EVONIK INDUSTRIES

DuraMem® and PuraMem®

Integrate solvent-stable membrane technology to increase the value in your production process

Evonik. Power to create.

Adding value with gentle molecular separation

Evonik is the creative industrial group from Germany, with specialty chemicals as its core business. With our high performance polymer membranes DuraMem® and PuraMem®, we offer you high performance solutions in your chemical production with measurable energy and mass efficiency. This is because nanofiltration processes do not require phase change of liquid-based feedstock to achieve molecular separation.

Until recently, molecular separations using membrane technology were almost exclusively based on aqueous systems. Originally, nanofiltration was used for water treatment or for water softening. Like reverse osmosis, the use of nanofiltration has broadened from waste water treatment and sea water desalination to milk and juice production.

With the development of solvent-stable membranes, the application fields for nanofiltration membranes can now be extended to the chemical process industries, e.g. Pharma, Fine Chemicals and Flavour & Fragrance Industries. The breakthrough in OSN technology with the commercialisation of the DuraMem® and PuraMem® range of membranes has opened up possibilities for applications in a variety of organic solvents ranging from non-polar through polar to polar aprotic. Operating separation processes at room temperature and carrying out gentle molecular separation are the key features that will you reduce your process cost and increase your efficiency!

The Evonik MET DuraMem® series is solvent-stable and compatible with a wide range of organic solvents, and organic/aqueous solvent mixtures, including polar and polar aprotic solvents such as acetone, tetrahydrofuran and ethanol*.

The Evonik MET PuraMem® series is also solvent-stable and is compatible with non-polar solvents such as aromatic hydrocarbons, aliphatic hydrocarbons and ethyl acetate*.

* More details can be found on our membrane datasheets.

DuraMem® and PuraMem®:

How do they work?

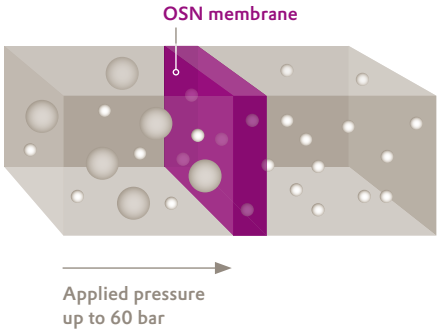
OSN involves a membrane and a solvent containing at least one solute (="feed"). The feed is pushed through the membrane with an applied pressure of up to 60 bar. Due to the nanoporous structure of the membrane, the solvent passes through the membrane and becomes the "permeate" whereas the concentrate 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. The membrane selectivity, characterized by the "molecular weight cut-off" ranges from 150 Da to 900 Da.

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

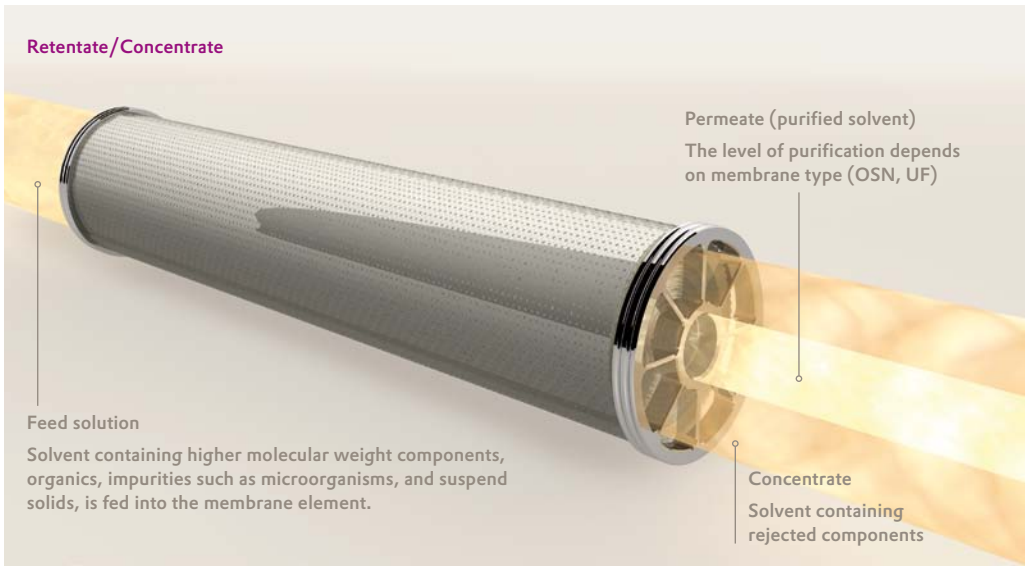
- At least 150 Da difference in molecular weight between key components
- Or a significant difference in molecular shape (linear vs spherical)
- Or a significant difference in polarity (charged vs uncharged)
- The molecular weight cut-off to highly retain a molecule is usually 100 – 150 Da smaller than the retained molecule, e.g. DuraMem® 300 is used to retain a product of 400 Da
- 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/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, the DuraMem® and PuraMem® membranes are available in flat sheet format. The membranes are also available in spiral wound module format. 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 0.1 m^2 for the smallest module to about 29 m^2 for the largest.

