



Alfa Laval - membrane filtration

It's all about size



Membrane filtration enables you to bring down overall production costs, and boost product quality – both at the same time.

Alfa Laval's experience within membrane filtration dates back almost as far as the technology itself, and we wish to share our experience with you.

Membrane filtration complement our range of separation technologies and allows us to provide you with the most efficient solution.



What is membrane filtration?

Physical separation

Membrane filtration is a physical separation process in which the driving force is the difference in pressure between the two sides of a special membrane. This process is characterized by the ability to separate molecules of different sizes and characteristics.

Almost all industrial membrane filtration is carried out as cross-flow filtration, where the liquid being filtered flows parallel to the membrane at high velocity and under pressure.

Physical barrier

In its most basic terms, membrane filtration involves passing a single feed stream through a membrane system that separates it into two individual streams, known as the permeate and the retentate. The membrane that separates them is a physical barrier with highly specialized characteristics – a barrier that only certain selected components in the feed stream can pass through.



Passing through

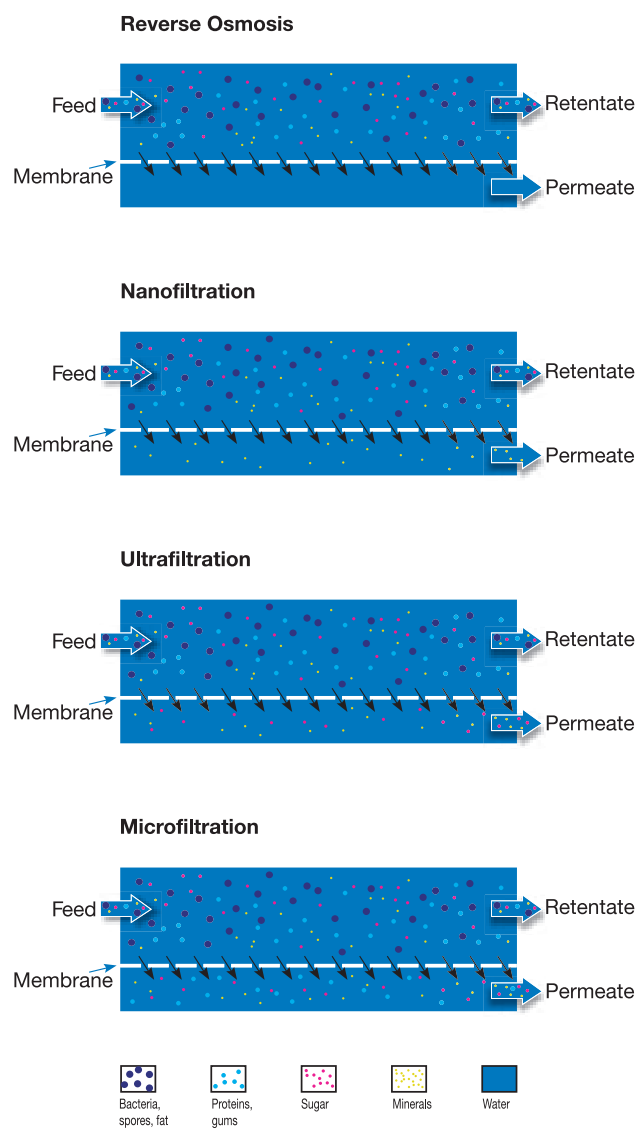
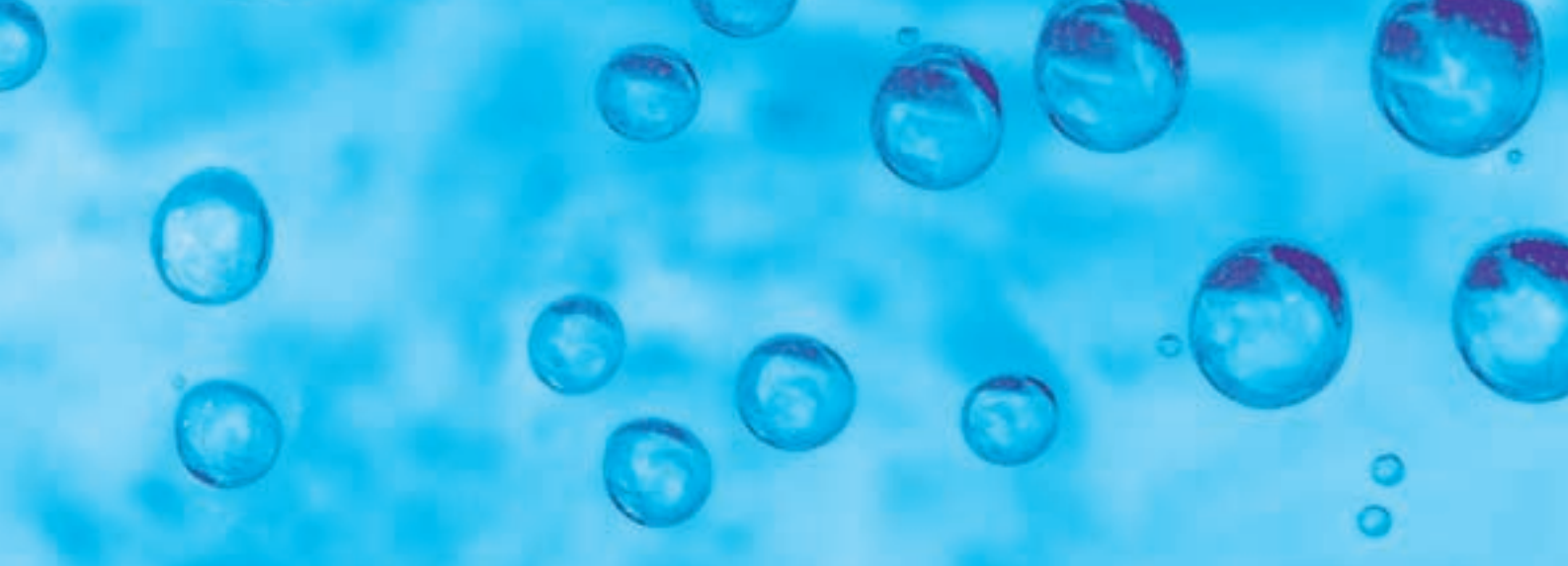
The pores of such membrane material are so small that they are measured in Angstrom (10^{-10} m), and pressure is required to force the liquid through them. In fact, the pores in the membranes used for nanofiltration and reverse osmosis are so small that they cannot be seen even with a scanning electron microscope.

