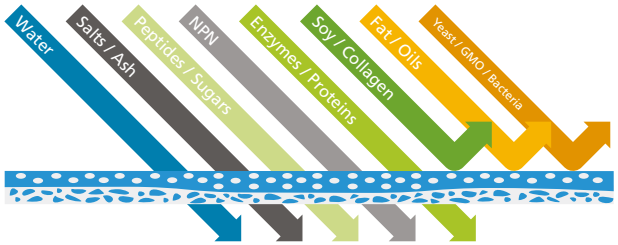
Microfiltration (MF)
Microfiltration is a low pressure-driven membrane filtration process based on a membrane with an open structure. It allows dissolved components to pass, while most non-dissolved components are rejected by the membrane. In the food industry, microfiltration is widely used for clarification of sugar streams or hydrolysed proteins, fat and oil removal, bacteria control and separation of the valuable components from a fermentation broth of specialized food ingredients.

Microfiltration

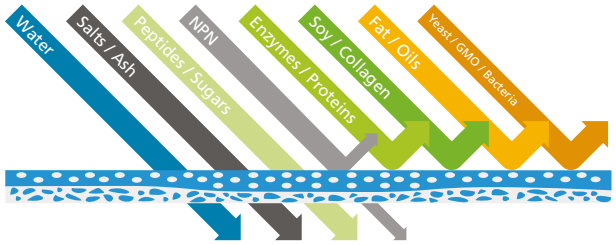


Ultrafiltration (UF)
Ultrafiltration is a medium pressure-driven membrane filtration process. Ultrafiltration is based on a membrane with a mediumopen structure allowing most dissolved components and some non-dissolved components to pass, while larger components are rejected by the membrane. In the food industry UF is widely used for protein concentration like soy protein, egg-white, gelatine as well as for special food additives like poly saccharides, enzymes.

Ultrafiltration (open)

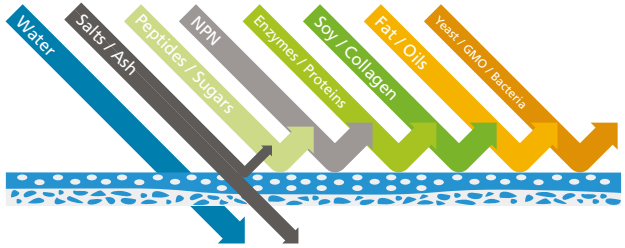


Ultrafiltration (tight)



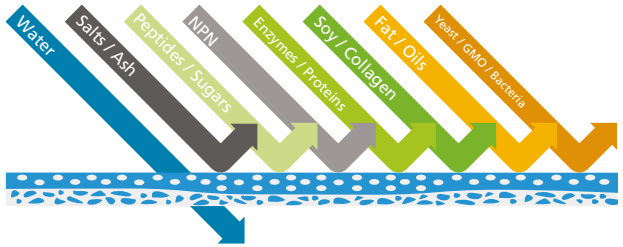
Nanofiltration (NF)
Nanofiltration is a medium to high pressure-driven membrane filtration process. Generally speaking, nanofiltration is another type of reverse osmosis where the membrane has a slightly more open structure allowing predominantly monovalent ions to pass through the membrane. Divalent ions are - to a large extent - rejected by the membrane. In the food industry, nanofiltration is mainly used for special applications such as concentration of peptides, amino acids, fractionation of sugars and sweeteners, de-ashing and product adjustments.

Nanofiltration



Reverse osmosis (RO)
Reverse osmosis is a high pressure-driven membrane filtration process which is based on a very dense membrane. In principle, only water passes through the membrane layer. In the food industry, reverse osmosis is normally used for the concentration of sugars (glucose), special food ingredients and mainly for water reclamation.

Reverse osmosis



Microfiltration (MF)

Microfiltration unit

Clarification

Natural sugar treatment and hydrolysed starched based sugars
Sugar sources as cane or beet sugar from natural base as well as dextrose/glucose from corn or wheat are clarified using ceramic microfiltration to remove solids, proteins and impurities. The advantage of the membrane solution is a full automated closed process compared to traditional filtering methods. By adding diafiltration water the yield can be increased to a maximum.

