



OITB service catalogue

# Types of services offered by the OITB

## Technical services for nano-enabled membranes

- Membrane properties characterisation techniques
- Development and scale up of membranes
- Membrane testing equipment
- Membrane equipment design and construction
- Membrane process design

## Non-technical services

- Techno-economic analysis and market validation
- Consultancy
- Innovation services





INNOMEM CATALOGUE

# OITB technical services for nano-enabled Membranes

# Membranes properties characterisation techniques

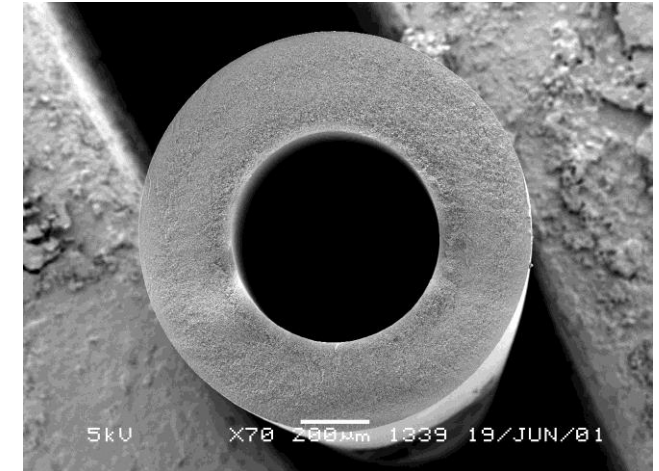
## PHYSICO-CHEMICAL CHARACTERIZATION TECHNIQUES

### EXPERTISE & CAPABILITIES

- Surface and bulk characterisation
- Laboratory rigs for membrane performance assessment

### ANALYTICAL EQUIPMENT

- SEM, FE-SEM, EDX, SAXS, TEM, AFM, XRD, XPS, Raman spectroscopy, AFM, FTIR, MALDI-TOF, STED, Confocal, TGA, DSC, FLIM, Ellipsometry, QCMD, EIS, HPLC, GC, ion chromatography, Zeta-potential (**VITO, EMI Twente, Hereon**)
- Porosimetry and Permporometry (**EMI Twente, Hereon**)
- Laboratory rigs for membrane performance assessment (**VITO, EMI Twente, Hereon**)





# Development and scale up of membranes

## POLYMERIC MEMBRANES – HOLLOW FIBER

### EXPERTISE & CAPABILITIES

- Development of recipes
- Fabrication of thin film composites
- Membrane surface modification
- Development of mixed matrix membranes
- Scale-up of spinning recipes

### MANUFACTURING FACILITIES UP TO SCALE

- Fabrication of Thin film composite membranes, Fabrication of Thin film nanocomposite membranes (**EMI Twente**)
- Development of hollow fiber membranes for aqueous and gas applications, ranging from small batches (recipe development), to medium batches (for parameter screening) and larger (pilot) scale batches for ‘proof of concept’ (**EMI Twente, TEC**)
- Membrane surface modification via coating and/or offline/inline E-beam treatment (**EMI Twente**)
- Polymeric and HF membranes: - geometries, Additives, Materials and solvents, Chemistry in a spinneret – simultaneous membrane formation and functionalization (**EMI Twente**)



# Development and scale up of membranes

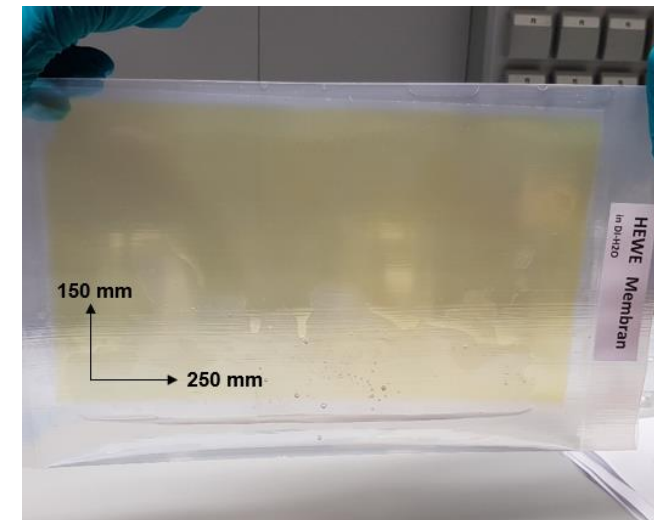
## POLYMERIC MEMBRANES - FLAT

### EXPERTISE & CAPABILITIES

- Development of recipes
- Fabrication of thin films composites
- Membrane surface modification
- Development of mixed matrix membranes

