

DuPont Water Solutions for Oil & Gas – Injection Water

DuPont innovative portfolio of water technologies for high performing and sustainable onshore and off-shore systems



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About DuPont Water Solutions

Companies, communities and homes around the world choose DuPont Water Solutions to help make water safer and more accessible. Industries and markets count on us to become more efficient. Our innovation and collaboration with the world's best water experts enables ecosystems of innovation to deploy vital technologies in new, market-shaping ways.

With a global network of accessible knowledge and a market-leading portfolio of purification and separation technologies, we enable the water productivity from which health, profits, and possibilities spring. In a world of increasing water scarcity, we provide a proven path that balances resource productivity and responsibility.



Our products are based on decades of industry leadership, and include ion exchange resins, reverse osmosis nanofiltration technology, ultrafiltration membranes, degasification modules and wastewater treatment products, with globally recognized brands like FilmTec™ Fortilife™, Memcor™ and the Amber series to meet your water, waste and other separation needs.

We provide support to markets and industries across the globe, including residential, municipal, power generation, oil & gas, healthcare, commercial industries, chemical & petrochemical, food & beverage and microelectronics, for a wide range of applications as well as minimal liquid discharge (MLD) consultancy.

Unmatched in our global reach, industry experience and expertise, our focus and dedication places us in a unique position to help industries, organizations, and communities prosper. We offer the broadest portfolio in the water treatment technology industry and provide leading innovations.

The broadest Portfolio in the industry

Water is the largest volume by-product of Oil & Gas production and requires treatment for use, reuse and discharge. To improve productivity, water with specific quality requirements is injected into the well for secondary and tertiary recovery. For discharge, the organic load (expressed as BOD, COD, TOC or oil & grease) is usually a limit for wastewater disposal permits.

needs. Like no other supplier, we can provide ultrafiltration (UF), reverse osmosis (RO) elements, sulfate-removal nanofiltration (NF) membranes, degassing membranes and Wastewater solutions like membrane bio-reactor (MBR), polymeric adsorbents and selective ion exchange resins (IX). The use and details of these products are further described in this brochure, providing a sample of our expertise and growing portfolio of technologies that targets the unique needs of hydrocarbon exploration and production.

From injection to produced water, we provide a complete set of treatment technologies to handle oil and gas production

	Memcor® MBR & UF	inge® Multibore® UF Membranes	DesaliTec™ CCRO	DuPont™ Ligasep™ Degasification Modules	
Wastewater					Ultrapure Water
	OxyMem MABR	DuPont™ IntegraFlux™ Ultrafiltration	FilmTec™ Reverse Osmosis Nanofiltration	Amber Series Ion Exchange Resins	DuPont Electrodeionization

