

**Poster presented at the 15th
Aachener Membran
Kolloquium 12th - 13th
November 2014
Proceedings Pages 477 - 482**

H.M. van Veen
M.M.A. van Tuel
J.P. Overbeek
mw. M.D.A. Rietkerk
H.J. Marsman
J.F. Vente

December 2014
ECN-M--14-072



Hybrid silica nanofiltration membranes with low MWCO values

Authors

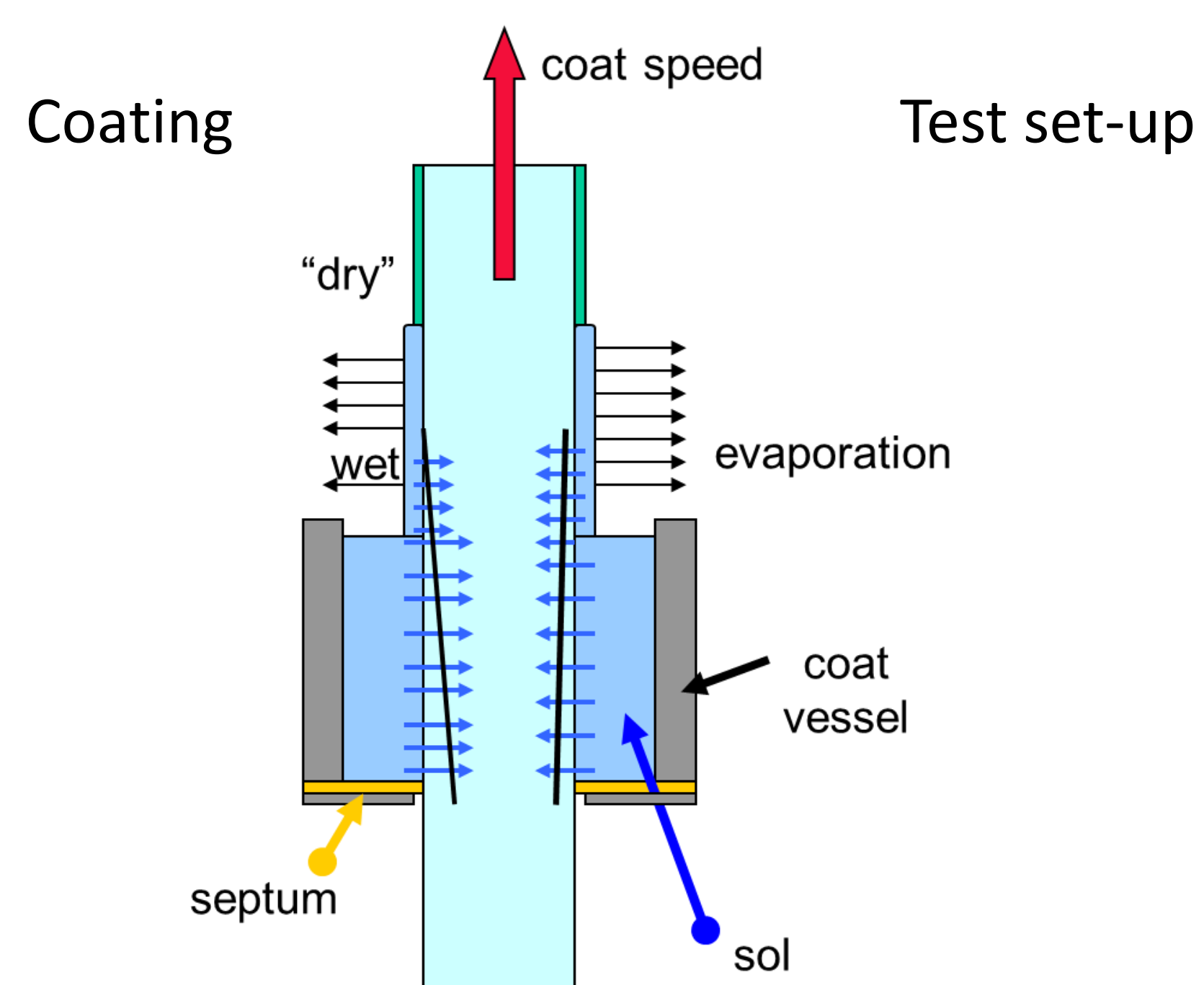
H.M. van Veen¹, M.M.A. van Tuel¹, J.P. Overbeek¹, M.D.A. Rietkerk¹, H.J. Marsman¹, J.F. Vente¹