Please contact us for more information about process conditions.



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



DuraMem® and PuraMem®:

Where can you use them?

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

Fine Chemistry and Pharmaceutical Industry

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

Oil- & Petro Chemistry

- Removal of tar components in FCC feed
- Purification of gas condensates
- Dewaxing

Bulk Chemistry

- Continuous recovery of homogeneous catalysts
- Decolorization of products
- Product polishing

Natural and essential oils and products

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

Using DuraMem® and PuraMem® in regulated industries

We cater to industries that operate under regulated production environments and have tested our membrane modules for use in FDA-regulated and other regulated industry production set-ups. We provide a Regulatory Support File to our Pharma (and other regulated industries) customers to ensure that our products meet the strict requirements of regulators such as the FDA.

DuraMem® and PuraMem®:

Our two product families

We are offering two product families with different performance characteristics to address the needs of the individual industries and achieve the goals of the particular separation/purification/concentration application.

Your benefits

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

DuraMem® excels, where most solvent-stable membranes fail. It offers long term stability in aggressive polar solvents including the polar aprotic solvent family.

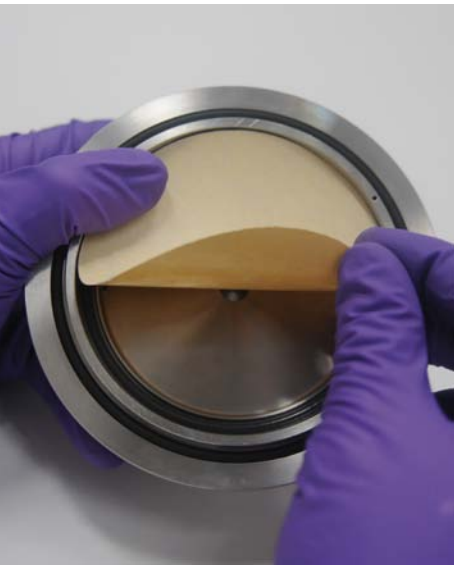
MWCO: 150, 200, 300, 500, and 900 Da
Useable in: acetone, ethanol, methanol, tetrahydrofuran, and more

PuraMem® and PuraMem® S are targeted at applications in non-polar solvents.

MWCO: 280 Da, 600 Da
Useable in: toluene, heptane, hexane, methyletherketone, high boilers and more

DuraMem® and PuraMem®:

From testing to piloting to industrial implementation



Evonik MET will accompany you throughout process development, from initial proof-of-concept to the proof-of-process. In addition to industrial upscaling to our two product families DuraMem® and PuraMem®, we also offer customized process development services and can 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 our BenchTop Unit are used for this stage of process development. The Bench-Top Unit uses manual in strumentation 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 engineering assistance for the conceptualization, costing and building of a full industrial filtration set-up. For the industrial implementation we offer individual customer-focused application development projects. We have experienced OEM partners around the world that can provide state-of-the-art industrial installations.