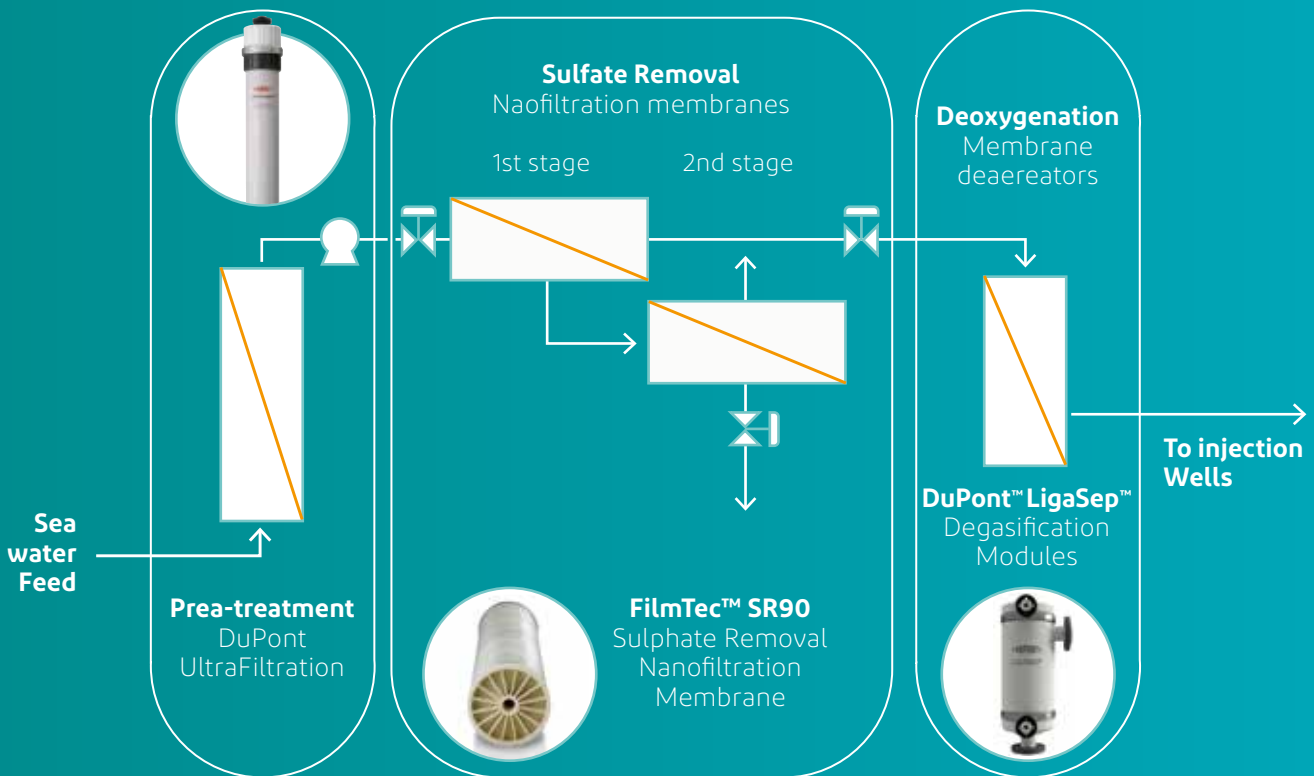
Injection Water

Experience lower costs and increased oil production with effective treatment for injection water

The prevention of sulfate scale precipitation is a major concern for oil and gas producers looking to extract most out of the wells, reduce costs, protect downstream equipment and mitigate safety and environmental risks. Since Injection

water quality is critical to improve oil recovery, DuPont™ Water Solutions provides membranes to be placed in the various steps of injection water systems to guarantee a safe and reliable operation.

Product Portfolio





Pretreatment for particle removal

DuPont with its patented technology has been a pioneer of low selective nanofiltration (NF) membranes used in the Oil & Gas to treat seawater for injection into oil reservoirs. We have vast experience of treating sea water and knowledge of fouling behavior of such water as it impacts the performance of NF membranes.

Proper pretreatment is a critical success factor for long-term performance of Sulfate Removal Units (SRUs). In operations that directly inject seawater (without employing an SRU), components in the seawater can instead cause plugging problems in the oil formation. In both cases, reliable pretreatment can provide effective and stable operations, helping to reduce downtime.

Designs of an offshore platform must consider important factors for pretreatment systems:

- Quality of filtrate & particle removal (algae, bacteria, sand).
- Footprint
- Weight
- Consistent and continuous operation
- Simple operation

DuPont Ultrafiltration carries a wide offering of Ultrafiltration (UF) products that are advantageous in meeting these needs.

DuPont Ultrafiltration Portfolio for Onshore and Offshore Applications

Product	Design	MEV/Single	Cleaning mechanism	Footprint
Integraflo™ Ultrafiltration Modules	Vertical	Both	Air Scour	Low
Integrated Ultrafiltration (iUF)	Vertical	Integrated MEV	Air scour/Backwash	Low
MEMCOR® P20N	Vertical	MEV	Backwash	Low
dizzer® L 0.9 MB 40 PB	Horizontal	Single	Backwash	Standard
dizzer® L 0.9 MB 55	Horizontal	Single	Backwash	Standard
dizzer® XL 0.9 MB 90 HP	Vertical	MEV	Backwash	Low
T-Rack® HP	Vertical	Integrated Single	Backwash	Standard

