QUALITY PERFORMS.

Reverse osmosis membrane elements for industrial and potable water treatment

Lewabrane®

QUALITY WORKS.

LANXESS
Energizing Chemistry

LEWABRANE®
PREMIUM PRODUCTS FOR EFFICIENT REVERSE OSMOSIS PROCESSES

Just a few years after their market launch, Lewabrane® reverse osmosis membrane elements from LANXESS have become synonymous with quality. The product line includes elements for all the main reverse osmosis (RO) applications, including desalination of seawater, brackish water, and low-salinity water. Key areas of application include the generation and treatment of potable water, but also the treatment of process water, other industrial water, and wastewater.

LANXESS's wide-ranging water treatment expertise lays the foundation for solutions that benefit from pioneering technology. This enables our customers to produce high-quality water both reliably and cost-efficiently. Lewabrane® reverse osmosis membrane elements are the perfect complement to our long-established Lewatit® ion exchange resins and offer users a whole host of possible combinations for customized plant/system configuration.

All Lewabrane® membrane elements are produced as spiral-wound, thin-film composite membrane elements designed specifically for highly efficient, cost-effective treatment of various types of potable and process water. The membranes' properties and the element structure create the basis for optimal operation – hand in hand with other process steps, for example in single-bed or mixed-bed ion exchange units incorporating our Lewatit® products.

Lewabrane® – the root of our success

Even though reverse osmosis is a long-established technology, LANXESS's know-how and innovations deliver significant additional benefits. Little details often prove crucial for the superior operating characteristics of our elements under a variety of conditions. Our scientists and engineers are continuously working on making good products even better.

Excellent production technology is the key to outstanding products for high-quality solutions. Lewabrane® membrane elements are produced at a fully automated production facility in Bitterfeld, Germany, using state-of-the-art technology and in strict compliance with German quality standards. Beginning with the composite membrane – the centerpiece – and extending all the way through to the ready-to-use element. Thanks to a highly cross-linked polyamide layer, our membranes are durable and ensure stable rejection, even in the case of complex salt mixtures.

A full-service package complements our product portfolio. The key element of this scope of supply is our innovative LewaPlus® design software tool, which incorporates all our know-how and project experience. LewaPlus® supports integrated handling of reverse osmosis, ion exchange, and combinations of the two. By offering the possibility of combining the two technologies in a single design software tool, LANXESS sets new standards – for reliable planning, dimensioning, and checking of your complete water treatment systems. We are able to advise you on the selection and configuration of the optimal/optimized solution for your application. We can also train your operating team and are available to provide advice during day-to-day operations. Furthermore, all our services are supported by our highly capable analytical laboratory, which uses ultramodern methods to test membrane elements as required.

We are your reliable, expert partner for all your water treatment needs.

LANXESS produces Lewabrane® membrane elements at an ultramodern, fully automated facility in Bitterfeld, Germany.

■ **Reverse osmosis membrane elements from LANXESS are used to produce boiler feedwater in power stations (photo: LEAG).**

Wide range of applications

Significant progress in membrane technology in recent years has played a key role in making reverse osmosis a preferred solution for removing salt from all kinds of water. The treatment solution needs to be customized, since quality parameters of the feedwater and user requirements concerning treatment results and system performance differ. Capital and operating costs are key criteria in this regard.

Our Lewabrane® product portfolio covers a wide range of specifications. This is a key prerequisite for achieving an optimized reverse osmosis process as a stand-alone system or in combination with Lewatit® ion exchange resins.

It enables us to meet the requirements of very diverse water treatment applications, including:

- Seawater desalination at municipal plants and industrial facilities
- Production of boiler feedwater for water-steam circuits
- Process water full demineralization and particle removal to produce ultrapure water
- Decentralized water desalination in applications such as car washes, laundries, and ships
- Groundwater remediation and recharging to obtain potable water
- Industrial and municipal wastewater treatment

LANXESS has extensive experience from numerous projects worldwide, especially when it comes to designing and equipping mid-sized facilities with up to several thousand membrane elements.