### MANUFACTURING FACILITIES UP TO SCALE

- Polymeric membranes for gas and vapour permeation, pervaporation and organic solvent nano filtration manufactured as thin film composite flat sheet membranes and mixed matrix membranes (**VITO, Hereon, EMI Twente**)



# Development and scale up of membranes

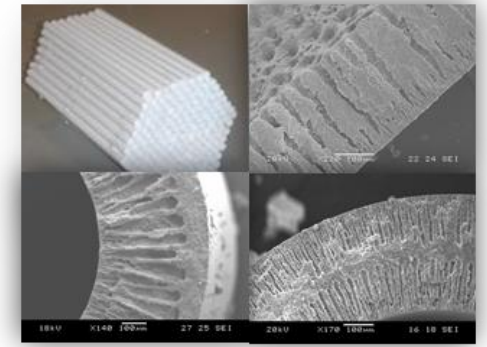
## INORGANIC MEMBRANES

### EXPERTISE & CAPABILITIES

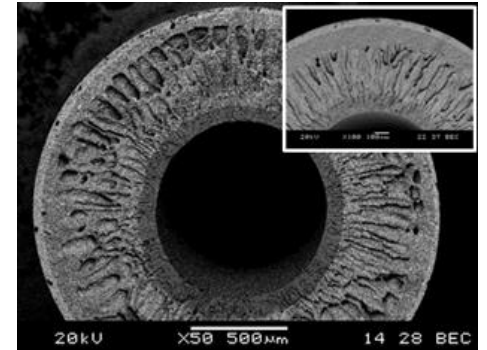
- Functionalisation of ceramic membranes
- Feasibility and proof of concept testing
- Organic solvent nanofiltration testing

### MANUFACTURING FACILITIES UP TO SCALE

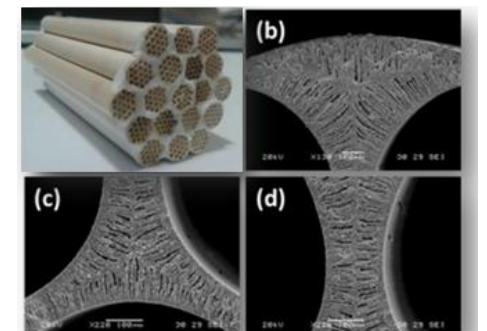
- Development of new methods for efficient functionalization of ceramic membranes, aimed at increased performance in liquid filtrations; extensive feasibility and proof of concept testing from lab to pilot scale in a broad range of separation problems. Unique expertise in Organic Solvent Nanofiltration (**VITO**)