Special food ingredients based on biotechnology
As alternative solution to traditional separation ceramic microfiltration is used to clarify the valuable food ingredients from the solid phase of the fermentation broth. At the same time the microfiltration rejects the GMO and is seen additionally as containment. By its geometry of the pores the microfiltration process step is similar to a physical barrier due to its low cut of the inorganic ceramic layer.

Hydrolysed peptides
Depending on raw material and extraction process ceramic microfiltration is used for the clarification of hydrolysed peptides. The application is operating in the range of 75-95°C and mainly rejecting the remaining content of fat, oils as well as further residues of solids to get a turbid free permeate stream with less than 5 NTU. At the same time possible microbiology is controlled as well.

Bacteria removal
Despite sanitary design raw food material can lead to enter bacteria into the production line. In food processing many processes are driven hot. Even though, bacteria growth and bacteria control are playing more and more a bigger role increasing the level of sanitary processing and so further the food safety. Depending on product, composition and viscosity different technical approaches are possible and can be adopted to the specific needs to our clients. Microfiltration is used to reject bacteria while the product is passing. If upstream a batch process is implemented in which bacteria growth cannot be avoided or bacteria are part of the raw source the filtration step will protect the multi-stage downstream process. For such applications different solutions can be provided based on polymeric, ceramic or stainless-steel membranes depending on customers demands.

Ultrafiltration (UF)

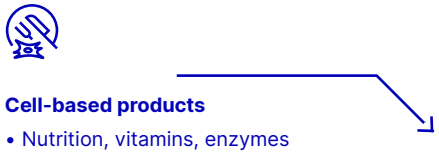
Pre-Concentration

Ultrafiltration is mainly used as pre-concentration process step for proteins. As this process step applies a low pressure only combined with a small footprint due to modular plant design this solution supports better sustainability and lowers carbon footprint when production capacity needs to be expanded. By adding diafiltration water proteins can be washed increasing the clarity by passing impurities, ash or other unwanted side components out into the permeate.

Gelatin
Gelatin is a color and odorless food ingredient with water binding and texture giving properties. Gelatin is extracted from collagen from different raw sources as pig, cattle or fish. After extraction and demineralization pre-concentration by means of ultrafiltration is nowadays the settled process solution in the market. The concentration handed over to the following thermal process step has been increased over the recent years which reduces significantly operation costs compared to thermal treatment. As the membrane process has a low retention time the method is protecting the product against degradation and colouring while keeping the bloom value high. By adding diafiltration water de-ashing can be realized to a certain extend.

Plant-based protein
The market share of plant based proteins in the food business is rapidly increasing year by year which leads to the demand of bigger production lines. More and more specialized food products and meat replacements for vegetarian and vegan consumers are entering the food market. To cover these demands GEA provides to our customers different solutions for clarification, fractionation, pre-concentration and washing of plant based proteins with special focus on soy and pea proteins. With the know how in the new area GEA can provide solutions fitting to the individual needs of our clients.

Biotech: clarification, fractionation, concentration, purification
Ultrafiltration plays a major role in special food production processes based on biotechnology in regards to clarification, fractionation, purification and concentration of special food ingredients based on GMO sources. Especially in combination with diafiltration the product can be purified from ash and nutrition's mandator for the fermentation process. A complementary line solution with low dead volume and high rate of product recovery is the target for the success of our customers.



Cell-based products
- Nutrition, vitamins, enzymes
- Special flavors (heme)
- Cell-based meat

Meat and poultry
- Animal protein hydrolysates
- Gelatin
- Blood plasma, whole blood
- Chicken hydrolysate
- Egg white powder
- Lysozyme

Fish, seafood, algea
- Fish protein, fish peptides
- Mussel extract, surimi
- Algea, carrageenan, alginate
- Seaweed

Food Ingredients
Stabilizers
Thickeners
Texturizers
Sweeteners
Colors
Aromas
Flavors

