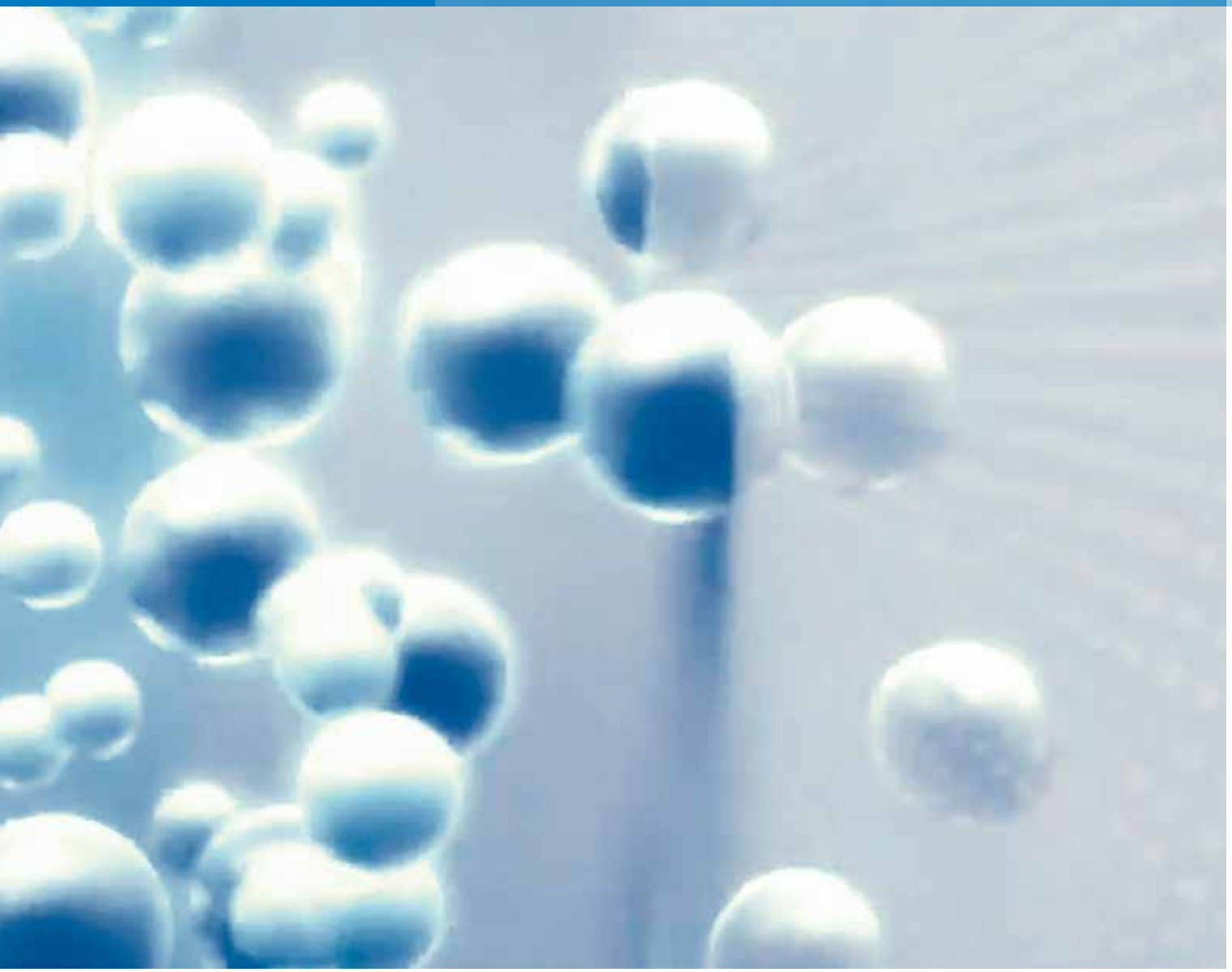
BORSIG

BORSIG
MEMBRANE
TECHNOLOGY
GMBH

ORGANIC SOLVENT NANOFILTRATION (OSN)

LOW ENERGY SUSTAINABLE PROCESSING



www.osn-membranes.com

CONTENT

INNOVATIVE MEMBRANE TECHNOLOGY

BORSIG Membrane Technology GmbH

BORSIG Membrane Technology GmbH is an internationally renowned system supplier of leading and innovative membrane technology solutions for new and existing industrial processes. With 30 years of experience, we are your partner for the development, engineering and supply of membranes, modules and units.