Our success stories

Improving process yields: OSN and chromatography

The Johnson &Johnson (J&J) case study* is a prime example of how OSN can be successfully integrated into an API production set-up as a process efficiency tool. The aim of the project was to purify an API intermediate stream in order to make the subsequent chromatography process more efficient. The oligomer impurities (>1,400 Da) present in the API intermediate (700 Da) stream had the effect of reducing the chromatography yield. After initial proof of concept, the OSN process was introduced at pilot scale. The process is called dual membrane diafiltration as it uses two sets of membranes with (i) a loose membrane to separate the oligomer impurities from the API intermediate molecules and then (ii) a tighter membrane to recover the API intermediate and recycle the solvent (THF) used for diafiltration. This integrated OSN process resulted in a 99%+ yield of API intermediate and reduced the impurities significantly. This subsequently made the chromatography process more efficient, in a successful synergy of OSN and chromatography.

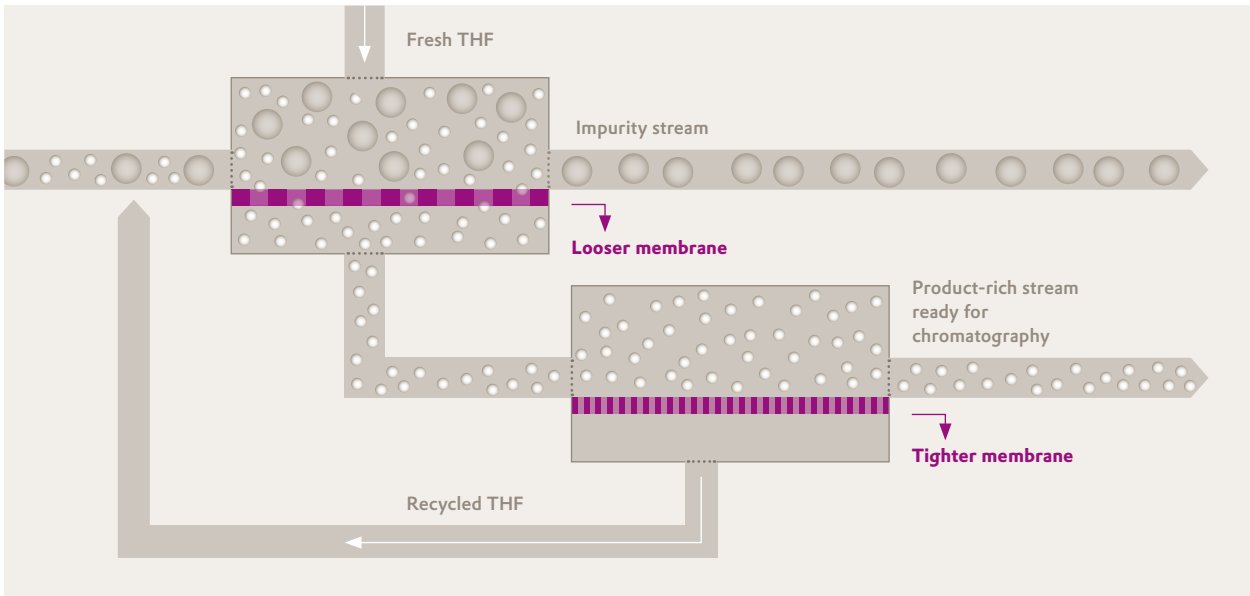
With dual membrane diafiltration, solvent use was minimized, i.e., reduced ten times from the original consumption.

Mass efficiency: Recycling of homogeneous catalyst

Improving process efficiency also means reducing or optimizing production costs. For most chemicals manufacturers, the use of homogeneous catalysts is very common in molecular synthesis at production scale. In conventional processes, fresh catalyst is used for the conversion reaction, which in most cases can represent an annual budget of up to € 3 million for homogeneous catalyst. In this instance, the customer used OSN to recycle the catalyst used in production. As the homogeneous catalyst molecule (800 Da) was larger than the synthesized molecule (200 Da), the membrane was used to recover the catalyst from the product, allowing the recovered catalyst to be reused for subsequent reactions. Employing OSN reduced the annual budget for homogeneous catalyst by as much as 80 percent.

* Ref: Organic Process Research & Development 2010, 14, 600–611

Dual membrane diafiltration – Johnson & Johnson case study



EVONIK INDUSTRIES

Evonik MET Ltd.
Unit 8 Wharfside
Rosemont Road
London HA0 4PE
United Kingdom

PHONE +44 208 902-0040
emet@evonik.com

www.puramem.com
www.evonik.com

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