

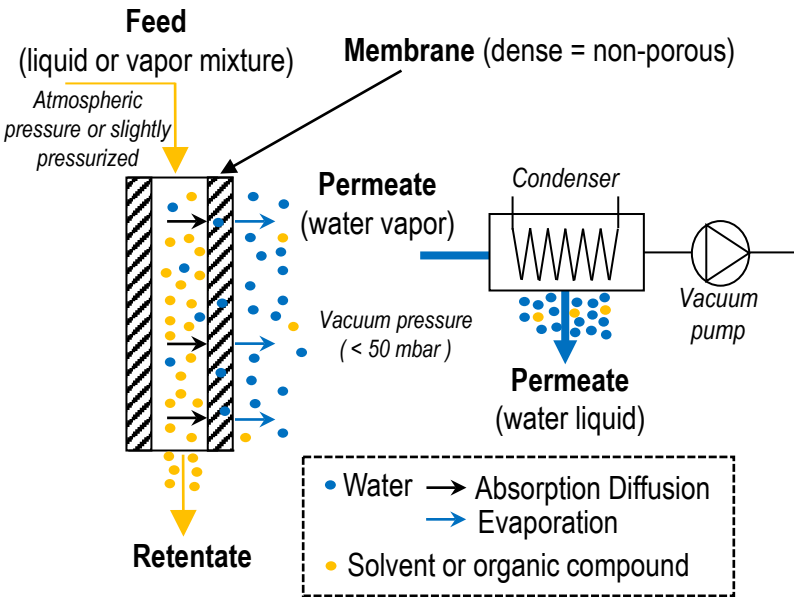
PERVAPORATION

Hydrophilic ceramic membrane and Pilot plant system

Pervaporation is a process for the separation of mixtures by partial vaporisation

Innovating for the sustainability and reliability of industrial processes, ORELIS Environnement has various capabilities in the field of pervaporation:

- ORELIS has experiences in the applications of **dehydration**: solvent recycling by dehydration (Pharmaceutical), concentration of aromatic mixtures (Fine chemistry) and improvement of esterification processes by selectively eliminating water from the reaction mixtures (Chemicals).
- ORELIS has access to the Hybsi® technology of **hydrophilic ceramic pervaporation membranes** which allows water to be separated from solvents and organic compounds
- ORELIS also has a mobile **pilot plant system** for feasibility and process design studies



ALSYS experiences in the field of pervaporation technology

Industries	Applications	Benefits
<ul style="list-style-type: none"> Pharmaceutical 	<ul style="list-style-type: none"> Solvent mixtures recycling by dehydration 	<ul style="list-style-type: none"> High selectivity Low energy consumption
<ul style="list-style-type: none"> Chemicals Petrochemicals Biofuels 	<ul style="list-style-type: none"> Alcohols dehydration (IPA, Butanol...) Esterification mixtures dehydration Azeotropic breaking Solvent recycling 	<ul style="list-style-type: none"> Implementation with minimum process modification Flexible for batch or continuous processes
<ul style="list-style-type: none"> Fine chemistry Flavor & Fragrances Food & Beverage 	<ul style="list-style-type: none"> Concentration of aromatic mixtures 	<ul style="list-style-type: none"> Process intensification Aromatic stability

Main benefits of pervaporation

- **Vs. distillation:**
 - 30% less energy: latent heat only in the permeate stream
 - 30% less CAPEX: no pressure swing required to break azeotrope
- **Vs. activated carbon:**
 - No additional steps
 - No waste generated

Performances with HYBSI® hydrophilic ceramic membrane (hybrid silica)

Feed composition	Temperature (°C)	Flux (kg/h.m²)	Permeate composition
95% Butanol, 5% Water	80	3,5	2% Butanol, 98% Water
90% Ethanol, 10% Water	75	3,5	20% Ethanol, 80% Water
88% Ethanol, 5% Methyl isobutyl ketone, 7% Water	70	2,5	80% Water
92% Ethyl acetate, 2% Ethanol, 2% Toluene, 1% Acetic acid, 3% Water	70	1,5	87% Water
Ester acrylate, Alcohol, Acrylic acid, 15% Water	75	12	Ester acrylate, Alcohol, Acrylic acid, 90% Water
Water, 30g/L Polyphenols, 50g/L Suspended solids	40	2,5	Containing traces of organic compounds