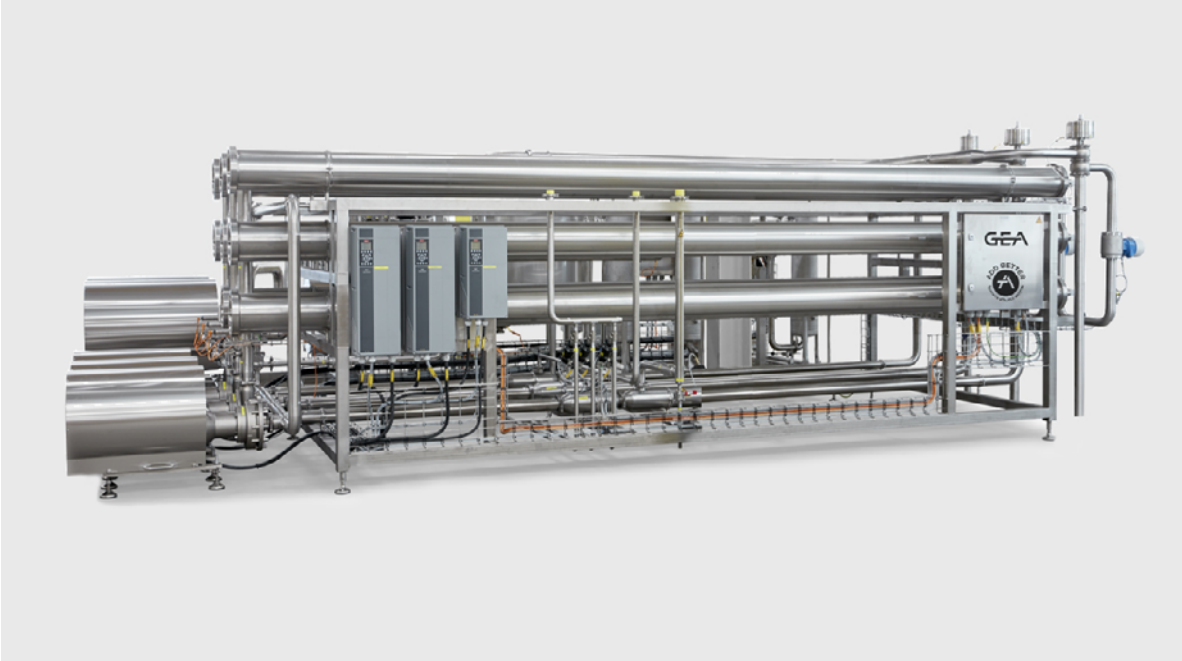
Sugars and sweeteners
- Beet sugar, cane sugar, molasses
- Corn, wheat based sugars
- Dextrose, glucose, fructose and derivatives
- Inulin, lysine, xylose
- Agave juice
- Potato protein
- Starch and potato wash water

Coffee, tea, plant extracts
- Cold brewed coffee
- Instant coffee / tea
- Extracts: colors, flavors
- Vinegar

Plant-based proteins
- Proteins from soy, pea, rice, oat, canola
- Plant-based whey processing
- Hydrolyzed derivatives
- Polysaccharides

Nanofiltration (NF)

Nanofiltration is a cost-effective technology for partial demineralization



Hydrolysed peptides
Depending on raw material, extraction process and ash content the nano-filtration process is used to concentrate peptides while passing mono-valent ions to the permeate side. With choosing the appropriate membrane the product quality can be adjusted to customers needs. Due to the wide range of experience in this market GEA is the right provider to develop these specialized applications.

Egg white
As membrane filtration is a physical concentration process that works under cold process conditions (compared to evaporation) such process is special qualified for egg white concentration as temperature sensitive and risky in regards to bacteria impact. The NF membrane will reject the egg white while having no impact on the quality nor denaturation due to cold processing and is so an accepted concentration solution.

Recovery of fermentation media
By implementing production processes based biotechnology and on top increasing the production capacities the questions arise of media recovery in general and so comes more and more into focus – where applicable. In special cases NF membranes can be used for the fractionation and concentration media streams for re-use.

Reverse osmosis (RO)

Reverse osmosis unit

Cold brewed coffee
The special drink cold brewed coffee has lower oil content and less fouling ingredients so that reverse osmosis is the recommended concentration method. The cold concentration keeps the aroma while the product quality stays unchanged.

Dextrose/glucose concentration
As alternative to the standard thermal concentration process for sugar concentration reverse osmosis can be used instead. The plants in such applications are adjusted to the customers needs as each project is specific.

