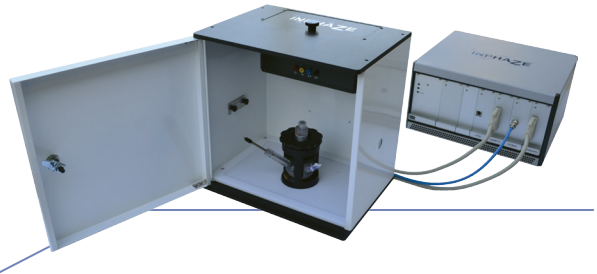
INPHAZE High Resolution Characterisation



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INPHAZE offers a powerful high-resolution system for characterising membranes, transport processes and fouling at the nano scale. Two specialised precision chambers are available to suit specific applications. Along with user friendly software and dedicated support, talk to us today about using the INPHAZE system for your research.

Membrane Applications

The INPHAZE system is ideal for:

- Predicting membrane fouling
- Distinguishing among organic, inorganic and bio fouling
- Obtaining the extent of fouling
- Providing feedback on membrane cleaning (chemical or backwash)
- Characterising membrane compaction
- Characterising membrane structure and performance
- Membrane autopsy

Applications:

- Development of novel membranes
- Diagnosis of surface modifications
- Development of antifouling technologies
- Critical flux studies
- R&D on desalination and waste water
- Monitoring precursor deposition
- Testing targeted biofouling cleaning protocols

Prediction and identification of membrane fouling

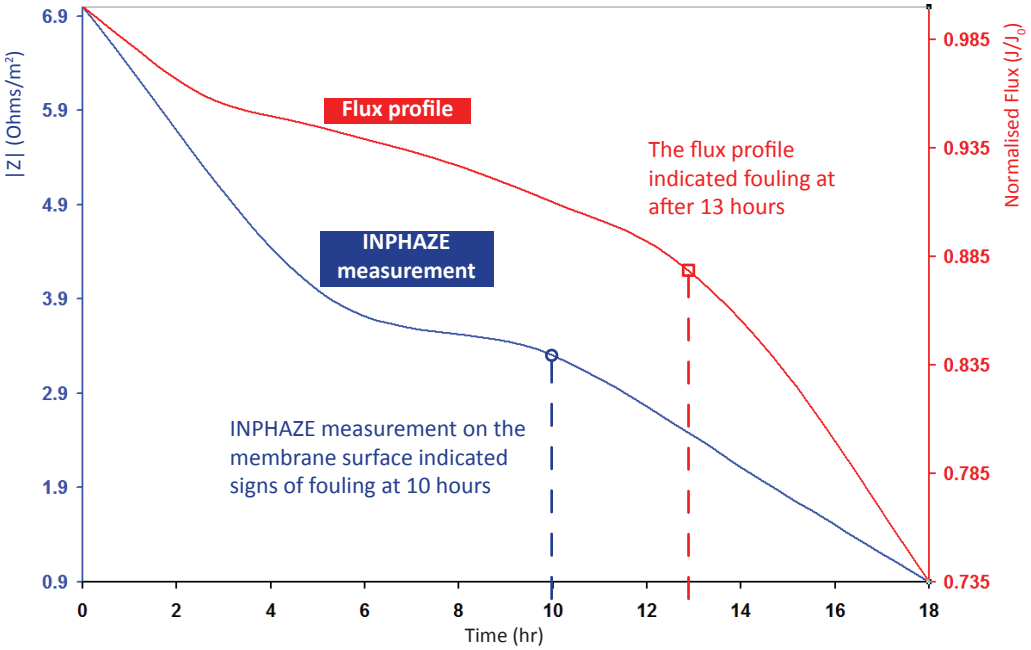
Fouling prediction

Under constant flux operation, membrane fouling is indicated by the increase in trans-membrane pressure (TMP), but the criteria often vary from one operator to another.

Similarly under constant pressure operation, fouling is indicated when flux has decreased below a certain level. What causes the pressure or flux to change is the buildup of fouling layers on the membrane surface.

Extensive research by customers has shown that the INPHAZE system is a valuable tool for predicting membrane fouling.

The system monitors any changes that occur on the membrane surface, in particular the initial deposition of layers. This gives predictive signs of fouling well before significant changes in pressure or flux can be observed.



The result on the left shows the characterisation of a RO membrane during $CaCO_3$ filtration at 90 bar pressure.

Fouling could only be noticed from the flux profile after 13 hours, whereas the INPHAZE system detected significant change on the membrane surface at 10 hours.

This indicates that monitoring the changes on the membrane surface is a more sensitive approach, which is able to give warning before fouling happens.