PERVAPORATION PILOT PLANT and LAB PILOT systems

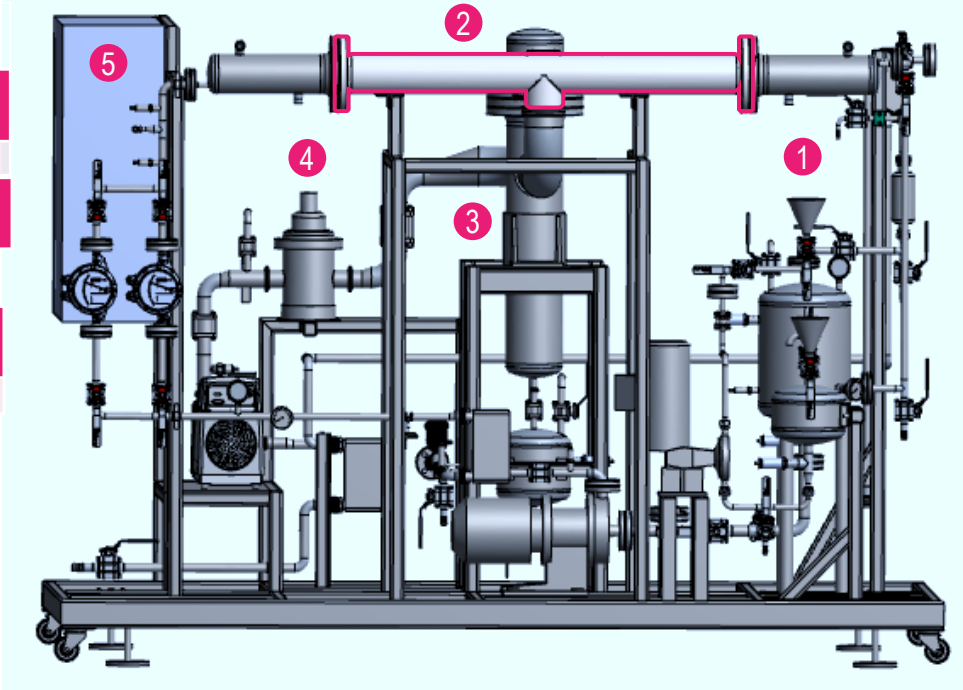
Pervaporation pilot plant with industrial membranes

(1): Feed

Max Temperature	Max Pressure
175°C	8 bar
pH 2 to 14	

(2): Membrane module

1 membrane	7 membranes
0,15 m²	1,05 m²



(5): Monitoring

Control interface



(3) & (4): Permeate

Condenser	Cold trap
0 to -50°C	- 180°C



What makes PERVAPORATION PILOT PLANT unique?

- Compact design, small footprint, large membrane area for a small feed volume
- Easy integration into an industrial plant
- **Versatile pilot plant**
- Could work with vapor or liquid feed
- Extrapolation / Scaling-up: x 100
- Extremely stable process conditions
- Fast and complete dehydration of organic mixtures (100 ppm of water possible at the end of the purification)
- High water permeation flowrate > 4 kg/h
- Compatible with most types of solvents
- Continuous permeate condensation

Versatile pilot plant

- Ceramic or polymeric membrane
- Pervaporation or vapor permeation
- Dehydration at stable conditions or extremely quick purification
- Semi-automatic or automatic control

Pervaporation lab-pilot with laboratory membranes

- (1) Condensation with liquefied nitrogen
- (2) Pervaporation module with ceramic membranes with single channel
Lenght: 400 mm
Diameter: 10 mm
- (3) Feed pump
- (4) Feed tank
- (5) Condensation with cooling fluid



Contacts:

Europe: +33 (0)4 66 85 95 36
North America: +1 857 504 2250
Asia: +86 (0)21 6350 3377