Water recovery
Better sustainability and protection of the environment a core focus when implementing new processes - especially for new greenfield projects. Optimizing the water consumption becomes more and more a necessity also in existing production lines. By polishing water streams like UF permeates or condensates from thermal concentration steps it can lead to reduction in fresh water and waste-water as well as energy recovery.

Hydrolyzed peptides
Nowadays, instead of NF membranes RO membranes are used when the hydrolyzation grade is very high. In these cases the majority of the molecular size distribution of the peptides is short chain in its character. Compared with NF membranes where the desalination grade parallel to the concentration plays a role the RO membranes do only focus on the peptide concentration with target achieving highest yield.

Processing units for each application

GEA provides membrane filtration units specifically tailored to meet your needs and requirements.

With our extensive theoretical and practical experience within membrane filtration along with our well-defined standard modules, we are able to design membrane filtration units for all membrane filtration applications within the food industry.

Our breadth of membrane filtration equipment means that we can be with you from initial testing on pilot units to small standardized units and, ultimately, custom-designed full-scale production, while meeting local regulations. Our unique plant sizing software works to identify the optimal plant configuration.

The “plug-and-produce” unit philosophy provides our customers with several benefits such as space-saving designs, seamless integration and short installation time. We are able to deliver membrane filtration solutions with low energy consumption and noise emission and reduced product and detergent waste.

GEA membrane filtration units have a compact, hygienic design for easy cleaning. They are designed to process your products safely. Our cross-flow membrane filtration pilot units are available to test any application, including clarification, bacteria and spore removal, fractionation, concentration and/or separation including diafiltration, in the food and beverage, dairy, chemical, biotechnology and fermentation industries, on-site or at our test centers.

Membrane types

Membranes are selected to meet the specific requirements of the application in question. The range of membranes can be split into two main groups - polymeric (organic) and ceramic (inorganic).

Polymeric
Polymeric membranes include a range of different membrane types such as spiral wound, hollow fiber and flat sheet (plate-and frame) membranes - all of which are made from organic materials. Polymeric spiral wound membranes provide a high membrane area per element, leading to a reduced footprint and cost-efficient plant designs.

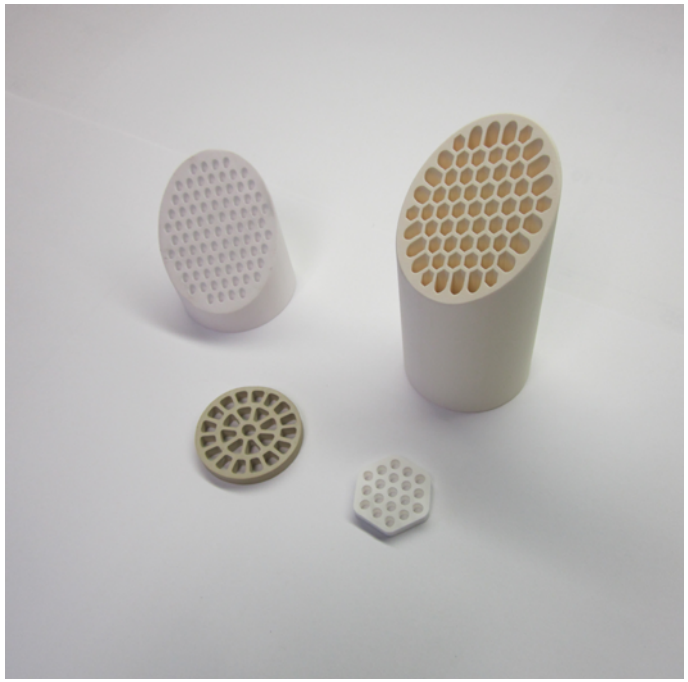
Cleaning of these types of membranes requires specially formulated cleaning detergents to extend their lifetime. As polymeric membranes come in a wide range of pore sizes, they can be used for a large number of dairy filtration applications from RO to MF.

Ceramic
Ceramic membranes include a number of membranes which are all made from inorganic materials. As ceramic membranes are very resistant to temperature and chemicals, they are easy to clean. The lifetime of ceramic membranes is longer than that of polymeric membranes. Compared to polymeric membranes, ceramic membranes have a much higher flux, but to due their tubular design, they have less membrane area per element.