Corresponding author: vanveen@ecn.nl

Introduction

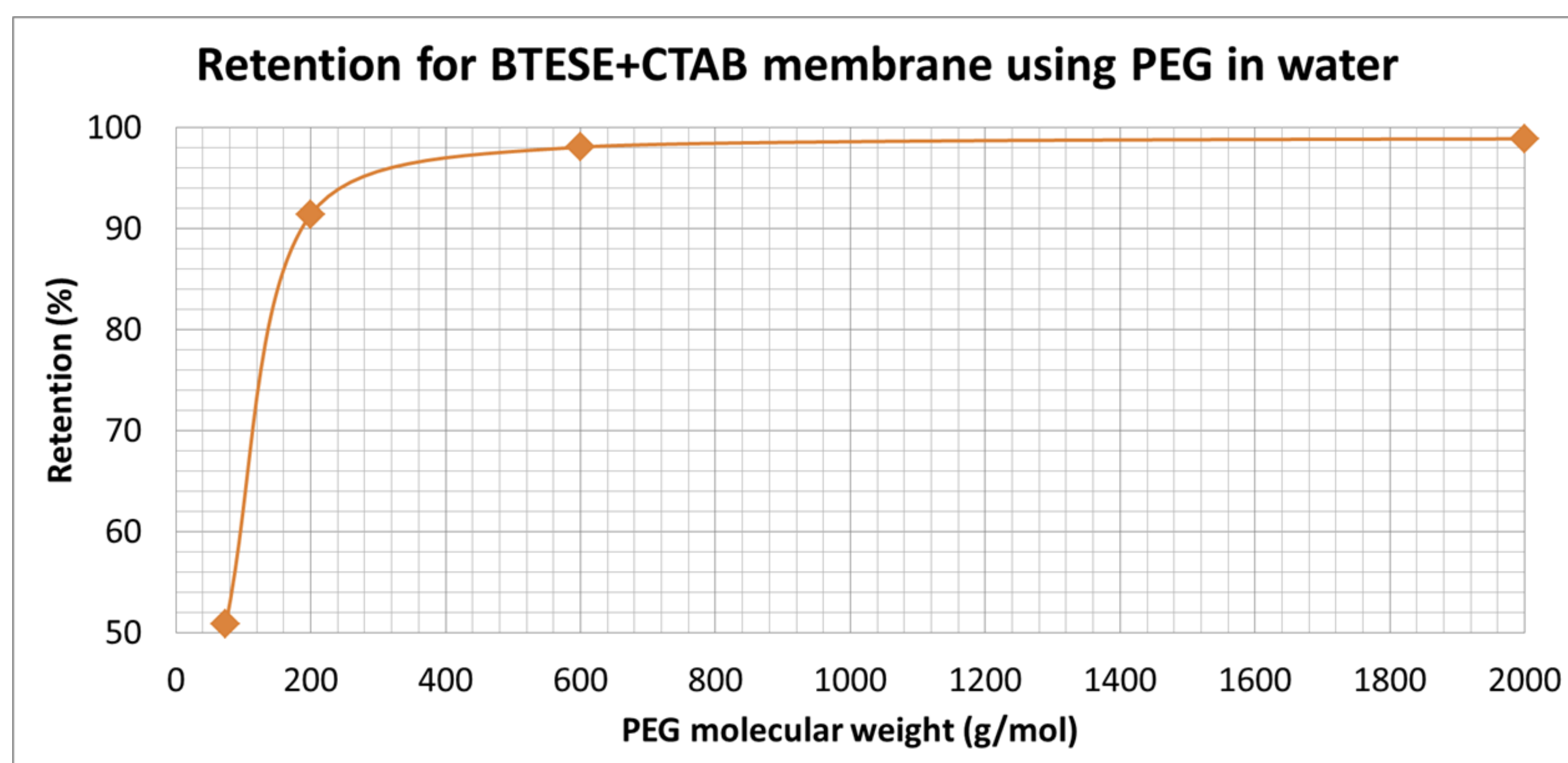
Industrial processes need solvent stable NF membranes

- Cut-off value of a few 100 Dalton
- Important process improvements and energy savings are possible
- Tune the pore size from microporous to more open meso-porous using hybrid silica (BTESE) as precursor and a micelle/ionic surfactant like molecule (CTAB) as pore former in the sol
- Apply the sol via dip coating technology on a ceramic support
- Flux and retention measurements using 1 wt.% PEG (with different molecular weights: 200, 600, 2000 and 10000 Dalton) in a solvent