Small-scale

To put the size of these pores into perspective – it has been said that if one square foot of membrane material were the size of the entire Pacific Ocean, one single reverse osmosis pore in that material would be roughly the size of a US dime.

Types of membrane filtration

There are four commonly accepted categories of membranes. These are defined on the basis of the size of material they are required to separate from the feed liquid. The membrane types are known as reverse osmosis, nanofiltration, ultrafiltration and microfiltration, in order of increasing pore size.



Reverse osmosis (RO)

Reverse osmosis uses the tightest possible membrane in liquid separation. In principle, water is the only material that can permeate the membrane. All other materials (salts, sugars, etc.) will be unable to pass through.

Nanofiltration (NF)

Nanofiltration is not as fine a separation process as reverse osmosis, and uses membranes that are slightly more open. Nanofiltration allows small ions to pass through while excluding larger ions and most organic components.

Ultrafiltration (UF)

Ultrafiltration involves using membranes in which the pores are larger and the pressure is relatively low. Salts, sugars, organic acids and smaller peptides are allowed to pass, while proteins, fats and polysaccharides are not.

Microfiltration (MF)

In microfiltration, suspended solids, bacteria and fat globules are normally the only substances not allowed to pass through.

Membrane filtration

– built-in advantages

Membrane filtration

Membrane filtration can be either dead-end filtration or cross-flow filtration.

Cross-flow filtration provides significant built-in advantages over dead-end filtration. Because the liquids being processed flow continuously across the membrane, there is no filter cake that can lead to fouling and uneven flow.



This makes it possible to operate a continuous, automated filtration process that results in a consistent, controllable product quality. No filter aids are needed, and the membranes have an extended lifetime.

Membrane filtration provides many significant advantages when used in industrial-scale applications where reliability, consistency and operating costs are crucial considerations.