Ceramic membranes come in a limited range of pore sizes, and are normally used for microfiltration and in some cases ultrafiltration processes.

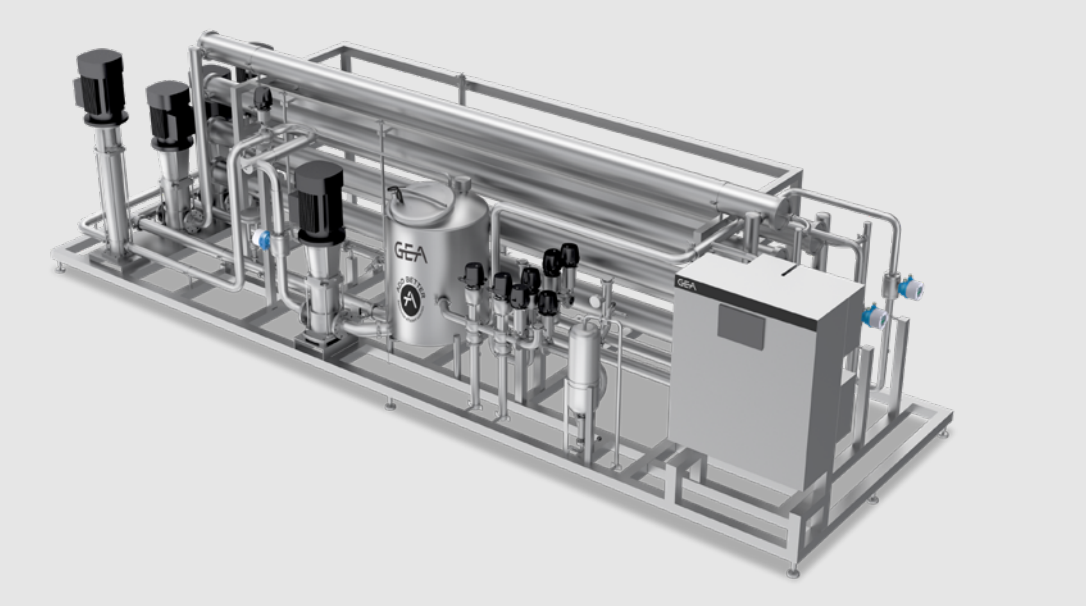
Polymeric membranes

Cerameric membranes



GEA EasyCon Filtration Unit

A compact membrane filtration system



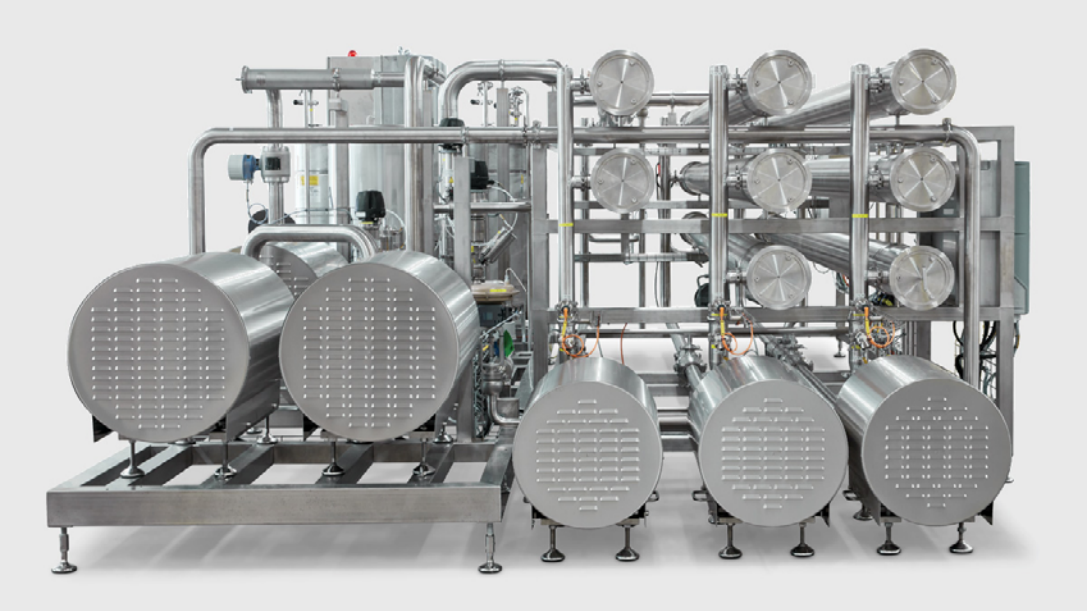
The compact and standardized “plug & play” EasyCon unit is available for small-to-medium feed rates and can concentrate a feedstock to provide a solution with a total solids (TS) content of up to 25%.