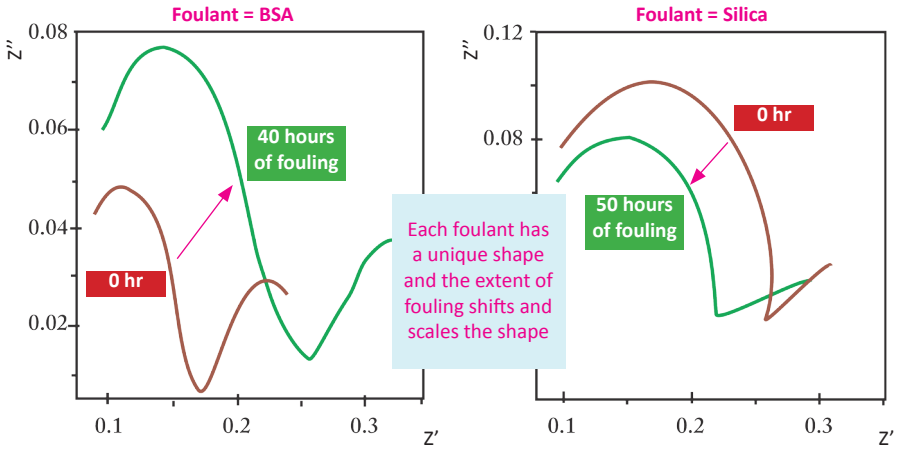
Detecting changes on membrane surface using the INPHAZE system to obtain quantitative indications before fouling occurs

Foulant identification

The INPHAZE system monitors the membrane surface continuously and generates multi-dimensional measurement data.

In addition to providing warning signals before fouling takes place, this data also provides characteristic "signatures" for different types of foulants and for their degree of fouling.

Knowing the type and the extent of fouling is most useful for optimising cleaning protocols and for verifying the effectiveness of cleaning procedures.



Characteristic signatures for different types of foulant and their degree of fouling obtained using the INPHAZE system

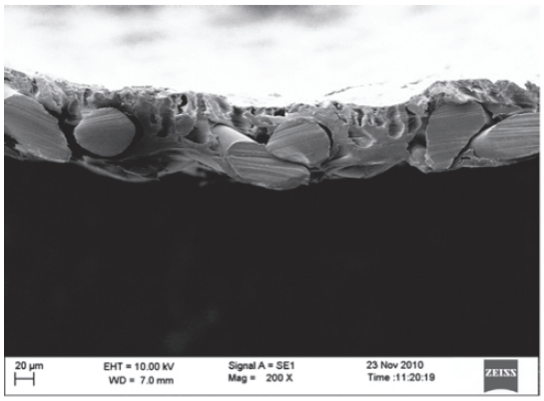
References:

- Alice Antony, Terry Chilcott, Hans Coster and Greg Leslie (2012) "In situ structural and functional characterization of reverse osmosis membranes during mineral scale formation using electrical impedance spectroscopy (EIS)", **Journal of Membrane Science** in print
- ZJ Wang, LN Sim, J Gu, HGL Coster and AG Fane (2012) "Detection of Reverse Osmosis membrane fouling with Silica, Bovine Serum Albumin and their mixtures using in-situ Electrical Impedance Spectroscopy", **Journal of Membrane Science** (submitted)
- Jie Cen (2012) "Characterization of real time behaviour of fouling on the surface of Reverse Osmosis and nanofiltration membranes", PhD Thesis (submitted), University of Sydney

Characterisation of membrane microstructure and performance

The microstructure of membranes is one of the key factors that determine the membrane performance. In general membrane microstructures are characterised using light or electron microscopy, but they provide almost no information on the interaction of membrane microstructure and transport processes. The INPHAZE system is a non-invasive tool that is particularly useful for detailed *in situ* membrane characterisation.

A



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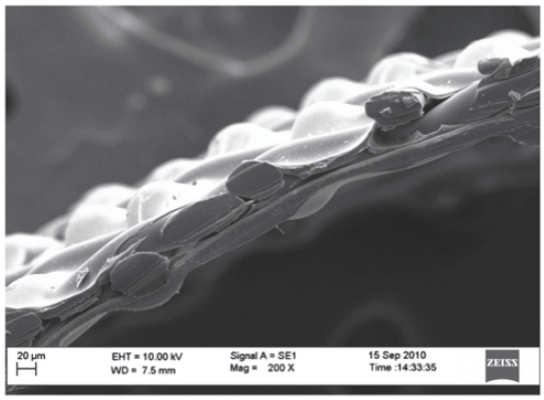