These advantages include:

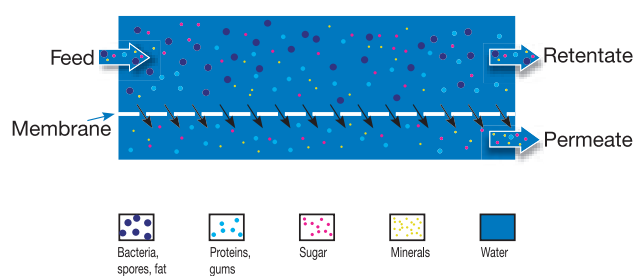
- Lower overall production costs
- High end product quality
- Flexibility



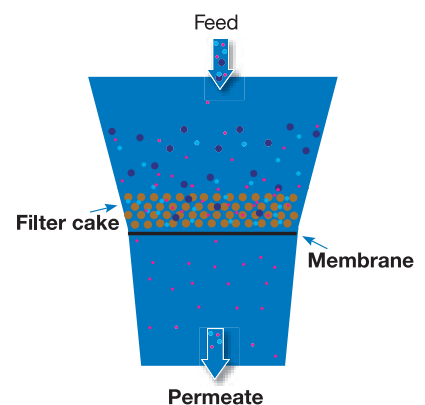
Lower overall production costs

Membrane filtration systems are often less expensive than many other alternative technologies. The installation costs are lower, as are the energy costs.

Cross-flow filtration



Dead-end filtration





Membrane filtration includes fewer processing steps and makes it possible to achieve both a greater degree of purity and higher overall yields.

In addition, because membrane filtration does not result in a filter cake, there are no costs associated with the removal and disposal of this residue.

High end product quality

Membrane filtration is a clean technology. The separation process is carried out solely on the basis of molecular size, making the use of additives unnecessary. This results in an end product with top quality, and makes it easier to comply with the many stringent requirements from both consumers and public authorities.

Flexibility

Membrane filtration can be used for feed products with a range of different viscosities, including high-viscosity products that can otherwise be difficult to process. A wide range of different membrane filtration products also ensures that the best possible solution is available for each particular application. This also eliminates unnecessary energy costs.

Alfa Laval membrane filtration equipment is designed on a modular basis that gives a high degree of flexibility, as membranes are built into modules, modules are built into loops and loops are built into systems. The design of a system can thus be customized to meet any process needs

