

The background of the entire page is a soft-focus image of numerous spheres in shades of orange and white, scattered across the frame. The spheres vary in size and are rendered with realistic lighting and shadows, giving them a three-dimensional appearance. A purple rectangular box is overlaid on the upper left portion of the image.

PuraMem®

Integrate solvent-stable
membrane technology

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EVONIK IS ONE OF THE
WORLD LEADERS IN SPECIALTY
CHEMICALS.

THE COMPANY GOES FAR
BEYOND CHEMISTRY TO CREATE
INNOVATIVE, PROFITABLE AND
SUSTAINABLE SOLUTIONS FOR
CUSTOMERS.

As a global innovation leader
in membrane-based separation
technology we boost the chemistry
of high-performance polymers into
highly efficient membranes for
gas separation, organic solvent
nanofiltration and for separation
of volatile organic compounds.

With our PuraMem® high per-
formance polymer membranes
we offer high performance solutions
for chemical production processes
with measurable energy and mass
efficiency. These nanofiltration
membranes provide efficient separa-
tions at near-ambient temperatures
without the need for a phase change
of the liquid feed.

ADDING VALUE WITH GENTLE MOLECULAR SEPARATION

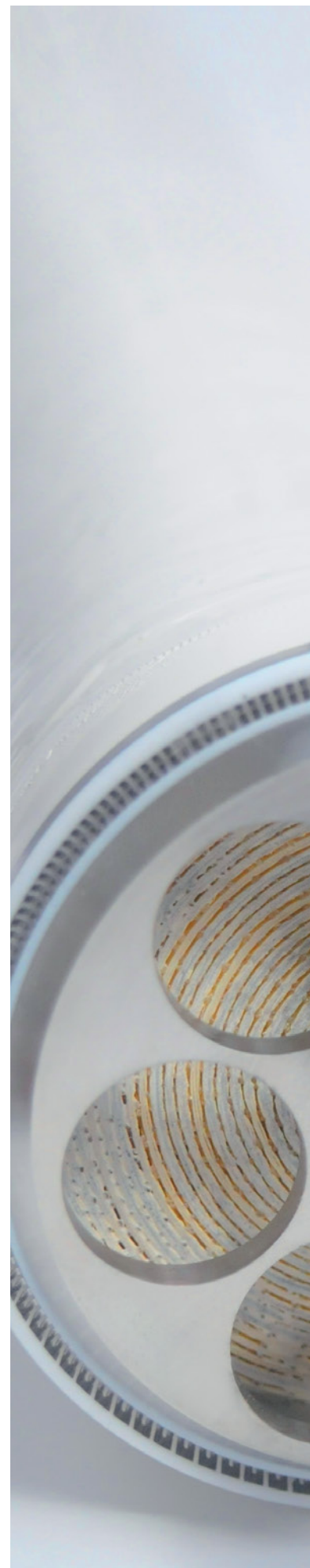
Until recently, molecular separations using membrane technology were almost exclusively based on aqueous systems. Nanofiltration was initially developed for water treatment and softening and its applications have broadened into sectors such as the food industry (milk and juice production) and fermentation processes (e.g. pharmaceutical production).


With the development of solvent-stable membranes, the application fields for nanofiltration are being extended to the full spectrum of chemical process industries, e.g. Oil-and Petro Industry, Fine Chemicals and Flavour & Fragrance. The breakthrough in OSN technology with the commercialisation of the PuraMem® range of membranes has opened up possibilities for applications in a variety of non-polar or slightly polar organic solvents. Highly selective membranes operating at room temperature and carrying out gentle molecular separation are the key features that reduce process costs and increase its efficiency!

Evonik provides OSN membrane products with performance characteristics targeting the needs of the chemical process industries for separation-, purification-, recovery- or concentration-based applications.

PuraMem® membranes are solvent-stable and are compatible and designed for use with nonpolar and slightly polar solvents, e.g. aromatic hydrocarbons, aliphatic hydrocarbons, long chain aldehydes and alcohols, THF and ethyl acetate*.

* More details can be found on our membrane datasheets.





PuraMem[®]
membranes (PM)
are targeted at
applications in
non-polar solvents.

Products

- PM Selective
- PM Performance
- PM Flux

Usable in

- toluene
- heptane
- hexane
- methyletherketone
- high boilers and more

Your benefits

- Reduced operating costs
- Reduced processing time
- Environmentally friendly processing
- Increased product value

WHERE CAN PURAMEM® MEMBRANES BE USED?