Pressure rating aligned to offshore requirement

DuPont can provide UF with both configurations: multi-element vessel (MEV) or single-element racks, both capable of delivering pressure rates aligned to various platforms needs. The MEV consists of a pressure vessel with unique adaptor to house multiple ultrafiltration modules operating in parallel. It has a reduced footprint due to better packing and elimination of piping manifolds, which provides better access and less maintenance. Apart from vertically-stacked MEV systems, DuPont also provides UF cartridges that can fit into standard horizontal pressure vessels, organized similarly to a RO system, being a more flexible option for pre-built systems.



Diversity in fiber chemistry

DuPont offers both elements with PVDF (polyvinylidene fluoride) and PES (polyethersulfone) fibers. PVDF membranes offer high chemical resistance and are tolerant to temperature variation, promoting longer module life. Hollow-fiber PVDF membranes will provide exceptionally high filtrate quality at very stable and long-term filtration operation.

On the other hand, PES elements can provide higher fluxes. The Multibore® fibers have outstanding resistance against breakage. Not a single fiber breakage incident has occurred since Multibore® was first launched and is therefore the optimum choice for maximum operating reliability.

Backwash requirements

Our variety of products allow customers to select which of the different cleaning requirements better suit their demand, being space, equipment performance or system reliability. For instance, multi-element vessels do not require to

carry-out backwash, Multibore® membranes does not need air scouring during backwash or you may use air scouring with XP Fibers for maximum recovery.

Sulfate Removal Nanofiltration

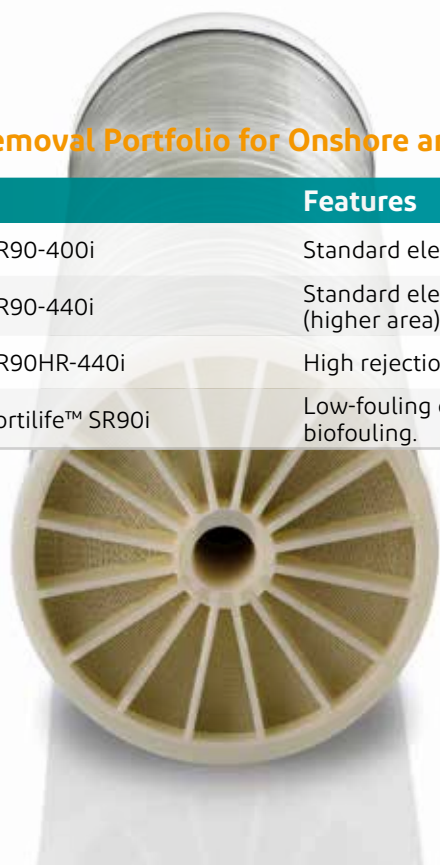
DuPont has been in the Oil & Gas industry since 1987, when we introduced the first Nanofiltration membranes for sulfate mitigation in the North Sea, while patenting this application. Our ion selective NF membranes have been used for all these years to treat seawater prior to injection into oil reservoirs. They remove sulfates to prevent and control reservoir scaling and souring.

There are two main advantages from Sulfate Removal Units (SRUs):

- Removal of sulfate eliminates the main components from injection water that causes scale formation thus reducing or eliminating this problem.
 - By removing the sulfate in the injected seawater- the source of sulfur that is converted to hydrogen sulfide by sulfate reduction- bacteria is eliminated, contributing to souring mitigation inside the wells.
- The FilmTec™ SR90 family is the first and best option to selectively remove sulfates from seawater used for water-flooding injection operations.

Sulfate Removal Portfolio for Onshore and Offshore Applications

Product	Features
FilmTec™ SR90-400i	Standard element with excellent permeability, ideal for cold-water SRU systems
FilmTec™ SR90-440i	Standard element with excellent permeability, ideal for cold-water SRU systems (higher area)
FilmTec™ SR90HR-440i	High rejection element for demanding requirements in water permeate quality
FilmTec™ Fortilife™ SR90i	Low-fouling element with enhanced chemical resistance for systems prone to biofouling.