Cost-effective EasyCon
Designed to concentrate solids by nanofiltration (NF) or reverse osmosis (RO) membrane filtration technology, the EasyCon is the right choice for concentrating solids when cost is key and improved return on investment (ROI) is of great importance. GEA cross-flow filtration technology with nanofiltration or reverse osmosis spiral-wound membranes can be used to concentrate the solids content of various feedstocks. For concentration applications, reverse osmosis membranes should be used. If a partial demineralization is required, nanofiltration membranes are recommended. Operating at temperatures of approximately 10–15 °C, the filtration unit eliminates the risk of thermally stressing the product.

EasyCon - easy to install and operate
Frame-mounted and ready for installation, the EasyCon unit includes filtration modules, pumps, instruments, a clean-in-place (CIP) dosing unit and control technology for automatic and easy operation.

EasyCon at-a-glance
- Plug & play design for fast installation and commissioning
- Compact system design for small footprint
- No assembly on site as all components are frame mounted
- Automatic control and visualization with touchscreen for easy operation
- Processing of multiple products possible
- Spiral-wound nanofiltration or reverse osmosis membranes
- Standardized modular design to reduce investment costs and improve the return on investment

GEA CIP Recovery



With increasing volume, treatment also becomes more expensive.
As lowering our overall environmental impact becomes increasingly important, there is growing pressure on industry to reduce the amount of process wastewater that's discharged to sewers. Having to treat higher volumes of this wastewater can, however, be expensive.

Most industries have already reduced their water consumption to a minimum. However, even with the implementation of efficient clean-in-place (CIP) systems and the ability to recycle detergents a number of times, large volumes of caustic wastewater are often generated. With repeated use, cleaning solutions — which mainly consist of a 2% to 4% sodium hydroxide solution — become loaded with impurities, such as proteins, sugars and colorants, and must subsequently be changed. However, using a nanofiltration (NF) plant from GEA, these solutions can be cleaned and regenerated for continued use, thereby saving money and avoiding disposal issues.

The regeneration of these CIP solutions is achieved using membrane filtration at the normal operating temperature of the fluid (up to 80°C). The contaminated CIP solution is fed into the main storage tank via a bypass system and subjected to automatic self-cleaning filter . This removes suspended colloidal impurities.

Often, CIP solutions can be directly treated in a nanofiltration (NF) system to remove color and low-molecular weight impurities. This concentrates the impurities in the retentate, thereby allowing the purified caustic solution permeate to pass through at the same concentration and temperature as the feed.

Benefits and advantages
- Reduced chemical loss saves money and extends application intervals
- Lower cost to neutralize wastewater
- Reduced energy costs owing to high-temperature filtration
- Plug & play design for easy implementation into existing CIP systems
- Standardized modular design to reduce investment costs and improve your return on investment

Membrane Filtration Pilot Plants

Our pilot plant units are ideal for developing new products, optimizing process parameters, testing different membrane types, achieving new concentration levels, and making product samples.

Choose to rent a pilot unit or conduct in-house testing with GEA

Our pilot units vary from small- to medium-scale and offer a wide range of capacities, depending on the application tested. The pilot units can simulate the operating behavior of fullscale production and can be adapted to run according to your required specifi cations. Data collected from pilot trials can then be used to determine process parameters for the design of future full-scale production units. at results in the formation of a very exact tprotein particle size.

Renting pilot units

We provide rental pilot units for testing membrane fi ltration equipment and solutions at your facilities in connection with other process equipment. All GEA pilot units can be shipped globally, allowing you to perform tests – either on your own or with support from GEA – using your own raw materials and your own packaging. This method eliminates the risks associated with the storage and transport of raw material which can otherwise compromise testing.