Evonik OSN membranes
can be used in the following
industries and applications:



Bulk, Oil- and Petro Chemistry

- Homogeneous catalyst recovery
- Decolorization and polishing of products
- Dewaxing
- Additive removal from light hydrocarbons

Natural and essential oil and products

- Fractionation of crude extracts
- Enrichment of natural compounds
- Natural oils processing (dewaxing and enrichment)
- Gentle separation

Fine Chemistry and Pharmaceutical Industry

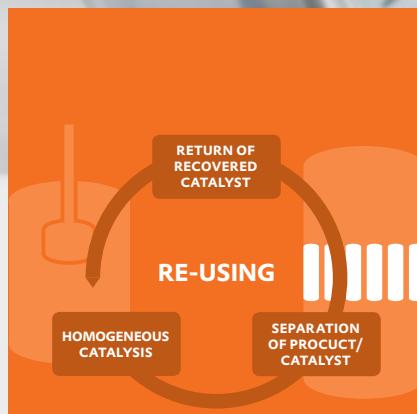
- Gentle API concentration and purification
- Non-thermal solvent recovery and management
- Room temperature solvent exchange

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2

3

Bulk, Oil- and Petro Chemistry



Homogeneous catalyst recovery

Homogeneous catalysts are very efficient but expensive materials that are difficult to separate in an active form with conventional separation technology. They are generally large molecules that are well retained by OSN membranes. This allows them to be recovered and re-used in a production process.

Decolorization and polishing of products

In many cases, the output of a chemical reaction is not the product in pure form. There is a variety of unwanted compounds present that originate from side reactions or post-reaction processing steps. These unwanted compounds lower the quality of the final product (undesired color, composition, density, melting and boiling point etc.) and have to be removed. When the MW of product and impurities differs an OSN membrane can be successfully applied for the product purification.

Dewaxing

Lube oil dewaxing is an energy-intensive operation within an oil refinery involving the evaporation and condensation of large volumes of solvent. OSN membranes can be applied to reduce the energy consumption in this process.

Additive removal from light hydrocarbons

Large molecules (e.g. additives) are commonly used in processing light hydrocarbons. The large difference in molecular weight between the additive and the hydrocarbon makes the removal of the additive possible with PuraMem® series membranes. This is a low-energy approach to additive removal.



2
Natural and essential oil and products

Fractionation of crude extracts

Components derived from natural extracts (from fruit, vegetables, nuts, seeds, herbs) are used in a variety of different industries, e.g. pharmaceutical, nutraceutical, flavor & fragrance, etc. due to their inherent properties and chemical diversity. Their use as a crude extract, however, is often not practical and the molecules of interest constitute only a small part of the extract. The use of Evonik's different OSN membranes enables fractionation of the crude extracts according to solubility or MW of the molecules in (different) solvents and mixtures.

Enrichment of natural compounds

Valuable compounds are often present in low concentration in the natural matter or extract. With the help of PuraMem® OSN membranes the target molecules can be enriched by separation from the extract or extraction solvent.

Natural oils processing (dewaxing and enrichment)

Natural oils are widely used as additives in the food, beverage and cosmetic industries. They enrich the taste, flavor or fragrance of products. Their ingredients, however, should not affect the appearance and quality of the final goods. Unwanted compounds (e.g. waxes in citrus oils) can be removed with Evonik's OSN membranes replacing conventional high-energy consuming technologies (e.g. crystallization).

Gentle separation

The separation with Evonik's PuraMem® membranes is performed at gentle conditions (near-ambient temperature) which maintains the bio-activity of natural components.



Fine Chemistry
and Pharmaceutical
Industry

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**Gentle API concentration
and purification**

Processing APIs and their intermediates at lower (near-ambient) temperature minimises damage to these often complex molecules. APIs and intermediates can be concentrated or purified using OSN membranes without exposure to damaging heat.

**Non-thermal solvent
recovery and management**

Our PuraMem® OSN membranes provide the separation capability for recovering process solvents without the need for boiling and condensing the solvent. Solvents can be recovered at high purity with an energy-efficient OSN process.

**Room temperature
solvent exchange**

Many fine chemical synthetic routes require different process solvents for different reaction types. OSN membranes allow the solvents to be exchanged at room temperature without using conventional thermal techniques.