Single-layer



Multi-layer



Multi-channel

# Development and scale up of membranes

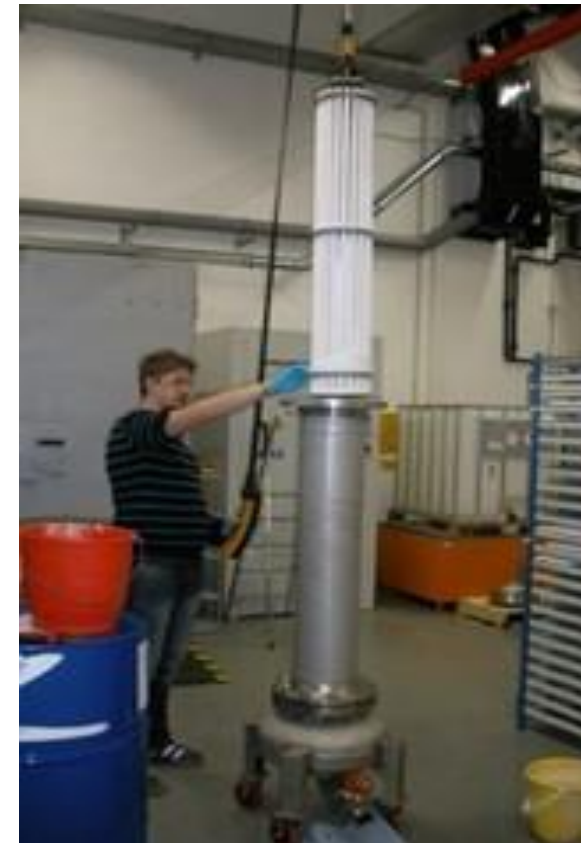
## INORGANIC MEMBRANES

### EXPERTISE & CAPABILITIES

- Fabrication of tubular inorganic membranes for gas separation
- Fabrication of metallic capillary membrane

### MANUFACTURING FACILITIES UP TO SCALE

- Metallic membranes (i.e. Pd-based thin film membranes by electroless plating) (**TEC**)
- Carbon molecular sieve membranes by dip coating (**TEC**)





# Development and scale up of membranes

## DESIGN AND PRODUCTION OF MEMBRANE MODULES

### EXPERTISE & CAPABILITIES

- Potting of membranes
- Sealing of membranes
- Selection of glues
- Selection of housing materials

### MANUFACTURING FACILITIES UP TO SCALE

- Design and fabrication of membrane modules and reactors (**TEC**)
- Design of modules for gas separation (**Hereon**)
- Design and fabrication of hollow fiber membrane modules via potting centrifuge (**EMI Twente**)



# Membrane testing equipment

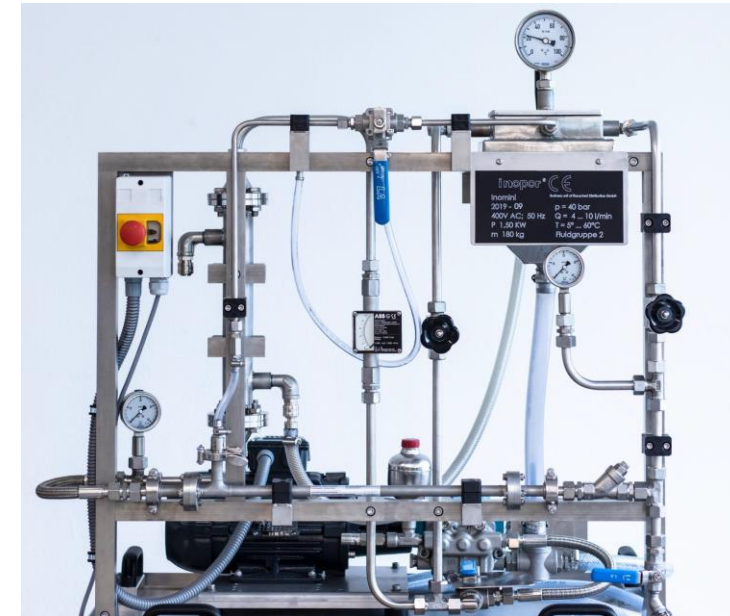
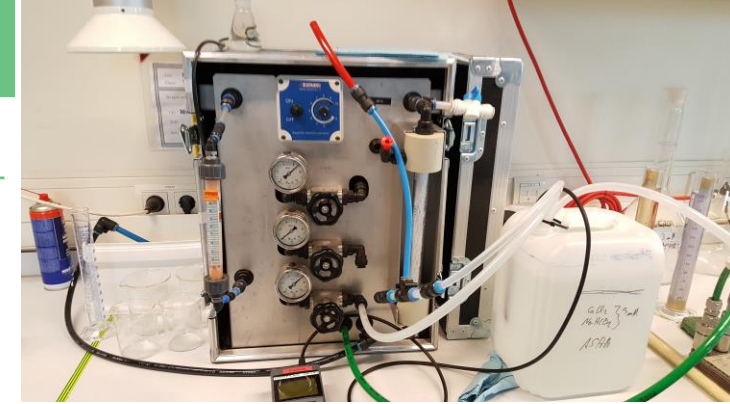
## MEMBRANE LAB SCALE TESTING EQUIPMENT FOR LIQUIDS

### EXPERTISE & CAPABILITIES

- Flexible lab-scale equipment for performance testing in different liquid separation applications