In-house testing at GEA site

Alternatively, customers can elect to test fi ltration equipment and solutions at GEA test centers. Featuring state-of-the-art GEA pilot units, our facilities in Ahaus and Hildesheim (Germany), and in Hudson, WI (U.S.) are optimally equipped to perform pilot studies on the full range of GEA membrane filtration technologies. Our diverse range of membrane types supports the processing of high-quality raw materials.

GEA pilot units are available in a wide range of membrane and module confi gurations, including:

- **Reverse osmosis (RO):** spiral wound
- **Nanofi ltration (NF):** spiral wound
- **Ultrafiltration (UF):** spiral wound, plate-and-frame, ceramic
- **Microfiltration (MF):** spiral wound, ceramic and sintered stainless steel
- Membrane and module configurations for polymeric tubular and hollow fiber

Membrane replacement and process performance service

A unique and individual membrane replacement service to optimize the total cost ownership (TCO) of your plant.

Membrane replacement service
To help avoid the risk of a breakdown, GEA focuses on preventive maintenance and regular service to keep your plant and equipment running, saving you from potentially expensive downtime.

GEA supports and supplies replacement membranes and parts for all known membrane filtration technologies including microfiltration, ultrafiltration, nanofiltration and reverse osmosis.

Organic membranes have a limited life span and typically need replacement once or twice per year (depending on the processing rates and conditions) to maintain consistent performance of the unit. The most significant factor affecting the performance of membrane processing systems is membrane fouling. It is the result of insoluble materials coating the membrane surface and causing a reduction in product quality.

Membrane formula
GEA stocks replacement membranes and works with each servicetechnician to maintain a service replacement history and predictwhen new membranes will be needed. With GEA, you can counton dedicated service specialists to make service optimizationvisits on request, carry out a follow-up of the installation and itsparameters, or provide staff training.

Membrane and process performance service
Where membrane filtration is a part of a processing plant, its role is key to the efficiency of the plant. It is therefore essential to maintain membranes diligently to maximize profits and keep them in top operating condition.

GEA offers an innovative membrane lifetime extension program Perform'Up. Perform'Up is a performance program with regular process, hygiene and quality checks. By analyzing the specific membrane fouling compensation, we are able to recommend a customized clean-in-place (CIP) program to improve overall production performance and reduce TCO.

Become future-proof with the Add Better ecolabel.

Get an idea of what the sustainability pipeline of the near future looks like. The Add Better label is our overall holistic approach to signal greener times ahead in specific cases.

Discover more at gea.com

Our Green Label process step by step
In order to systematically generate awareness for our “Better Product” branding, GEA rolled out the Add Better ecolabel for a variety of solutions. The cornerstones for qualification are:

1. Recognized proof of performance
GEA’s Add Better label process meets ISO requirements for self-declared environmental claims, ensuring sustainable solutions that are more resource-efficient than their predecessors.

2. Meaningful documentation protocol
GEA defines the technical, geographical, and temporal scope of the solution and its assessment. On this basis, relevant data about the technology and its predecessor is collected and verified.

3. Independent verification
A high level of certainty and authenticity is achieved through validation by TÜV, a global leader in independent testing, inspection, and certification services.

Add Better helps to reduce greenhouse gas emissions
Every day, our purpose “Engineering for a better world” drives us to develop solutions that use less energy, water, and raw materials and produce less waste. The Add Better label identifies the most significant advances we are making in this area.

YOUR SUSTAINABILITY DEVELOPMENT PLAN FOR YOUR MEMBRANE FILTRATION EQUIPMENT.

ADD BETTER
Resource efficient solution

Smart Filtration CIP

Smart Filtration CIP is a software-based patent pending method that regulates cleaning efficiency. It causes the pumps to operate in a pulsating manner as opposed to running continuously. It works at the same concentration, time, and temperature as a conventional CIP but with lower electrical power consumption. The benefits are:

- Up to 46% less electrical energy consumed;
- Less cooling water needed to maintain a steady temperature;
- Suitable for use in all applications in all industries, such as: dairy, beverage and food (new food);
- Optimizes energy consumption without compromising the quality of the CIP.