LEWABRANE®
THE IDEAL SOLUTION FOR ANY APPLICATION

With a length of 40", our RO elements meet the industry standard. In addition, elements with a diameter of 8" have membrane surface areas of between 34.4 m² and 40.9 m², and versions with a diameter of 4" have a surface area of 7.9 m² for smaller facilities.

All RO elements have a fiberglass outer wrap, a brine seal, interconnectors, and universal ATDs (anti-telescoping devices) for standard elements with a diameter of 8" or 4". The elements' special chemical makeup makes them particularly effective in rejecting critical substances such as borates, nitrates, and silica.

Further benefits of Lewabrane® RO elements include:

- Optimized barrier layer chemistry for a high level of cross-linking
- Stable rejection of salt mixtures throughout their element lifetime, even with changing process parameters
- Excellent organic compound rejection
- Long service lives with consistently high performance levels
- Lower biofouling thanks to enhanced feed channel flow

Combined water treatment for greater efficiency

Wherever Lewabrane® membrane elements are used to produce feedwater for downstream ion exchange (IX) processes, the integrated LewaPlus® design software tool is especially effective in unlocking additional efficiency potential because it enables specific dimensioning of the individual purification steps.

Lewabrane® membrane elements also produce a permeate with a consistently low salinity, which minimizes the load on downstream ion exchange processes for a longer service life. The amount of regeneration chemicals required and thus the overall operating costs are also lower.

Certified for potable water treatment

One key area of application for RO membranes is generating potable water from both brackish water and seawater. This takes place at large-scale facilities – often municipal plants – but also in decentralized installations in locations such as restaurants, hotels, or cruise ships. LANXESS has full certification from the U.S. National Sanitation Foundation (NSF) for all Lewabrane® products. This attests that the RO elements have been evaluated and deemed suitable for use in potable water treatment plants. Other potable water certifications have also been obtained.

Use in desalination of brackish water

LANXESS currently offers four product lines with Lewabrane® elements for treating brackish water:

- Brackish water high-rejection (B HR) type with high salt rejection (99.7% under standard conditions*) for optimal permeate quality
- Brackish water high-flow (B HF) type, combining high flow productivity with good salt rejection
- Brackish water fouling-resistant (B FR) type to reduce fouling
- Brackish water low-energy and ultra low pressure (B LE and B ULP) types for energy-efficient use

Certified to NSF/ANSI 61

*2,000 mg/l NaCl, 15.5 bar, 25 °C, pH 7, yield: 15%.

For quality assurance purposes, each individual Lewabrane® product is checked in an element tester.

Use in treatment of surface water and wastewater (brackish water FR types)

Lewabrane® FR (fouling-resistant) membrane elements are developed specifically for water with a high level of biological, inorganic, and especially organic fouling, which encourages the growth of, for example, algae and bacteria.

A special feed spacer is incorporated in the elements to reduce fouling. At 0.86 mm (34 mil), it creates a thicker feed channel than standard components, which enables solutes and in particular dispersed particles to flow through more easily.

This helps prevent particles from being deposited, which makes the elements easier to clean and gives them a longer service life.

The thicker feed channel also results in a lower pressure drop through the membrane element. FR elements are based on a 15.5 bar test pressure and are available with diameters of both 4" and 8". They are ideal for treating surface water and wastewater. The salt rejection is around 99.5% for most types under standard conditions but around 99.7% for FR ASD (alternating strand design) types.