Why should you choose FilmTec™?

- DuPont FilmTec™ SR90 has been the pioneer and has the longest track record in Sulphate Removal for Offshore EOR.
- DuPont Water Solutions has more than 30 years of operational experience and excellence.
- DuPont has a list of references from 80+ units in offshore with successful operation.
- More than 80,000 FilmTec™ SR90 elements installed worldwide.
- More than 12 MM BWPD installed capacity.
- Long Term Partnership with leading System Integrators
- Largest portfolio of sulphate removal membranes in the market.

A solution for every problem



High productivity elements for efficient operation: FilmTec™ SR90-440i Nanofiltration Element



High rejection elements for high quality permeate: FilmTec™ SR90HR-440i Nanofiltration Element



Nanofiltration elements with an antifouling design for sustained operation in biofouling prone areas: FilmTec™ Fortilife™ SR90i Nanofiltration Element

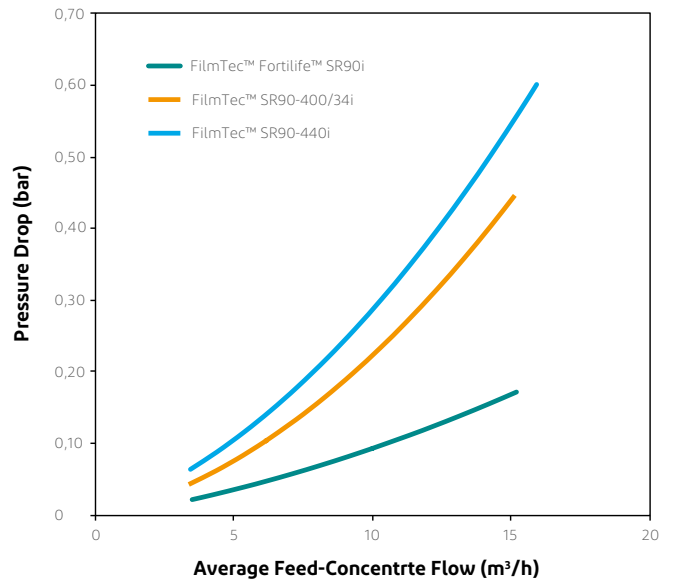
FilmTec™ Fortilife™ SR90i

The Next Generation of Low Fouling elements for Sulfate Removal

FilmTec™ Fortilife™ SR90i

Elements are specifically designed to handle biofouling in sulfate removal systems in oil production. These elements are equipped with advanced fouling resistant and cleanability features, helping plants reduce the number of cleanings, while maintaining high sulfate rejection and permeability. With FilmTec™ Fortilife™ SR90i operators can expect to improve SRU operations by reducing maintenance costs and downtime on offshore platforms, made possible by:

- Fouling-resistant technology reducing cleanings by 50%.
- Low differential pressure.
- Durable membrane chemistry.
- More effective and efficient cleaning of biofilm and organic compounds.



Desalination for Low-salinity Injection

Low Salinity Waterflooding is one of the emerging oil enhanced recovery (EOR) techniques which has gained popularity in the past decade.

The injection of low-salinity water into aging oil reservoirs has been found to enhance oil recovery compared to the more traditional high-salinity water injection. The improvement is brought by the alterations to the wettability of the rock formations which oil occupies. Typically, the salinity used in this type of management strategy requires concentrations of 0.1 % to 1% salinity, depending on oil-well chemistry. The incremental oil recovery was attributed to redirection of clay swelling and plugging of pore spaces available to oil and water.

DuPont carries a range of **reverse osmosis and nanofiltration membranes** that can achieve the desired water quality for successful low-salinity injection.





Membrane Degasification

When industrial equipment is in contact with water used in the process or water is used as an ingredient for the production, oxygen and carbon dioxide in that water might damage the asset by causing corrosion, for example or might affect production issues. Various grades of water used in Oil & Gas installations may regularly require degasification to prevent oxidation and reduce the ionic load on downstream processing equipment: demineralized water, boiler feed water, injection water or oil recovery or ultrapure water for high-grade products.