HOW DO PURAMEM® MEMBRANES WORK?

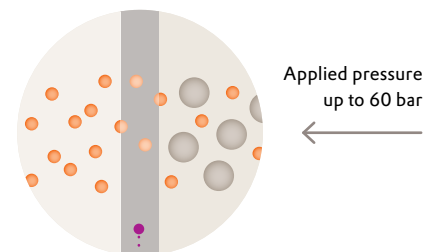
OSN involves a membrane and a solvent containing at least one solute (=“feed”). The feed is pushed through the membrane with an applied pressure of up to 60 bar. Due to the intrinsic properties of the membrane, the solvent passes through the membrane and becomes the “permeate” whereas the concentrate is retained by the membrane (=“the retentate”).

Applications may also involve a mixture of organic solutes in the solvent. One or more of the solutes passes through the membrane in the “permeate”, while the other(s) are retained in the “retentate”. The stability of the membrane and its molecular selectivity essentially determines this process.

There are some heuristic criteria (physical, process and chemical aspects) that need to be considered to make OSN with PuraMem® most valuable and successful:

- At least 150 Da difference in molecular weight between key components, or a significant difference in molecular shape, or a significant difference in polarity
- Generally molecules need to have a molecular weight above 250 Da to be retained
- The process stream being filtered should be a homogeneous solution with zero or minimal tars, waxes and solids
- Filtration temperature should be <50 °C
- Filtration pressure should be 5-60 bar
- Solution viscosity should be <10 cP
- The solute concentration in the feed solution should in general be <25 % solute
- Recommended pH: 7

For initial membrane screening and proof-of-concept testing, PuraMem® membranes are available in flat sheet format. The membranes are also available as spiral wound modules. Smaller modules are typically used for proof-of-process and piloting trials, and the larger modules are used for commercial processes. Modules are available in industry standard sizes from 0.2 m² for the smallest module to about 30 m² for the largest.



OSN membranes

The larger molecules are rejected by the membrane while the smaller molecules permeate through.

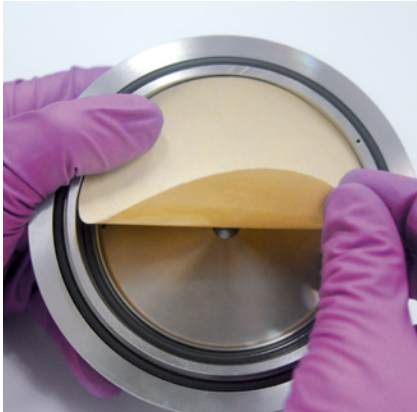
Feed solution

Solvent containing higher molecular weight components, organics and impurities is fed into the membrane element.

Retentate or Concentrate

Solvent containing rejected components

FROM TESTING TO PILOTING TO INDUSTRIAL IMPLEMENTATION



Evonik will accompany you throughout process development, from initial proof-of-concept to the proof-of-process. Additionally, we can assist in customized process development and are also able to provide customers with lab and pilot scale test equipment.

With our team of process engineers and our experience in process development, we offer comprehensive process solutions for your difficult separations using superior solvent stable membranes combined with customized process engineering solutions. A typical process implementation will go through three main steps.

1. Proof of concept

The feasibility testing is done using flat sheet membranes and determines the best performing membrane for a specific application. For this initial testing, equipment such as the METcell, a dead-end filtration cell, or our CrossFlow system are used.

2. Proof of process

The proof of process is carried out in pilot trials using small spiral wound membrane modules. Equipment such as Bench-Top Unit are used for this stage of process development. The Bench-Top Unit uses manual instrumentation so that it can be easily installed in the laboratory environment in a normal fume cupboard. It is especially suitable for longer-term testing of membrane modules. During this proof-of-process stage, valuable data are gathered that

allows the technical design of the commercial scale installation to be completed and the process economics to be accurately evaluated.

3. Industrial implementation

Industrial implementation is the last stage, with full scale up of the process established in pilot trials. We provide the membranes and we will also assist you in finding solutions for the conceptualization as well as for the costing and building of a full industrial filtration set-up. For the industrial implementation we are able to arrange individual customer-focused application development projects. We have experienced OEM partners around the world that can provide state-of-the-art industrial installations.

Permeate (purified solvent)

The level of purification depends on membrane type (e.g. MWCO).

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