### UPSCALING FACILITIES

- Reverse osmosis, nanofiltration, ultrafiltration, microfiltration, membrane condensers, membrane contactors, membrane distillation (**VITO, EMI Twente, Hereon**)
- Organic Solvent Nanofiltration (**VITO, EMI Twente, Hereon**)
- Pervaporation (**VITO, EMI Twente, Hereon**)
- Electrodialysis (**VITO, EMI Twente**)
- Vapor permeation (**EMI Twente**)
- Automatic time lag permeation apparatus (**TEC, Hereon**)
- Modules autopsy (**EMI Twente**)



# Membrane testing equipment

## MEMBRANE LAB SCALE TESTING EQUIPMENT FOR GASSES

### EXPERTISE & CAPABILITIES

- Flexible lab-scale equipment for robustness testing for different gas separation applications

### UPSCALING FACILITIES

- High pressure gas permeation testing setup (pure and gas mixtures): up to 100 bar (**TEC**)
- Pilot scale units for the investigation of mixed gas permeation performance up to 20 m<sup>2</sup> module scale, 65 bar feed pressure and 250°C feed temperature, gas separation, vapour permeation, organic solvent nanofiltration and pervaporation modules (**Hereon**)
- Separation performance and long-term stability of membranes up to 65 bar in mixed and single gas environments. (**Hereon**)
- Modules autopsy (**EMI Twente**)





# Membrane testing equipment

## MEMBRANE PILOT EQUIPMENT FOR DIFFERENT APPLICATIONS

### EXPERTISE & CAPABILITIES

- Flexible lab-scale equipment for aqueous as well as organic solvent filtration fit for down-stream purifications, gas separation but also for reaction-separation coupling.

### TEST FACILITIES/PILOTS

- Mobile pilots for liquid filtration, both water and organic solvent filtration (ATEX). Some of them are also fit for GMP applications or high temperature applications (**VITO, EMI Twente**);
- Test equipment for membrane-dewatering of solvents (**VITO, Hereon**).
- Pilot installations for gas and liquid separation testing: - Ultrafiltration - Nanofiltration - Reverse Osmosis - Organic Solvent Nanofiltration - Electrodialysis – Pervaporation, High pressure and temperature mixed gas permeation setups (**VITO, EMI Twente**)





# Membrane equipment design and construction

## TUNED TO WISHES OF CLIENT

### ENGINEERING CAPABILITIES

- Construction and installation of membrane filtration units
- Design and construction of lab scale to pilot scale hollow fiber spinning lines

### EQUIPMENT

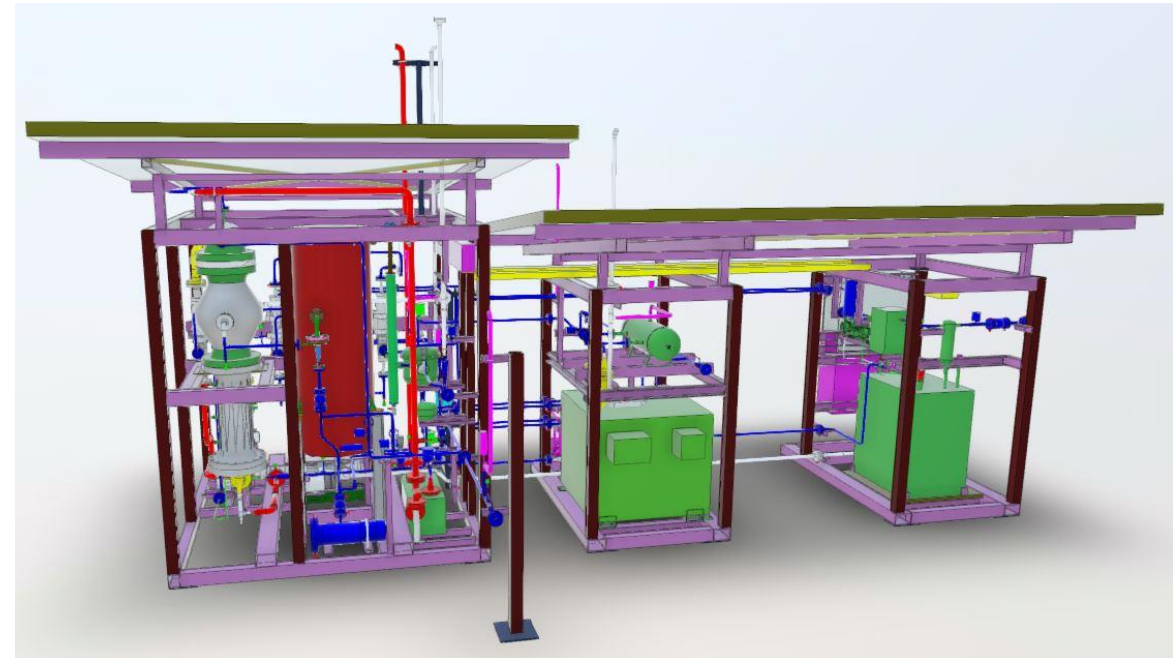
- Engineering and construction of hollow fiber spinning lines (ranging from lab scale to pilot scale), spinnerets, potting centrifuge (**EMI Twente**)