On the other hand, some water streams or production effluents may become rich in hydrogen sulfide, ammonia or methane. These streams cannot be discharged in the environment

without treatment, and the extraction of these dissolved gases appropriately may enable the recovery of valuable resources.

In order to remove dissolved gases from water, one may find three main type of solutions: based on chemicals, based on stripping towers or based on membrane degasifiers.

The DuPont™ Ligasep™ Degasification Modules product line is a hollow-fiber-based technology that enable the removal of the gas from the water by physical means. These modules can be installed in series within the water treatment system, ensuring efficient degasification and achieve ppb levels (parts-per-billion) of dissolved gasses for a wide range of flow rates in water treatment applications.

Compared to the use of chemicals or stripping towers, the Ligasep™ product features:

- Enables chemicals-free operation and residual-free removal vs. the use of chemical scavengers
- High packing density, which translates into smaller footprint, reduced weight and heights vs. stripping towers
- A membrane barrier prevents contaminants on the gas side to transfer to water side.
- Flexibility and robustness: adapt to variable production demands.
- Unattended and fully automated operation can be implemented with ease. Compared to other membrane degasifiers, the Ligasep™ product family is based on a skinned gas permeable membrane which translates into the following advantages:
- Ability to remove Oxygen without using nitrogen gas.
- Reduction of the water vapor transfer, which might cause auxiliary and piping equipment damage.



Degasification Module Portfolio for Onshore and Offshore Application

Product	Max. waterflow per module	Application
Ligasep™ LDM-040-LS	Up to 11 m ³ /h	Preferred for the removal of low solubility
Ligasep™ LDM-120-LS	Up to 50 m ³ /h	Gases (O ₂ and CH ₄)
Ligasep™ LDM-040-HS	Up to 11 m ³ /h	Preferred for the removal of high solubility
Ligasep™ LDM-120-HS	Up to 50 m ³ /h	Gases (CO ₂ , H ₂ S, and NH ₃).

Powering performance worldwide

With a large global manufacturing footprint, strong R&D expertise and technical support services and systems, we supply high market volumes with high quality. DuPont partners with you, our customer, to understand unmet needs and develop tailored solutions. With a large global manufacturing footprint, strong R&D expertise and technical support services and systems, we supply high market volumes with high quality. DuPont partners with you, our customer, to understand unmet needs and develop tailored solutions.

TECHNICAL SERVICE, RESEARCH & DEVELOPMENT

Chauny, France
Edina, MN, USA
Huzhou, China
Hyderabad, India
KAUST Jeddah, KSA
Midland, MI, USA
Shanghai, China
Singapore
Tarragona, Spain*
Wilmington, DE, USA

COMMERCIAL OPERATIONS

Astana, Kazakhstan
Bangkok, Thailand
Beijing, China
Bogota, Colombia
Buenos Aires, Argentina
Budapest, Hungary
Dubai, UAE
Chengdu, China
Delhi, India
Edina, MN, USA
Guangzhou, China
HCM City, Vietnam
Hong Kong, China
Jakarta, Indonesia
Johannesburg, South Africa
Kuala Lumpur, Malaysia
Madrid, Spain

Manila, Philippine
Melbourne, Australia
Mexico City, Mexico
Midland, MI, USA
Moscow, Russia
Mumbai, India
Nairobi, Kenya
Paris, France
São Paulo, Brazil
Seoul, Republic of Korea
Pfaeffikon, Switzerland
Shanghai, China
Singapore
Surubya, Indonesia
Taipei, Taiwan
Tokyo, Japan
Warsaw, Poland

MANUFACTURING

Chauny, France
Edina, MN, USA
Fombio, Italy
Huzhou, China
Jubail Industry City,
Saudi Arabia
Midland, MI, USA
Qingpu, China
Soma, Japan

*Global Water
Technology Center

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Water Solutions
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