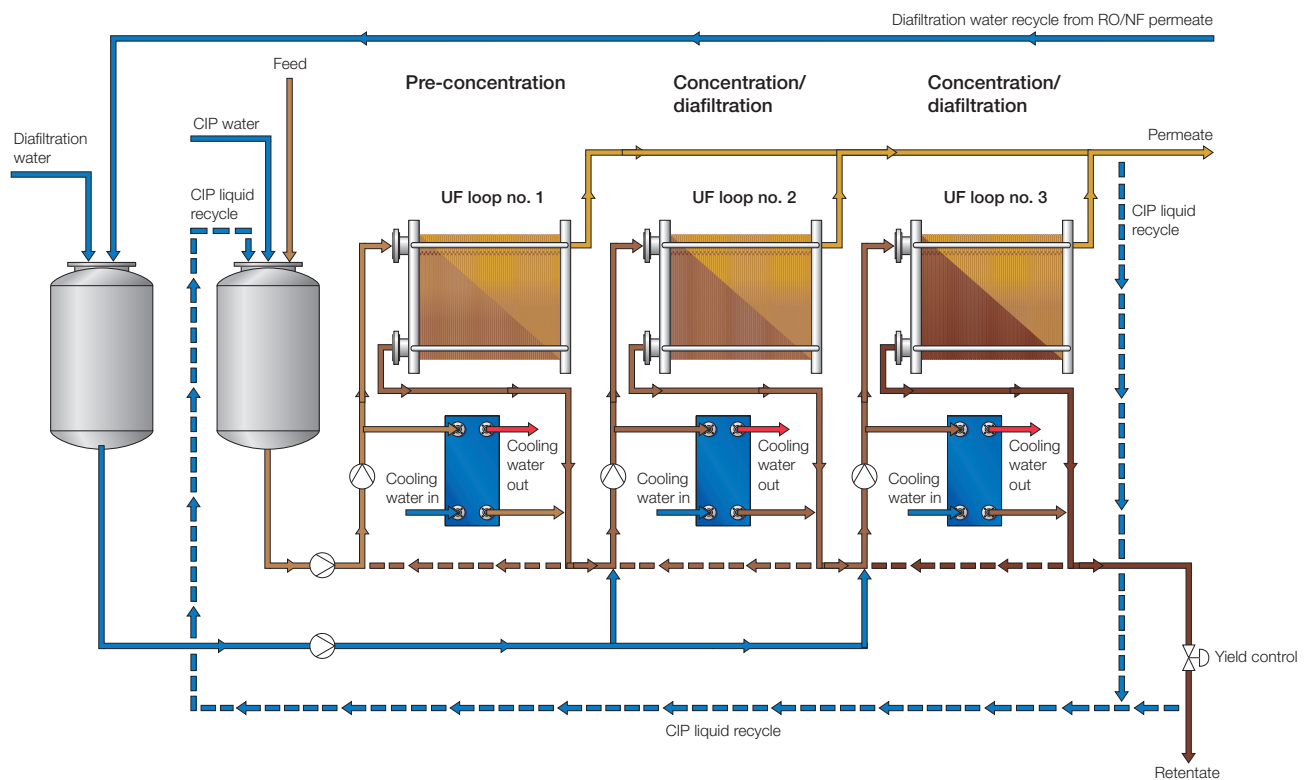


and it is easy to expand if production requirements increase. This means that your investment can follow any required increase in production capacity, as and when you need it – and at relatively low additional cost.



Membrane filtration solutions

Figure 1: Ultrafiltration system incorporating diafiltration



At Alfa Laval, we take pride in supplying our customers with complete, optimized solutions that take every aspect of the process into consideration. These are designed on the basis of feed product composition, production parameters, final product requirements and costs. The solution then selected can be based on Plate & Frame, spiral elements or a combination of both.

Spiral booster unit increases capacity by 50%

"When we had reached the limits of our capacity, Alfa Laval provided us with an alternative to extending the drying unit – by installing a "booster unit" in the form of a spiral section prior to the existing Plate & Frame unit".

This spiral-wound membrane filtration unit undertakes preliminary concentration of the blood plasma sent from the Danish Crown slaughterhouses, and increases the protein content from 7 to 8.5%. This means that we

can now boost our production capacity by 50% – without making any changes to the drying unit. Obviously, it's much cheaper to remove water by simply filtering it out, rather than having to use a relatively costly drying process to remove it. An extra bonus is that the spiral membrane unit doesn't take up any floor space – we were able to just mount it on the wall in the filtration room."

Svend Aage Christensen, Plant Manager, Edidan/Danish Crown, Denmark



Figure 2: Reverse osmosis or nanofiltration system with option for permeate recycling to upstream ultrafiltration process.