Organic Solvent Nanofiltration (OSN)

One of our innovative membrane technologies is Organic Solvent Nanofiltration (OSN), a new separation technology for the treatment of liquid process streams in the molecular range.
OSN is a pressure driven process that operates at moderate or ambient temperatures. The separation takes place in the liquid phase. No phase transition is required for efficient separation.
OSN perfectly complies with current trends and requirements in process design and optimization. It contributes to energy saving, sustainable production, reduction of waste streams and offers flexible capacities.
A solvent resistant polymeric membrane is the centerpiece of the BORSIG OSN unit. OSN membranes supplied by GMT Membrantechnik GmbH are well-known for their excellent stability in organic solvents and outstanding performance.
Several BORSIG OSN units have been successfully implemented in industrial processes in recent years.

oNF-1, *oNF-2* and *oNF-3*

Superior membranes designed for organic solvent nanofiltration.

Discover BORSIG OSN membranes for your process.

GMT Membrantechnik GmbH is a subsidiary of BORSIG Membrane Technology GmbH and an internationally successful manufacturer of industrial composite membranes and membrane modules. GMT products stand for competence, high quality and reliability.

MEMBRANE TECHNOLOGY FOR ORGANIC LIQUID PROCESSING

Organic Solvent Nanofiltration (OSN) or **organophilic Nanofiltration (oNF)** is a membrane-based separation technology for the gentle treatment of liquid process streams in the molecular range.

For a long time the industrial use of nanofiltration has been limited to applications in aqueous media. The development of solvent-resistant membranes provides a new separation technology for the treatment of liquid organic process mixtures to the petrochemical, chemical, pharmaceutical and food industries.

Unlike conventional thermal separation technologies, OSN operates at mild conditions. This enables the separation of temperature-sensitive components at ambient temperatures which increases product quality and reduces energy consumption.

Waste streams may be processed with OSN to recover valuable components, avoid product loss and reduce raw material costs.

In combination with conventional processes such as distillation, OSN is able to relieve distillation columns by treating side streams which reduces bottlenecks.

A single OSN unit can also simplify processes by replacing a sequence of separation units and its capacity can be flexibly adapted to meet current demand.

BORSIG OSN membranes have been successfully used in several industrial application.

BENEFITS

- Improved product quality and yields
- Gentle separation of temperature-sensitive compounds
- Reduced energy consumption
- Sustainable processing
- Easy and safe operation
- Low maintenance
- Flexible capacity with modular concept

SEPARATION PRINCIPLE

Process streams in the field of OSN are ideally regarded as containing a solvent and one or more solute.

By applying pressure of up to 40 bar, the solvent is forced through the selective membrane where it becomes the permeate. The solute remains on the upper side of the membrane as the concentrate. If the feed mixture contains molecules of different sizes (solutes), the smaller ones usually pass through the membrane, for example, in the fractionation of liquid hydrocarbon mixtures with different chain lengths.