Smart Filtration Flush

Smart Filtration Flush is a software-based patent pending solution combined with modern sensor technology. This intelligent method of flushing filtration equipment using inline measurements of product properties determines when the individual process streams have been flushed sufficiently. The system:

- Reduces water consumption by up to 50%;
- Minimizes total CIP time due to a shorter, more efficient flush;
- Creates less wastewater to be discharged into the treatment plant;
- Reduces the overall water installation costs of the membrane filtration plant.

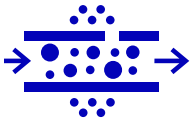
InsightPartner Filtration

Get full access to production data anywhere and anytime in your membrane unit. InsightPartner Filtration is a digital service product implementing IIoT in membrane filtration to leverage the power of cloud connectivity. It offers data visualization enabling fast and accurate decisions. The system:

- Monitors your membrane filtration systems status in real wtime;
- Displays your data and system KPIs on a digital dashboard;
- Provides an overview list of production processes;
- Follows historical trends to maximize productivity.

With the help of better products in many use cases.

Our membrane technology offers cost-effective processing solutions, supporting dairies in reaching their sustainability goals in a cost-effective way. Membrane filtration technology offers several options for achieving more sustainable processes in the dairy industry, which imply reductions in production costs.



Pure Innovation, saving every drop of water with GEA membrane filtration

Traditional methods of water treatment often involve substantial wastage due to the need for excessive flushing, backwashing, and chemical treatments. GEA membrane filtration disrupts this cycle by optimizing each stage of the process.

Unleash efficiency, preserve every drop with GEA

With GEA automation as your ally, the vision of conserving every precious drop of water becomes an achievable reality. Together, let's pave the way for a greener, more efficient tomorrow.

Better products from our business unit, reduces your carbon footprint and your energy and water consumption.

State-of-the-art automation

GEA is dedicated to continuously improve the automation system of GEA processing units, making your process more cost-efficient. The system provides many features, which can optimize your individual production process.

GEA Codex®
All Membrane Filtration Units are equipped with a standard software based on GEA Codex® technology.

The software enables:
- Intuitive and user-friendly HMI
- High productivity and consistency
- Efficient service

Connectivity and integration
For other integration, the unit comes with predefined signal exchange in- and outputs which allows the unit to be lightly controlled or control other surrounding equipment. A profinet connection can be used for full feedback on all the equipment and instruments for a SCADA implementation or other similar systems. All units are delivered with modem for remote connection for fast and efficient service.

GEA SERVICE - FOR YOUR CONTINUED SUCCESS.

Working with GEA Service means partnering with a dedicated team of service experts.

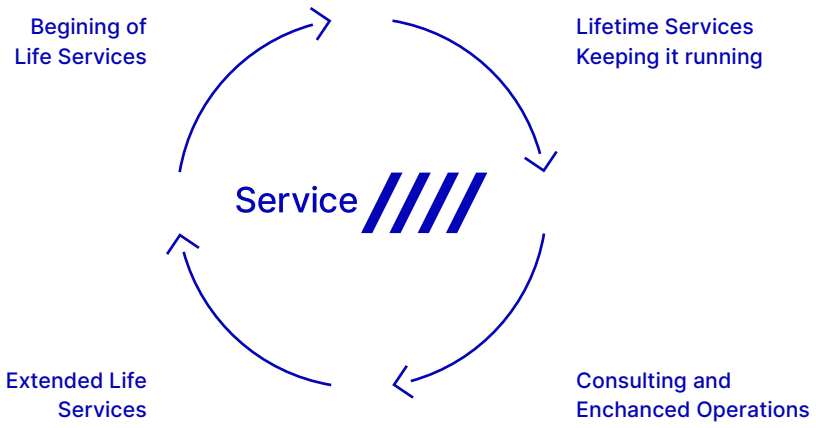
Our focus is to build, maintain, and improve customer performance throughout the entire life cycle of the plant and its equipment.

Begining of Life Services
Getting you started with seamless support for instant productivity and performance.

Lifetime Services
Keeping it running with the cost-efficient way of ensuring safety and reliability.

Extended Life Services
Constantly improving by sharing our knowledge to safeguard your investment

Consulting & Enhanced Operations
Together with you by enduring commitment to you and your business.



Engineering for a better world.

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