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Energy-efficient use with low-salinity water (brackish water LE/ULP types)

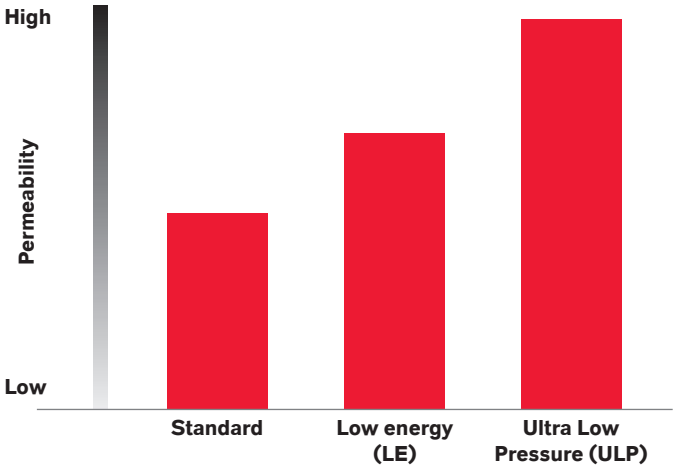
State-of-the-art, technologically sophisticated Lewabrane® membrane elements make RO inherently highly energy-efficient. Optimized membrane polymer chemistry combined with design measures make it possible to further improve this energy efficiency. Even at low operating pressures, high flow rates and a remarkable salt rejection of 99.5% can be achieved under standard conditions.

The LE (low energy) products in the Lewabrane® range are recommended in particular for low-salinity applications where energy consumption is an important consideration, for example in the case of decentralized use with limited energy resources.

LE elements benefit from a highly efficient, exceptionally thin polyamide membrane barrier layer. Even at high flow rates, good flow productivity is combined with excellent salt rejection that is a result of the membrane's high level of cross-linking. Like FR types, LE elements are used in difficult process flows, so they are also equipped with a thicker feed spacer to reduce fouling and make cleaning more effective. The elements are based on a 10.3 bar test pressure and are available with membrane surface areas of 7.9 m² (4") and 37.2 m² (8"). LE elements with an area of 40.9 m² have a 0.7 mm (28 mil) feed spacer and are specifically designed for second-pass applications of RO systems.

The latest addition to the Lewabrane® portfolio are ULP (ultra low pressure) elements based on a test pressure of just 7.6 bar. As with LE types, special feed spacers are used that are less likely to become blocked.

Enhanced permeability of ULP elements compared with standard and LE elements used in brackish water



The barrier layers have a lower level of cross-linking than in LE types. ULP elements are available with diameters of 4" or 8" and with membrane surface areas of 7.9 m² or 40.9 m². Their salt rejection under standard conditions is 99.5%.

ULP elements are ideal for purification of low-salinity water during potable water treatment. They help reduce the water's nitrate content, for example. These elements can also be used for the final stage of wastewater treatment after biological purification to remove low-molecular organics such as active pharmaceutical and agrochemical ingredients, X-ray contrast agents, and industrial chemicals that would otherwise pollute the environment.

ASD elements with innovative feed spacer for even better performance

The development of a feed spacer for RO elements that quickly made the transition from research laboratory to market proves that there is always room for further development. Based on an alternating strand design (ASD), three types of RO elements currently incorporate this innovative feed spacer:

- Lewabrane® B400 ULP ASD
- Lewabrane® B400 LE ASD
- Lewabrane® B400 FR ASD

Successful development partnership

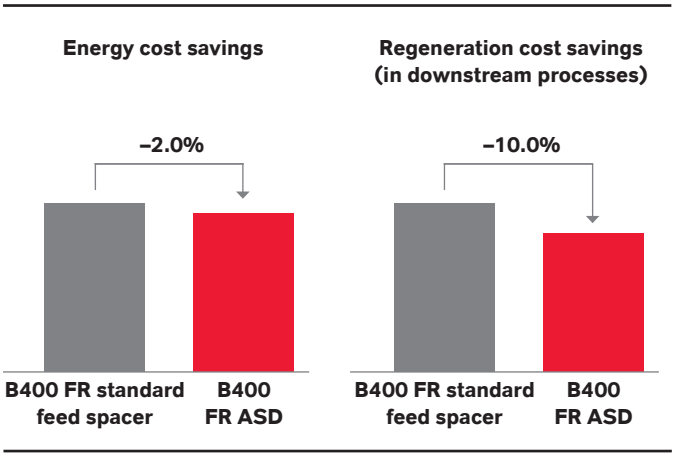
The ASD elements were developed as part of a cooperative research project involving LANXESS and a number of partners. Due to the multifunctionality of the feed spacers, the researchers needed to solve a complex optimization challenge. Feed spacers create space between the membrane surfaces for the flowing water and also produce a turbulent water flow. Although a turbulent flow helps to reduce the extent of concentrate polarization and thus to lower salt concentrations at the surface of the membrane, it also causes an increased pressure drop. The feed spacer design therefore plays a key role in determining the membrane elements' properties. The feed spacers of ASD elements are made up of alternating strands of different thickness. They also get their name from this alternating strand design (ASD). The structure lowers the number of low-flow areas, which reduces biological growth and facilitates cleaning. This makes ASD feed spacers the perfect compromise for reduced concentrate polarization and a low pressure drop.