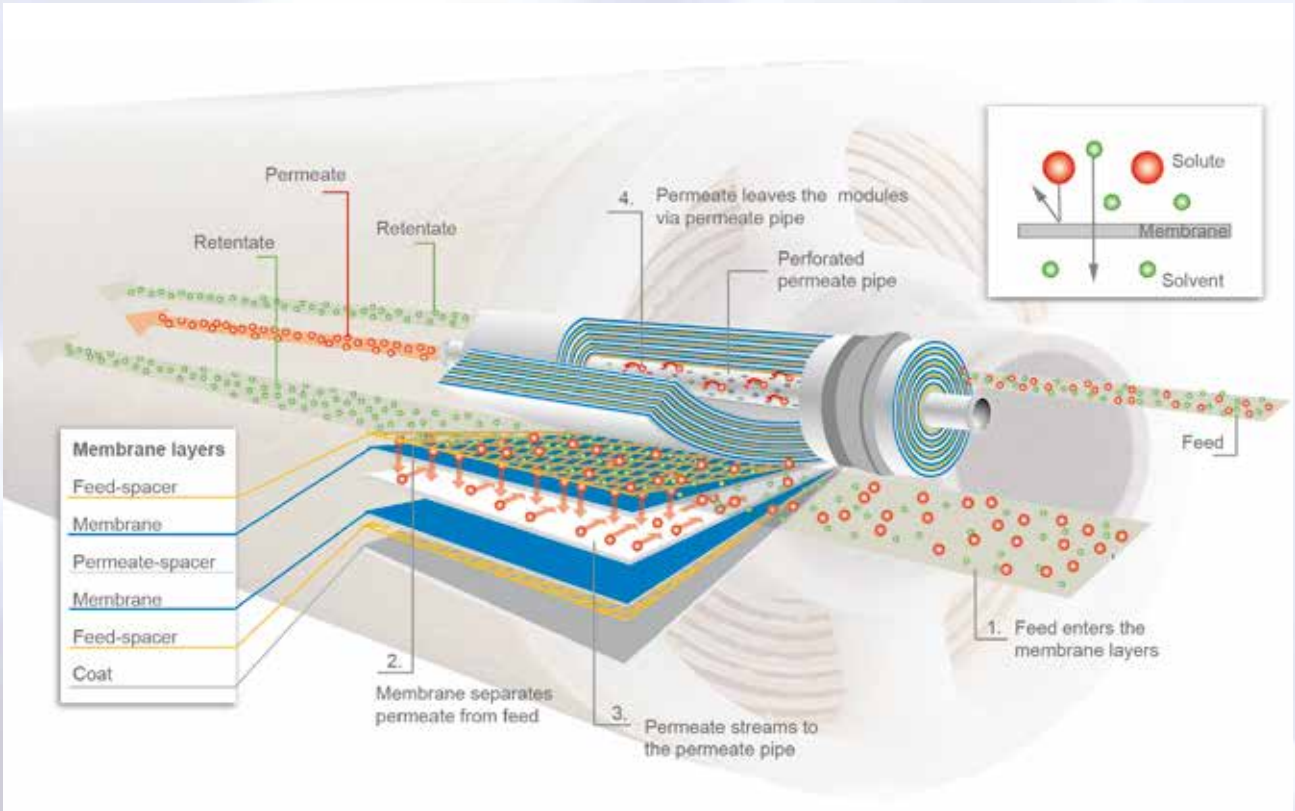
The selectivity and performance of an OSN process is determined by the proper selection of the OSN membrane and its stability in the process mixture.

The Molecular Weight Cut-Off (MWCO) is generally used as a criterion for the selectivity. The MWCO for OSN membranes ranges from 200 to 1.000 g/mol.

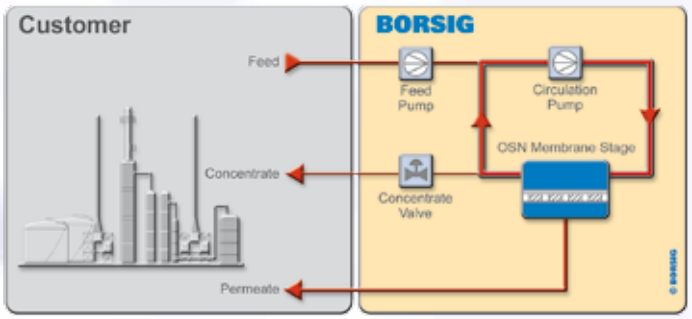
The performance of polymeric OSN membranes is strongly influenced by the interaction between the membrane and the feed containing solvent and solutes. The feasibility of the process idea therefore needs to be established in laboratory and pilot tests in order to select the most appropriate membrane and process conditions for each project.

Molecular Weight Cut-Off (MWCO)

The MWCO describes the retention capability of a membrane for a certain test system and refers to the molecular weight of a solute with a membrane retention of 90 %.



OSN UNITS



OSN Units are operated in cross-flow mode either batch-wise or continuously according to the application.

A typical process set-up for continuous OSN units is the feed-and-bleed system with partial recirculation of the concentrate. This configuration enables stable operation and is less sensitive to process-related fluctuations of the feed. The main components of a continuous OSN unit are the feed pump, circulation pump and membrane.