# Membrane process design

## PROCESS DESIGN FOR DIFFERENT APPLICATIONS

### EXPERTISE & CAPABILITIES

- Process development and optimization
- Liquid processes (such as removal of organic micropollutants, pesticides from water, separations in organic solvents etc.)
- Gas separation processes (H<sub>2</sub> production, CO<sub>2</sub> capture, biogas upgrade, gas purification, air separation)
- Design of liquid membrane-based processes solving industrial purification and/or process intensification problems (**VITO, EMI Twente, Hereon**)
- Design of gas membrane-based processes solving industrial purification and/or process intensification problems (**EMI Twente**)
- Design of processes, hybrid and integrated processes for gas separation. Performances and process simulation (**Hereon, EMI Twente**)



# Membrane process design

## PROCESS DESIGN MODELLING AND SIMULATION

### EXPERTISE & CAPABILITIES

- Process Design modelling, simulation for the development of membrane modules
- Prediction of topological, transport, separation and/or barrier properties, geometry characterization and 3D reconstruction.

### COMPUTER AIDED...

- Modelling of membrane modules and reactors (**TEC**)
- Design of modules, processes, hybrid and integrated processes for gas separation. Performances and process simulation. (**Hereon**)
- Nanofiltration/gas separation processes/electrodialysis/swelling of modelling, molecular simulations in nanoporous materials, Ab Initio (Quantum. Calculations on molecular materials and process design (**EMI Twente**))



INNOMEM CATALOGUE

# Non-technical services



# Non technical services

## TECHNO-ECONOMIC ANALYSIS AND MARKET VALIDATION

### EXPERTISE & CAPABILITIES

Techno-economic evaluations of membrane-based processes. Market studies for proposed technological solutions on green gases, Techno-economic evaluations of technologies. (**VITO**)

## CONSULTANCY

### EXPERTISE & CAPABILITIES

Module design, R&D activities in module development, Set up of the production process. desktop or consultancy work, feasibility studies, characterization of membrane samples, membrane development up to first prototype, application studies, small scale piloting, benchmarking, troubleshooting and building of customized equipment. (**EMI Twente, Hereon**)

## BUSINESS INNOVATION SERVICES

### EXPERTISE & CAPABILITIES

Market & Technology Trends Analysis; finding collaboration and scouting solution providers; tailored grant scan for public funding (**PNO**);



# Acronyms and the organisations they represent

## ACRONYM

## ORGANISATION

- 
- |              |  |
|--------------|--|
| • EMI TWENTE | • <a href="#"><u>European Membrane Institute Twente</u></a>                              |
| • FRAUN      | • <a href="#"><u>Fraunhofer-Gesellschaft zur förderung der angewandten Forschung</u></a> |
| • HEREON     | • <a href="#"><u>Helmholtz-Zentrum Hereon</u></a>  |
| • PNO        | • <a href="#"><u>PNO Consultants (Ciaotech)</u></a>                                      |
| • TEC        | • <a href="#"><u>Fundación Tecnalia Research &amp; Innovation</u></a>                    |
| • VITO       | • <a href="#"><u>Vlaamse Instelling voor Technologisch Onderzoek N.V.</u></a>            |
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