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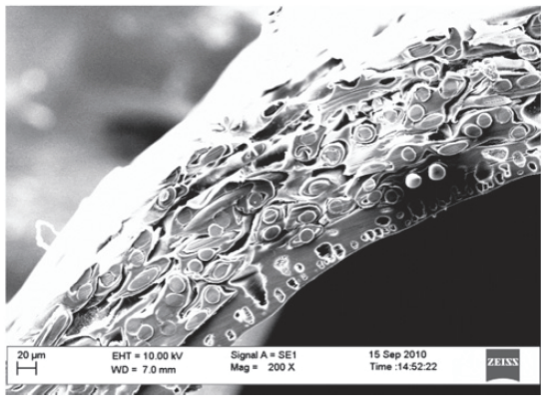
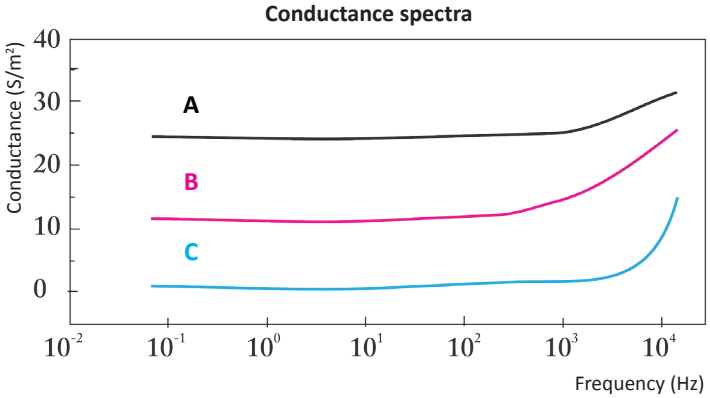
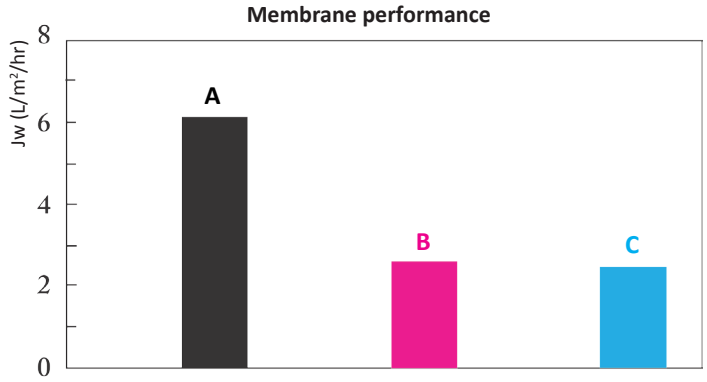


The SEM micrographs of three membranes: "A" (control), "B" (less porous substrate) and "C" (thicker substrate)

Membrane "A" is the control which has the reference substrate, membrane "B" has a less porous substrate, and membrane "C" has a thicker substrate.





Correlating the conductance spectra of different membrane microstructures as characterised using the INPHAZE system to their membrane performances

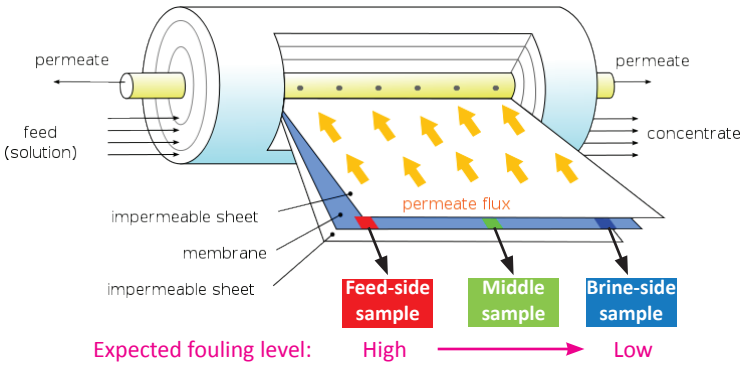
References:

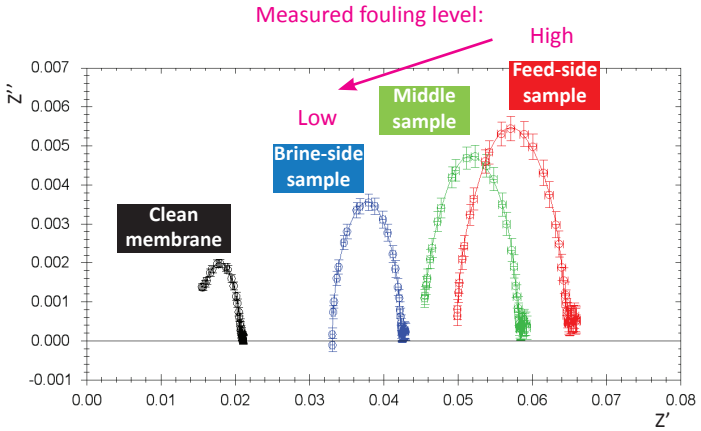
- Yiben Gao, Weiyi Li, Winson Lay, Hans Coster, Anthony Fane and Chuyang Tang (2012) "Characterisation of forward osmosis membranes by electrochemical impedance spectroscopy", **Desalination** in print
- Yiben Gao, Winson Lay, Chuyang Tang, Jie Cen, Hans Coster and Anthony Fane (2011), "Towards real-time non-invasive and sensitive characterization of Forward Osmosis processes", presented at ICOM 2011, **International Congress on Membranes and Membrane Processes**, Amsterdam

Membrane autopsy

Membrane autopsy is useful for determining the causes and the degree of fouling. Current techniques include visual examination, scanning electron microscopy (SEM) and microbial analysis.