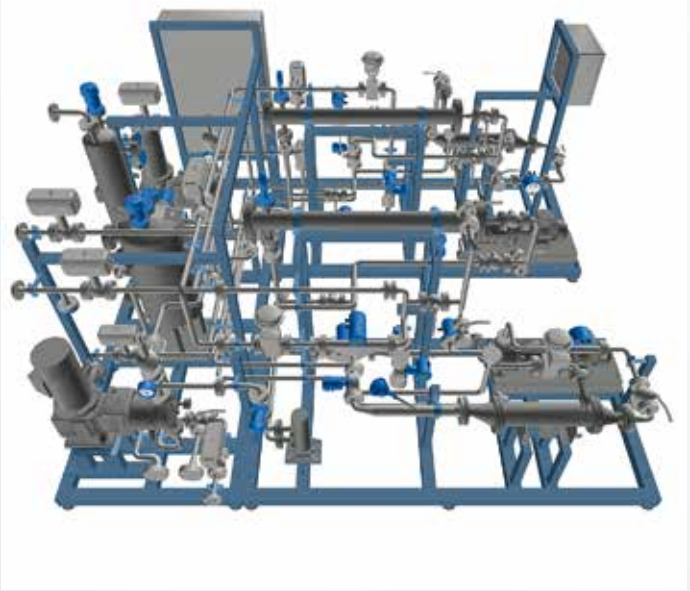
The feed pump pressurizes the feed mixture and the circulation pump ensures the necessary cross-flow over the membranes. The actual separation takes place at the membrane stage.

GUIDE FOR POTENTIAL OSN APPLICATIONS

- **Solutes should have a molecular weight of at least 250 g/mol to be retained effectively.**
- **The molecular weight difference of solvent and solute should be at least 200 g/mol for efficient separation.**
- **Typical filtration temperatures range between 10 to 60 °C and should not exceed 80 °C.**
- **Filtration pressure typically range between 5 and 40 bar.**
- **The feed should be a homogeneous solution with max. particle size up to 50 µm.**

BORSIG Membrane Technology GmbH supports you throughout the entire development process – from laboratory testing to industrial implementation. We carry out basic and detail engineering and supply customized OSN package units.

Our expertise in membrane technology and engineering makes us a reliable partner for process design.



BORSIG OSN MEMBRANES

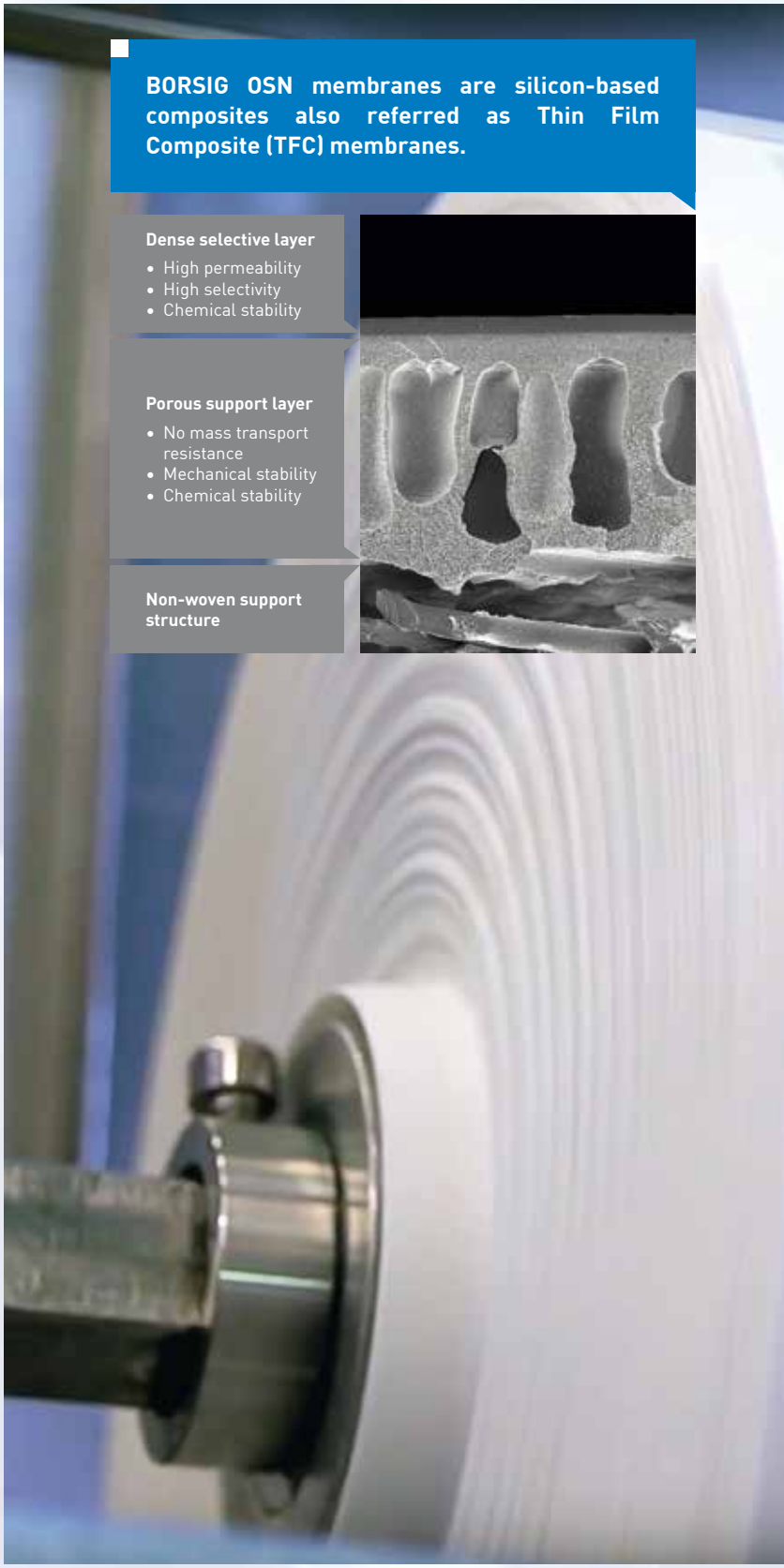
The centerpiece of the BORSIG OSN unit is a solvent resistant polymeric membrane.
BORSIG OSN membranes have excellent stability across a broad range of organic solvents and have a reputation for outstanding performance.

