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A new microbial polysaccharide membrane for ethanol dehydration by pervaporation

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Solvent dehydration processes have a high economic and environmental relevance in pharmaceutical, fine-chemistry and chemical industry. Among the available techniques, hydrophilic pervaporation has shown potential to solvent dehydration, due to its relative simplicity and low energy input, as compared to traditional energy-intensive methods. The dehydration of alcohols by hydrophilic pervaporation has been studied intensively and many efforts have been devoted to the development of new biopolymeric membranes with high separation performance and reliability; in particular, polysaccharides have received much attention, due to their good selectivity [1,2].

In this work, membranes were prepared from a microbial exopolysaccharide (EPS) produced by *Pseudomonas oleovorans* using glycerol, a by-product from the biodiesel industry, with high productivity and polymer yield [3]. These membranes show a high affinity for water and are resistant to organic solvents, which makes them particularly interesting to be applied in pervaporation systems for solvent dehydration. Two types of membranes were prepared: homogeneous (EPS) and composite of EPS with polyethersulfone (PES) as support (EPS-PES) and their morphological structure was characterized by scanning electron microscopy (SEM).

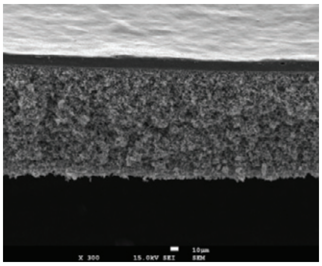

Fig.1. Cross-section image of the EPS-PES composite membrane.

The mechanical properties (stress and elongation at break) were measured for ambient conditions (T=19ºC, 44.3%HR) and also after immersion during 24 h in a solution of 10 %wt water in ethanol, mimicking the conditions of the pervaporation tests. For all the membranes a decrease of the Young's modulus after immersion during 24 h in a solution of 10 %wt water in ethanol, was obtained. This indicates that the membranes become more flexible due to swelling, which was also reported by other authors [5].

Experiments were performed for ethanol dehydration by pervaporation for a water concentration in the feed phase of 5% wt and 10% wt at a constant temperature of 30ºC.

The performance of the membranes was quantified in terms of permeability and selectivity, which are intrinsic properties of the membranes and thus, can be used to compare results obtained at different experimental conditions (Table 1).

Table 1. Comparison of permeability and selectivity values of water and ethanol of the composite membrane of EPS-PES with other membranes

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Membrane	**T (ºC)**	**$[Water]_{feed}$ (%wt)**	**δ active layer (μm)**	**P_w x 10^{12} (mol/m.s.Pa)**	**P_{et} x10^{14} (mol/m.s.Pa)**	**Selectivity (w-et)**	**Reference**
EPS-PES	30	5.2	12.5	1.8	0.0(6)	3000	Present study
PAAHCl-PVA-PVDF	70	5.0	-	4.7	0.2(4)	1950	Namboodiri & Vane, 2007
EPS-PES	30	10.4	12.5	3.8	2.9	134	Present study
PERVAP® 4101	30	9.9	≈3,5	7.2	1.3	554	Present study

The permeability values increased and the selectivity values decreased with the increase of water feed concentration. This increase may be explained by the modification of the membrane structure with the increase of water concentration in the feed phase, turning it more flexible (in line with the decrease of the Young's modulus), and hence, less selective. In spite of the promising results, the commercial membrane PERVAP® 4101 still shows a higher water permeability and selectivity.

Future work will be focused on implementing strategies in order to improve the flux and the selectivity of the membranes, which will include polymer crosslinking, incorporation of inorganic particles and development of bilayer polyelectrolyte membranes of EPS and chitosan.

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