Computational fluid dynamic (CFD) simulations had previously indicated that RO elements with ASD feed spacers would be capable of achieving higher performance levels. Tests on prototypes confirmed these simulations and independent testing proved that using an ASD feed spacer reduces biofouling. Experiments revealed an operating period over 30% longer before cleaning was required.

LewaPlus® design software was used to calculate operating costs based on the example of wastewater treatment and indicate the potential savings achievable when using Lewabrane® B400 FR ASD. In the example under consideration*, energy costs fell by 2% and regeneration costs by 10%.

* 5 x 126 elements, three stages, 20 °C, pH 7.5, TDS: 500 mg/l, feed: 160 m^3/h, yield: 84%, downstream mixed-bed ion exchange: Lewatit® MonoPlus S108H/ Lewatit® MonoPlus M500 MB.

Operating cost savings based on a sample wastewater treatment facility



Our customers' experiences with ASD products in the field confirm these projections. Many customer cases attest the capability of the ASD technology.

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Use in seawater desalination

Optimizations based on design and polymer chemistry have helped reverse osmosis become the most efficient and most widely used seawater desalination technology. Lewabrane® S types cater specifically to the requirements of high-salinity water.

- Seawater high-rejection (S HR) type with high salt rejection (99.8% under standard conditions*), specifically for single-pass desalination systems
- Seawater high-flow (S HF) type, specifically for double-pass processes, which are optimized for low energy consumption and exhibit a high permeate flow rate (S400 HF, 9,000 gpd*)

The high boron rejection** of 99.3% (S HR) respectively 99.2% (S HF) is worth noting and particularly important for potable water treatment. With these two membrane types we are able to fulfill the requirements for the different seawater qualities in various parts of the world. For example, HF types offer significant benefits in the Atlantic region and in Asia/Oceania, where the total quantity of dissolved substances is relatively low. Due to the higher salinity in the Persian Gulf and the Red Sea, HR types are more suitable here. The two types of elements can also be combined in a single pressure vessel to create hybrid systems for specific requirements.

*32,000 mg/l NaCl, 55.2 bar, 25 °C, pH 8, yield: 8%.

**Test conditions: 32,000 mg/l NaCl, 5 mg/l boron, 55.2 bar, 25 °C, yield: 8%.

The membranes are based on a three-layer composite structure that is manufactured in several stages. A single Lewabrane® membrane element consists of a bundle with more than 20 membrane layers. This final spiral-wound element is created in a fully automated production process.

LEWAPLUS®
DESIGN SOFTWARE

LewaPlus® design software is a comprehensive design, simulation, and analysis tool for water treatment systems using RO and/or IX. It supports the design of both separate and combined facilities with Lewabrane® RO membrane elements and Lewatit® ion exchange resins. Innovative data management makes it possible to use RO flow rates and permeate composition as ion exchange parameters and vice versa. The software also provides direct access to technical information, i.e.:

- Product data sheets for all Lewatit® and Lewabrane® types
- Safety data sheets for Lewatit® products
- Product Scout selection tool for Lewabrane® elements and Lewatit® resins

LewaPlus® currently includes modules for the following applications:

- Brackish water and seawater desalination with RO
- Batch processes for RO (Closed Circuit Reverse Osmosis = CCRO™)
- Full demineralization with mixed-bed IX
- Softening and decarbonization with IX
- Condensate polishing with IX
- Review of current full demineralization filter systems

The diverse functions of the RO module extend far beyond calculations for single- and double-pass designs and also include, for example:

- Hybrid element installation in the pressure vessel
- Calculating post-RO permeate treatment (e.g. adjusting pH, remineralization) to control the addition of chemicals
- Integrated access to technical service bulletins and normalization software
- Energy assessment of different configurations by calculating the actual energy consumption (kWh/m^3 permeate) in the RO system
- Capital and operating cost calculation (CAPEX/OPEX/NPV) taking into account typical project parameters (cost of capital, raw materials, energy, chemicals, etc.) for a comprehensive evaluation of the price of water

LewaPlus® can be downloaded free of charge at www.lpt.lanxess.com, and is currently available in 11 languages. The software is already actively utilized by over 6,000 users all over the world, and they are joined by hundreds of new users every year. It is fully functional offline, that is to say without an Internet connection, and is compatible with later versions of Windows, Linux, and Mac OS X operating systems. If you have any questions, do not hesitate to contact our LewaPlus® support team at lewaplus@lanxess-info.com.

TECHNICAL DETAILS OF THE LEWABRANE® PRODUCT FAMILY

RO element model	Permeate flow	Salt rejection	Membrane area	Feed spacer thickness	Dimensions
Brackish water membranes					
High Rejection (HR)*					**(L/Ø/CD)**
B370 HR	35.3 m^3/day	99.7%	34.4 m^2	0.8 mm	1,016/201/29 mm
	9,300 gpd	99.7%	370 ft^2	31 mil	40/7.9/1.125 inches
B400 HR	37.9 m^3/day	99.7%	37.2 m^2	0.8 mm	1,016/201/29 mm
	10,000 gpd	99.7%	400 ft^2	31 mil	40/7.9/1.125 inches
B440 HR	41.7 m^3/day	99.7%	40.9 m^2	0.7 mm	1,016/201/29 mm
	11,000 gpd	99.7%	440 ft^2	28 mil	40/7.9/1.125 inches
High Flow (HF)*					**(L/Ø/CD/OD)**
B085 HF 4040	8.9 m^3/day	99.5%	7.9 m^2	0.8 mm	1,016/100/19 mm (OD)
	2,400 gpd	99.5%	85 ft^2	31 mil	40/3.9/0.75 inches
B400 HF	39.9 m^3/day	99.5%	37.2 m^2	0.8 mm	1,016/201/29 mm
	10,500 gpd	99.5%	400 ft^2	31 mil	40/7.9/1.125 inches
B440 HF	43.9 m^3/day	99.5%	40.9 m^2	0.7 mm	1,016/201/29 mm
	11,600 gpd	99.5%	440 ft^2	28 mil	40/7.9/1.125 inches
Fouling Resistant (FR)*					**(L/Ø/CD/OD)**
B085 FR 4040	8.9 m^3/day	99.5%	7.9 m^2	0.86 mm	1,016/100/19 mm (OD)
	2,400 gpd	99.5%	85 ft^2	34 mil	40/3.9/0.75 inches
B370 FR	37.2 m^3/day	99.5%	34.4 m^2	0.86 mm	1,016/201/29 mm
	9,800 gpd	99.5%	370 ft^2	34 mil	40/7.9/1.125 inches
B400 FR ASD	41.5 m^3/day	99.7%	37.2 m^2	0.86 mm (ASD)	1,016/201/29 mm
	11,000 gpd	99.7%	400 ft^2	34 mil (ASD)	40/7.9/1.125 inches
B400 FR	39.9 m^3/day	99.5%	37.2 m^2	0.86 mm	1,016/201/29 mm
	10,500 gpd	99.5%	400 ft^2	34 mil	40/7.9/1.125 inches
Low Energy (LE)**					**(L/Ø/CD/OD)**
B085 LE 4040	7.4 m^3/day	99.5%	7.9 m^2	0.86 mm	1,016/100/19 mm (OD)
	2,000 gpd	99.5%	85 ft^2	34 mil	40/3.9/0.75 inches
B400 LE	34.8 m^3/day	99.5%	37.2 m^2	0.86 mm	1,016/201/29 mm
	9,200 gpd	99.5%	400 ft^2	34 mil	40/7.9/1.125 inches
B400 LE ASD	36.2 m^3/day	99.5%	37.2 m^2	0.86 mm (ASD)	1,016/201/29 mm
	9,600 gpd	99.5%	400 ft^2	34 mil (ASD)	40/7.9/1.125 inches
B440 LE	38.3 m^3/day	99.5%	40.9 m^2	0.7 mm	1,016/201/29 mm
	10,100 gpd	99.5%	440 ft^2	28 mil	40/7.9/1.125 inches
Ultra Low Pressure (ULP)***					**(L/Ø/CD/OD)**
B085 ULP 4040	8.2 m^3/day	99.5%	7.9 m^2	0.86 mm	1,016/100/19 mm (OD)
	2,150 gpd	99.5%	85 ft^2	34 mil	40/3.9/0.75 inches
B400 ULP ASD	38.6 m^3/day	99.5%	37.2 m^2	0.86 mm (ASD)	1,016/201/29 mm
	10,200 gpd	99.5%	400 ft^2	34 mil (ASD)	40/7.9/1.125 inches
B440 ULP	42.6 m^3/day	99.5%	40.9 m^2	0.7 mm	1,016/201/29 mm
	11,300 gpd	99.5%	440 ft^2	28 mil	40/7.9/1.125 inches