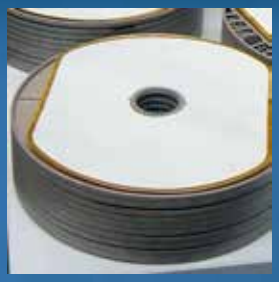
- **Chemical resistance across a broad range of organic media**
  - Alkanes (hexane, heptane, ...)
  - Aromatics (toluene, ...)
  - Alcohols (ethanol, methanol, ...)
  - Ethers (tetrahydrofuran, ...)
  - Ketones (acetone, ...)
  - Esters (ethyl acetate, ...)
- **High fluxes and rejections**
- **Mechanical stability up to 40 bar and 80 °C**
- **Proven long-term durability**

Three membrane types are available: ***oNF-1***, ***oNF-2*** and ***oNF-3***.

Each one covers a certain molecular range and offers high performance regarding permeability and rejection across a wide range of applications. For further information, please ask for our membrane data sheets.

Membrane type	MWCO (approx.) in Da
oNF-1	600
oNF-2	350
oNF-3	900





MEMBRANE CONFIGURATION

BORSIG OSN membranes are available in three different configurations:

- **Flat-sheet membranes** for lab-scale testing
- **Spiral Wound Elements** (SWE) for pilot testing and production
- Glue-free **Envelope Type Element** (ETE) for pilot testing and production

Both membrane element types are available in different sizes for individual process designs.

The membrane elements are built into suitable pressure housings designed according to the Pressure Equipment Directive (PED) and other international standards (e.g. ASME).

APPLICATIONS

The superior performance of the ***oNF-1***, ***oNF-2*** and ***oNF-3*** membranes opens up new fields of application.

Whether part of product development or process optimization, our OSN membranes are a valuable tool for achieving sustainable processing and gentle product treatment.

The following examples demonstrate what OSN can do for your process and product.

Fine & Specialty Chemicals

Fine and specialty chemical production is characterized by high raw material costs and high product purity requirements. BORSIG OSN membranes can help to reduce waste by enabling the recovery and recycling of valuable chemicals.

Homogeneous catalyst recovery from reaction mixtures

Homogeneous catalysts are expensive raw materials. The recovery of these catalysts from the reaction mixture is very complex and often involves catalyst deactivation and material losses. The highly selective ***oNF-2*** membrane enables the non-thermal recovery of the active catalyst complex.

