**How the fouling can affect the transport and energy generation in PRO process**

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**Highlights**

* Developing new expressions involving the fouling layer.
* This layer forms quickly and lowers essentially the performance..
* Seawater/river water pair provide not enough energy.
* An alternate solute might be the switchable polarity ionic liquid.

**1. Introduction**

Accumulation of a foulants on the membrane layer (or inside it) during energy generation by pressure retarded osmosis process, applying e.g. seawater/river water pair affects strongly the transport process and the power generation. Several paper studied the efficiency of the energy generation by seawater/river water pair [1,2]. The conclusion was, that the commercially available membrane does not provide nowadays enough selectivity and water transport to make this process economic. On the other hand, the mass transport through the transport layers, including the fouling layer, should accurately be described to be able to predict reasonably the process efficiency. In a study we have shown how the literature models have been extended for the fouling layer, as well [3]. Accordingly, this new transport model describes the real effect of the fouling layer on the mass transport process, namely on the solute and the water transport. Equations developed involve also the separate expression of the internal interface concentrations, thus they make possible to predict the osmotic pressure difference, and thus the power density more accurately than the literature expressions.

On the other hand if one wants to use draw solution with much higher solute concentrations than the seawater than the solution used should be regenerated for its repeated usage. It seems that a switchable polarity solvent might be suitable to it. For its investigation, high molecular weight dibutyl-(2-(2-metoxyethoxy)-ethyl)-amine was prepared, which forms water soluble ionic liquid in water+CO2 system. This ionic liquid can then switch back to the molecular (non-water soluble) form by expelling CO2 at 90 oC.

**2. Methods**

Organic fouling experiments using alginate are used to validate the model and observe the effects of feed salinity, cross-flow velocity, membrane orientation, feed spacers on foulant accumulation rates. Increasing feed salinity and cross flow velocity both lead to a decrease in foulant accumulation in PRO orientation. It will also be shown deviances in the osmotic pressure difference, using the individual interface concentrations of the active layer, and the literature approach. On the other hand, we have measured the energy generation with the ionic liquid prepared. Its regeneration have also been investigated.

**3. Results and discussion**

During the building the fouling layer, the water flux was significantly decreased, depending on the thickness of the fouling layer. Figure 1 illustrates the power density as a function of the draw side osmotic pressure, at three different thickness of the fouling layer, *Sc.* Its decrease is essential*.*

**Figure 1.** Maximum power density as a function of draw solution osmotic pressure and cake structural parameters in PRO system for a river water feed Parameters used were: *Cf* =0.862 g/L (0.015 mol/L; river water); *kd* = 8.43 × 10-5 m/s; *kf* = 2.07 × 10-5 m/s; *A* = 1.8 × 10-7 m/s-bar; *B* = 5 × 10-7 m/s (A, B are water and solute (NaCl) permeabilities)

It will also be shown the effect of the ionic concentration on the energy generation and results will be compared with those obtained with NaCl solution. On the other hand, the regenerability of the ionic liquid will be discussed as alternative solution to the seawater/river water pair. Namely, the easy regeneration of the solutes would enable to use high concentration draw solution, which can produce much higher energy density than the seawater/river water pair.

**4. Conclusions**

The production of the “blue” energy needs still essential improvement to become more economic. This presentation try to answer some questions to be solved for it.

**References [Calibri 10]**

1. A.P. Straub, A. Desmuckh, M. Elimelech, Environ. Sci. Technol., 9 (2016) 21-48.
2. G. O’Toole, L. Jones, C. Coutinho, C. Hayes, M. Napoles, A. Achilli, Desalination 389 (2016) 39-51.
3. E. Nagy, I. Hegedüs, E.W. Tow, J.H. Lienhard, J. Membr. Sci., 565 (2018) 450-462..