RO element model	Permeate flow	Salt rejection	Membrane area	Feed spacer thickness	Dimensions
Seawater membranes					
High Rejection (HR)****					**(L/Ø/CD/OD)**
S085 HR 4040	5.2 m^3/day	99.8%	7.9 m^2	0.8 mm	1,016/100/19 mm (OD)
	1,380 gpd	99.8%	85 ft^2	31 mil	40/3.9/0.75 inches
S400 HR	24.6 m^3/day	99.8%	37.2 m^2	0.8 mm	1,016/201/29 mm
	6,500 gpd	99.8%	400 ft^2	31 mil	40/7.9/1.125 inches
S440 HR	27.3 m^3/day	99.8%	40.9 m^2	0.7 mm	1,016/201/29 mm
	7,200 gpd	99.8%	440 ft^2	28 mil	40/7.9/1.125 inches
High Flow (HF)****					**(L/Ø/CD/OD)**
S085 HF 4040	7.2 m^3/day	99.8%	7.9 m^2	0.8 mm	1,016/100/19 mm (OD)
	1,910 gpd	99.8%	85 ft^2	31 mil	40/3.9/0.75 inches
S400 HF	34.1 m^3/day	99.8%	37.2 m^2	0.8 mm	1,016/201/29 mm
	9,000 gpd	99.8%	400 ft^2	31 mil	40/7.9/1.125 inches
S440 HF	37.5 m^3/day	99.8%	40.9 m^2	0.7 mm	1,016/201/29 mm
	9,900 gpd	99.8%	440 ft^2	28 mil	40/7.9/1.125 inches

Test conditions:

* 2,000 mg/l NaCl, 15.5 bar (225 psi), 25 °C (77 °F), pH 7, yield 15%.
** 2,000 mg/l NaCl, 10.3 bar (150 psi), 25 °C (77 °F), pH 7, yield 15%.
*** 500 mg/l NaCl, 7.6 bar (110 psi), 25 °C (77 °F), pH 7, yield 15%.
**** 32,000 mg/l NaCl, 55.2 bar (800 psi), 25 °C (77 °F), pH 8, yield 8%.

More detailed data sheets for all Lewabrane® products as well as reference lists, case studies, and technical documentation are available to download at www.lewabrane.com.

Dimensions:

L = length
Ø = diameter
CD = center pipe inner diameter, 8" element
OD = outer diameter, 4" element

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