OSN assisted crystallization

OSN enables the concentration of crystalline mother liquors and simultaneous recovery of the solvent. The phase transition is omitted and the solvent is recovered as liquid. This saves energy and improves solvent management.

Gentle concentration of valuable fine chemicals

OSN is a pressure-driven process that operates at ambient or near-ambient temperatures. This makes it a gentle concentration process ideal for separating valuable chemicals, especially when thermally unstable.

APPLICATIONS

Oil & Petrochemical

In the oil and petrochemical industry, large amounts of feed have to be processed. High-flux membranes such as the BORSIG ***oNF-1*** and ***oNF-3*** offer economically efficient processing. The modularity of OSN units and relatively quick and smooth start-up enable you to flexibly adjust your production capacity. When processing bulk streams, energy consumption is an important optimization factor. By using non-thermal processes such as OSN, the thermal energy demands can be significantly reduced .

Solvent recovery

Petrochemical and chemical processes often require large amounts of solvents. Following the reaction the solvent has to be separated from the products and by-products. The solvent is typically recovered by evaporation and condensation. Our high-flux membranes offer a less energy-intensive alternative for the solvent recovery as no phase change takes place.

Fractionating of liquid hydrocarbons

When the molecular weight of the desired liquid hydrocarbon fractions differs sufficiently, OSN provides an efficient method for separating long-chain hydrocarbons. In this way the viscosity of the target product can be adjusted.

Upgrading of used lube oil

Used lube oil contains many undesirable components such as consumed additives and thermally degraded products. The base oil components can be recovered from this complex mixture by implementing OSN in the re-refining process.

Fragrance and Food Industry

The processing of natural edible and essential oils with conventional unit operations such as steam distillation and solvent extraction are either energy–intensive or require large amounts of solvents. Natural oils contain valuable heat-sensitive compounds that are thermally degraded when processed at high temperatures. OSN enables processing at mild operating conditions which allows non-thermal solvent recovery.

Solvent recovery

Oil extraction from crops and seeds requires high amounts of solvents, which have to be removed by evaporation processes.
The solvent hexane is most commonly used for processing natural oils.
BORSIG OSN membranes with high hexane fluxes provide an attractive alternative for solvent recovery from hexane-oil miscella without phase transition.

De-colorization & dewaxing

Fragrances derived from natural oils are used in the food and cosmetic industries. Most pro-ducts have high sensory and optical requirements.
BORSIG OSN membranes enable the removal of molecules and waxes that can cause undesired coloring or an unpleasant odor.
The gentle separation process significantly reduces the degradation of valuable, heat-sensitive components.

Gentle separation

Essential oils contain heat-sensitive compounds with antioxidant or antimicrobial properties.
BORSIG OSN membranes enable OSN separation at mild conditions, thus preserving the valuable properties of the heat-sensitive compounds and reducing product and quality losses due to thermal de-gradation.

INDUSTRIAL REFERENCES

Several OSN units have been jointly developed and implemented with globally active petrochemical and chemical manufacturing companies.

The excellent process performance of BORSIG OSN units has consistently met all our customers' requirements.

Homogeneous catalyst recovery

Homogeneous catalysts and the ligands are expensive materials whose separation from the reaction mixture is complicated and often leads to the deactivation of the catalyst complex and material losses. OSN technology enables the active catalyst complex to be recycled directly.

The benefits for this customer's application are lower material losses and improved energy efficiency.

OSN assisted crystallization

Crystallization is an energy-intensive process in which evaporation is used to increase the concentration of the solute. Additional energy is required when the solvent has to be recovered in a liquid state by condensation. BORSIG OSN technology enables simultaneous concentration and efficient solvent recovery from crystalline mother liquor. This OSN unit offers improved (infrastructural) solvent management and reduced thermal energy consumption.

Solvent polishing

Large quantities of solvents with high-purity requirements are produced in bulk chemical processing. The purification of solvents from small amounts of substances with a higher molecular weight by rectification is an energy-intensive and therefore sometimes uneconomical process.

This BORSIG unit for producing highly purified solvent is one of the largest of its kind in the world with a feed capacity of 25 t/h.

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