First result

Membrane with layer thickness of 1220 nm



Reduce layer thickness

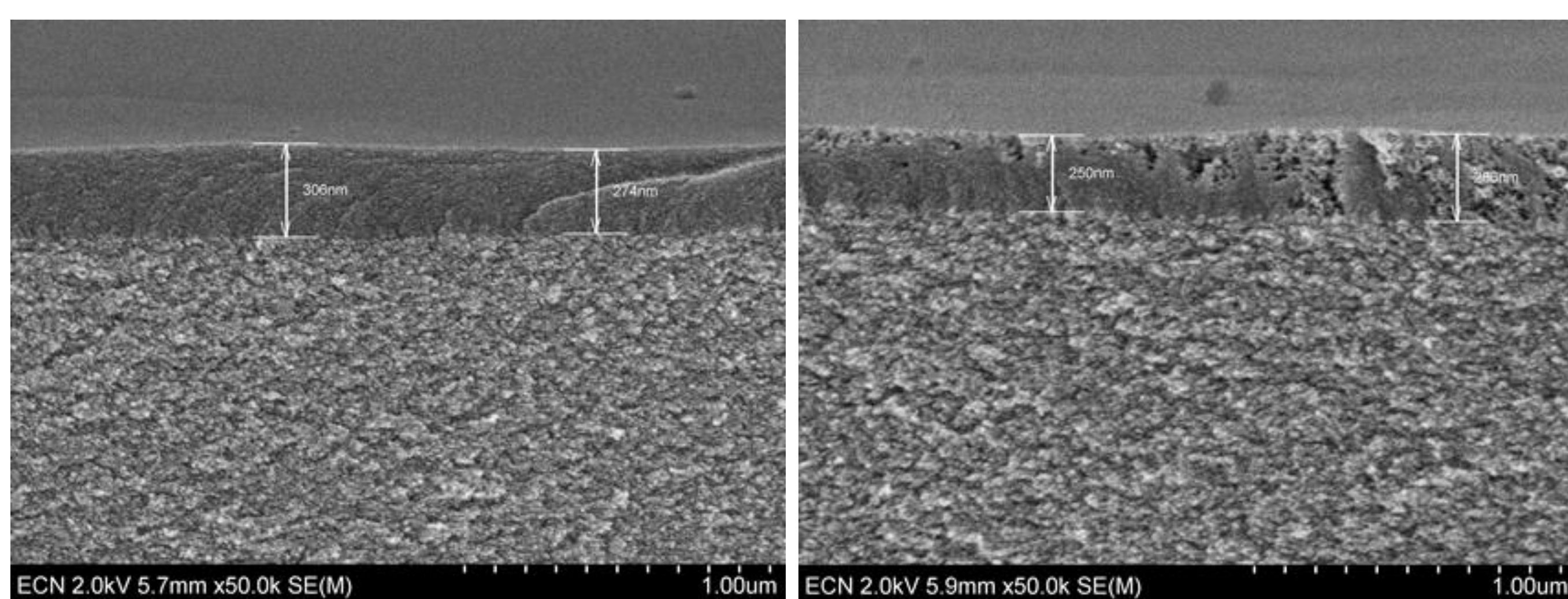
Table: Influence of the layer thickness (made by coating different sol concentrations) on the membrane performance

Membrane	Thickness (nm)	Permeance (kg/m ² hbar)	MWCO for PEG in water (Dalton)
1	1220	0.006 (water)	190
2	375	0.009 (water)	180
3	15	0.010 (water)	180
4	< 5	0.015 (water)	180
4	< 5	0.16 (acetone)	n.m.

Thickness decrease by a factor 250 → flux increase by a factor 2.5: partly infiltrated sol in sub-structure leads to high resistance

Modify pore structure

- Different CTAB concentrations: most optimal is about 0.2 mol/l
- Lower hydrolysis ratio's (water : ethoxy)



Membranes made with water : ethoxy ratio's, left 2.0 and right 0.75

Table: Influence of hydrolysis ratio on the membrane performance

Hydrolysis ratio	Thickness (nm)	Water permeance (kg/m ² hbar)	Retention for PEG 200 in water (Dalton)	Retention for PEG 1000 in water (Dalton)
2.0	275	0.003-0.008	57 %	84 %
0.75	~ 250 (infiltrated)	0.02-0.06	65 %	93 %

Lower hydrolysis ratio's (water : ethoxy) improves the NF performance as a less viscous sol leads to a more open structure but also a more infiltrated layer

Conclusions

- Hybrid silica membranes can be tailored towards NF membranes by using pore formers like CTAB
- A retention of only a few 100 Dalton is possible
- The water permeance has to be improved by a factor of 10 for industrial applications
- The acetone permeance is promising

Acknowledgements

The Dutch TKI-ISPT program within the cluster Energy Efficient Bulk Liquid Separations is acknowledged for partially funding this work

ECN

Westerduinweg 3
1755 LE Petten
The Netherlands

P.O. Box 1
1755 LG Petten
The Netherlands

T +31 88 515 4949

F +31 88 515 8338

info@ecn.nl

www.ecn.nl