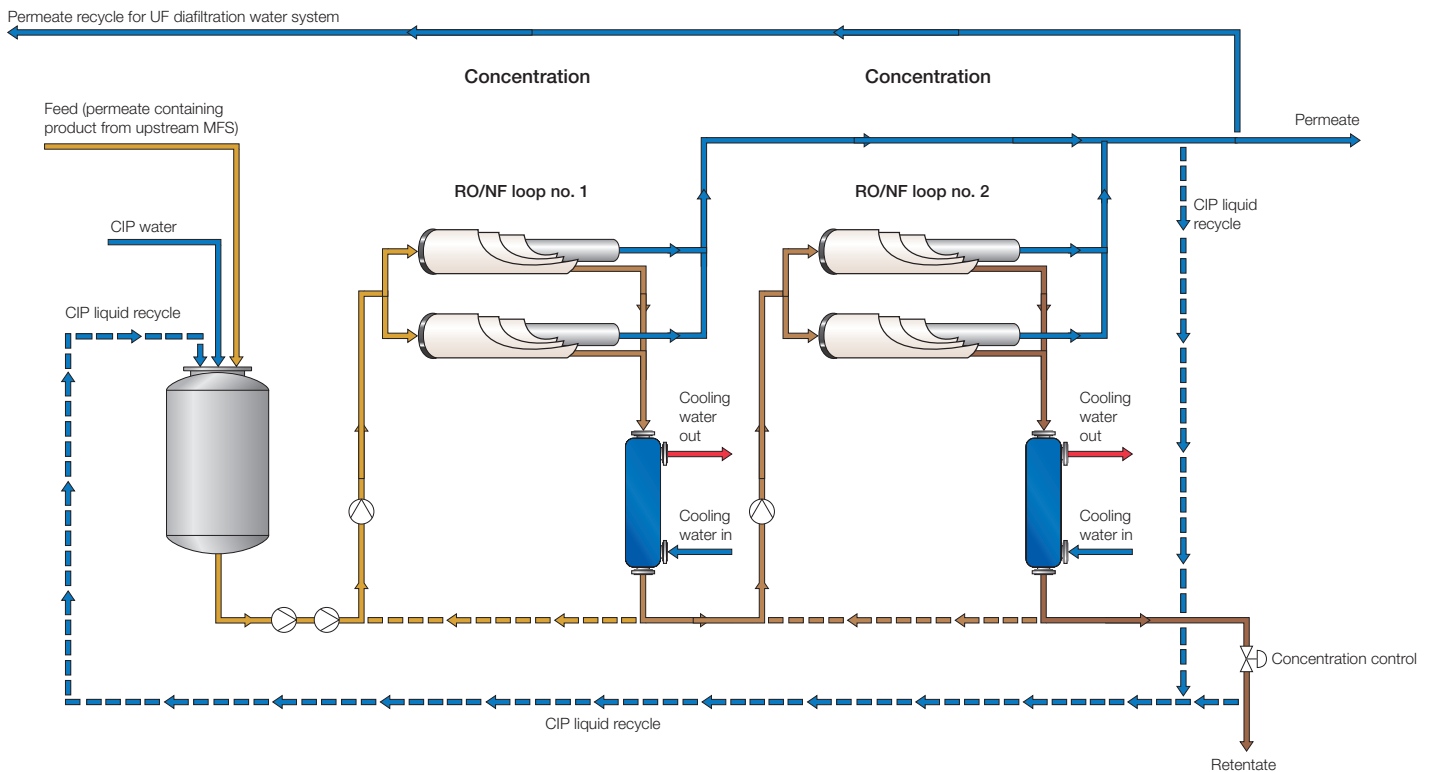


Figure 1 shows a Plate & Frame process, which is often used to process high suspended solids and viscous feed solutions.

Typical applications include the recovery of antibiotics from whole broth, concentration of enzymes and dextrans and clarification of juice.

Figure 2 illustrates a spiral system of the kind typically used for applications such as the concentration of

antibiotics, enzymes, yeast extract, egg white and juice, as well as for reducing the alcohol content in beer.

The system can also be equipped with ultrafiltration or microfiltration spiral membranes for concentration, clarification and purification.

The processes in figures 1 and 2 can also be combined, which gives the advantage of using permeate from the spiral process as diafiltration water in the Plate & Frame process. This reduces the need for process water.

Don't forget:

- Pre-treatment – to reduce fouling
- Automation – to secure the best overall plant operation
- Cleaning procedure – to promote optimum membrane performance

Membrane filtration can be used in a wide range of different processes. Alfa Laval's experience in this field dates back as far as the mid-sixties, soon after membrane filtration was introduced on a commercial scale. Our many reference installations can be found across a wide range of industries, which include:

Antibiotics

Recovery and purification of different antibiotics, including lactams, aminoglycosides, polypeptides, tetracyclines and macrolides. For increased efficiency and higher product quality.

Enzymes

Concentration, purification and desalting following fermentation. Can also be used to recover enzymes from animal or plant tissue. For higher concentration and purity with a minimum loss of activity.

Dextrans

Concentration and purification in one process at low cost.

Pyrogen removal

For high product quality and reduced contamination problems.

Yeast extract

Concentration and purification, with recycling of permeate. High purity at minimum operating costs.

Beer

Dealcoholization, which typically involves reducing alcohol content by a factor of 8–10 and provides a quality in line with standard beer at low cost. Filtration of beer as alternative to traditional kieselguhr or diatomaceous earth filtration for high beer quality with no waste disposal. Sterile filtration of beer prior to packaging for high shelf-life with no heat impact.

Food gums

Concentration and purification of substances such as carrageenan, agar, agarose, xanthan and pectin, with recycling of permeate. Inexpensive and reliable way to remove water and low molecular weight impurities.



**Juice**

Clarification and concentration of apple, strawberry, orange, blackcurrant, pear, hawthorn, pineapple and date juices. For high-quality products at low operating costs and with a minimum use of additives.

Eggs

Concentration and purification of egg white and whole egg. Dewatering of egg white prior to drying. For gentle treatment and high-quality products.

Sugar

Removal of haze and colour from sugar syrup. Concentration of sugar water. Environmentally friendly process that results in highly uniform products.

Animal blood plasma

Concentration and purification of blood plasma, with recycling of permeate. For high-quality product at low operating temperatures.

Gelatine

Fractionation, concentration and purification. For gentle processing to avoid denaturing.

Vinegar

Substitution of many steps in the traditional clarification/filtration process. Reduces storage time and requires no use of filter aids.