The INPHAZE system configured with the Membrane Chamber is particularly effective for autopsy work. The system is sensitive enough to distinctively characterise samples taken from different locations of a fouled RO module.





Autopsy of a fouled RO module along 3 different locations using the INPHAZE system. The measured fouling level for each location exactly matches its expected fouling level.

References:

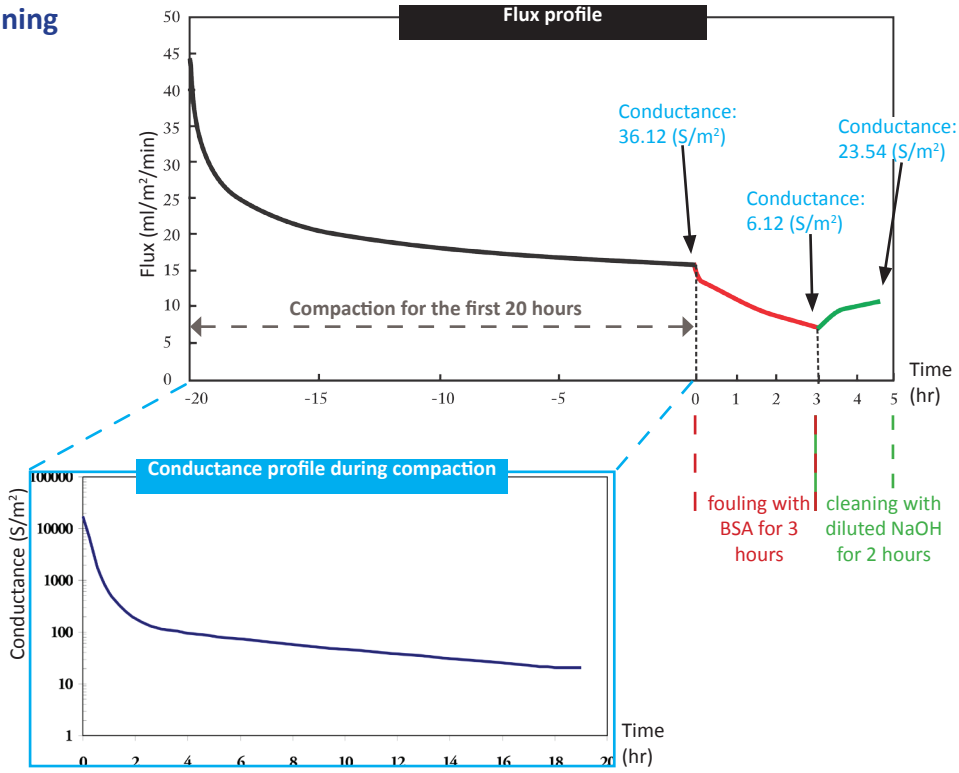
- INPHAZE Customer Report [A53], September 2011.
- Jie Cen, John Kavanagh, Hans Coster and Geoff Barton (2012) "Fouling of reverse osmosis membranes by cane molasses fermentation waste water", presented at **Desalination for the Environment, Clean Water and Energy**, Barcelona, Spain

Membrane compaction and cleaning

When the TMP or flux profile has indicated fouling, it is common practice to initiate membrane cleaning using chemical agents.

However there are no specific tools for determining when to clean, what chemicals to use, the amount of dosing, or for monitoring the effectiveness of cleaning.

The INPHAZE system provides a unified solution to monitor and optimise cleaning cycles. The continuous measurements of the membrane surface deliver quantitative parameters for defining when to clean, which chemicals to use, their dosage amount, and to observe the cleaning results real-time.



Characterising the membrane during the entire compaction, fouling and cleaning cycle using the INPHAZE system and correlating the conductance readings to the flux profile

Reference:

- Jie Cen (2012) "Characterization of real time behaviour of fouling on the surface of Reverse Osmosis and nanofiltration membranes", PhD Thesis (submitted), University of Sydney

Australia & NZ:
www.atascientific.com.au

Europe:
www.panco.de

Headquarter:
INPHAZE PTY LTD
41 Muston St, Mosman
NSW 2088, Australia
ph: +61 2 9969 8159
www.inphaze.com.au