In addition to these specific applications, we are continuously developing and expanding our know-how in these fields. Our experience with membrane filtration can bring significant advantages to many industrial processes.



The product range

Membranes

The range of membranes from Alfa Laval covers all filtration processes – reverse osmosis, nanofiltration, ultrafiltration and microfiltration. They are resistant to high temperatures and a wide pH range. All materials comply with EU Commission Directive 90/128 EEC + amendments and FDA regulations (CFR), Title 21.

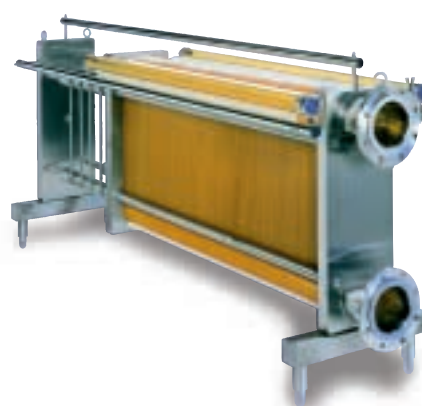
Our range of flat sheet membranes is available by the metre, as 20x20 cm sheets and for all Alfa Laval Plate & Frame configurations. We have a comprehensive range of spiral elements, with different combinations of membrane, diameter, length and spacer. The spiral elements all feature a full-fit sanitary design.

Membrane filtration systems

Alfa Laval designs, manufactures and installs complete cross-flow membrane filtration systems. These can be based on either our unique Plate & Frame modules or on spiral elements of varying sizes. For some applications, a combination of both types can be used to give the best possible solution.

We develop our systems in close cooperation with customers and can provide batch and continuous operation as well as sanitary and industrial design. Validation support is available, as is support in installation and commissioning.

Alfa Laval Plate & Frame modules are designed to handle a wide range of viscosities and can therefore match varying feed product characteristics. Our spiral modules are a compact, inexpensive solution that is easy to use.



Pilot laboratory equipment

In order to ensure the optimum solution, it is often advisable to conduct experiments on a small scale. These can be used to establish process feasibility, determine design data for scale-up, optimize existing production lines or even carry out small-scale processing of high-value/low-volume products.

Alfa Laval provides pilot laboratory equipment both for testing on site in connection with other process equipment and for testing at our own state-of-the-art pilot facilities in Nakskov, Denmark. In both cases, we also provide highly skilled process consultancy services.





Reliable performance

Through 16 years of collaboration, Alfa Laval has installed, restored and replaced a number of membrane filtration systems. "For us, the important things are an informal yet close collaboration, mutual trust, willingness to cope with problems, and a high degree of professionalism.

It is a pleasure to work with a company that acts like a real partner, rather than a mere supplier. It's exactly what we're trying to provide for our own customers."

*Tomasz Cieslewski, site manager,
Lonza Biotec, s.r.o., Czech Republic*

Service and spare parts

To ensure maximum benefit from membrane filtration systems, it is important that customers plan service intervals carefully and use the right spare parts.

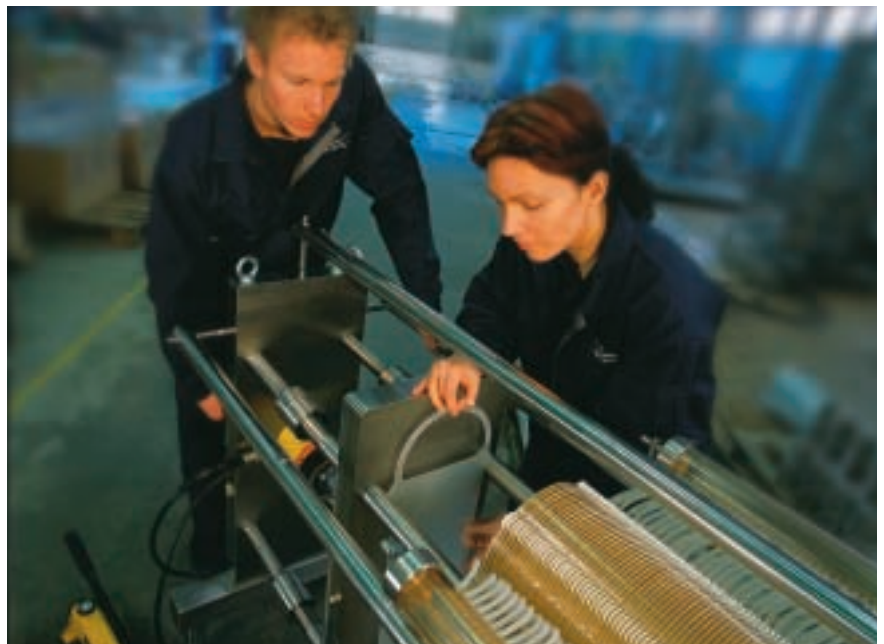
Using Alfa Laval service programmes and genuine spares helps ensure:

- better plant economics
- maximum service efficiency
- more reliable operations

To do this, Alfa Laval provides customers with:

- tailor-made Alfa Laval service agreements. These can include performance analysis, upgrading, remembraning and operator training.
- membrane replacement using genuine top-quality membranes and other spare parts
- plant component audits that help boost both output and quality
- appropriate Cleaning-in-Place (CIP) procedures to ensure optimum performance at all times

The Alfa Laval Parts & Service organization ensures customers a highly efficient service and spare parts infrastructure with visible bottom-line benefits.



This overall concept is called Alfa Laval Nonstop Performance, and aims at ensuring that our customers' processes always run at peak performance.



Membrane filtration and Alfa Laval



Complete familiarity

Buying membrane filtration solutions from Alfa Laval means you are tapping into the know-how and experience that comes from complete familiarity with every step of the process. The expert Alfa Laval staff are probably unique in their ability to address your needs at whatever stage of the process chain. This is because we ourselves develop, manufacture, install and service the membrane filtration systems.

And with experience extending as far back as 1965, Alfa Laval specialists can develop and fine-tune a solution that meets your exact needs, combining your expertise in your particular field of processing with our unparalleled membrane filtration know-how.

Complete consistency

When you include membrane filtration technology in your process solutions, you need to know that you can rely on it completely.

At Alfa Laval, we can be sure of the quality of the membranes we provide. We are one of the few companies in this field with the capacity, expertise and experience to manufacture them ourselves.

Completely tested

We are also one of the very few companies in the world that can scale its membrane filtration know-how seamlessly from R&D, testing and trials up to full-scale manufacture, and process implementation that you and your company can rely on – completely.

Alfa Laval has its own extensive test facilities in Nakskov, Denmark. These facilities allow us to invite you to work alongside with our expert staff to develop solutions for your specific process. We also have a wide range of pilot laboratory equipment available if it is more convenient for you to do the work on your own premises.





Membrane filtration crucial for artificial plasma

Serumwerk Bernburg in Germany installed its first membranes from Alfa Laval in 1996, to produce hydroxyethyl starch for medical uses as artificial plasma. Membrane filtration proved to be crucial in the manufacture of pure hydroxyethyl starch. Advanced ultrafiltration membranes are needed to remove by-products and ensure that only molecules of a specific size are retained. It is also important to ensure that the processed products are sterile, and "ultrafiltration at high temperatures is how we

stop the growth of germs, a hugely important criterion for our choice of membranes," says Werner Zimmermann, head of technology at Serumwerk Bernburg. Due to the modular design of the membrane filtration system, it was easy for Serumwerk Bernburg to double the company's production capacity in 2002 and Werner Zimmermann states, "We want to achieve another doubling of capacity next year..."

Werner Zimmermann, head of technology, Serumwerk Bernburg, Germany

Complete spectrum

Alfa Laval can provide customers with solutions from the full spectrum of separation technologies.

This means that when you contact Alfa Laval, you can always be sure of getting a solution tailored to your specific process requirements. At Alfa Laval, we have the capacity and the technology spread to be able to consider all the parameters – knowing that we can provide a highly efficient solution using the best technology for the job. Or a combination of technologies if this will improve the total performance.



Experience counts

Our experience within membrane filtration extends almost as far back as the technology itself – and Alfa Laval solutions give you the full benefit of all that accumulated experience.

Membrane filtration complements our range of other separation technologies and ensures that we are always in a position to provide you with the ideal solution for your particular process. By using membrane filtration alone or in combination with our range of centrifuges, decanters or evaporators.

Size matters

The pores of the membranes used in membrane filtration are so small that they are invisible to the naked eye.

Yet separation on this diminutive scale, working on the basis of molecular size alone, results in benefits that are correspondingly great in importance.

Alfa Laval membrane filtration systems make it possible to achieve a greater degree of purity, higher overall yields and lower costs.

Small size can make a very big difference.



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

