Produced water treatment by low fouling polyelectrolyte multilayer based nanofiltration membranes

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Motivation

Produced water (PW) is the largest waste stream generated by oil and gas (enhanced) recovery operations [1,2]. Many technologies are available to treat produced water, including gas flotation, hydrocyclones, adsorption, media filtration and membrane technology. Typically, only a process including multiple of these techniques can really give the desired effect [1], hence each of these technologies will be part of a larger process. In such a large process, membrane technology is especially interesting as it is one of the few techniques that can successfully remove the smallest (< 10 µm) and most stable oil droplets. Membrane technology also has clear downsides, and in produced water treatment membrane fouling is a very serious problem. Since PW is a complex mixture, many of its components can foul the membrane, leading to very substantial decreases in the flux of treated water. In this project we propose the development of a novel nanofiltration (NF) membrane, with a surface chemistry optimized towards a low fouling propensity in PW treatment.

Technological challenge

Low fouling NF membranes will be prepared by polyelectrolyte layer-by-layer deposition on ultrafiltration (UF) supports. A large benefit of this approach is its versatility, allowing us to control the chemistry of the membrane surface, and the membrane geometry on which the layer is applied. In this way it also becomes possible to study membrane fouling in PW treatment from a very fundamental viewpoint, by careful variation of chemistry and geometry. We propose that this membrane will allow a unique process where de-oiling and control over the salinity can be achieved in a one-step membrane process.
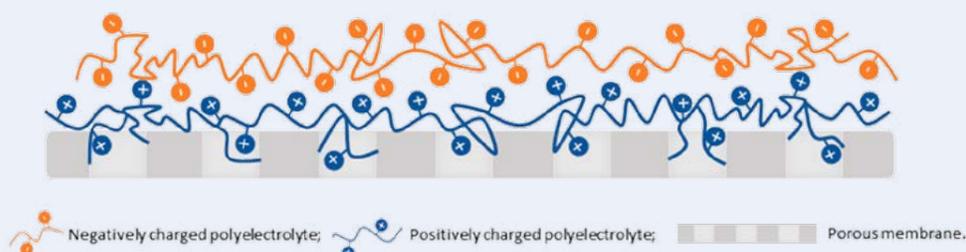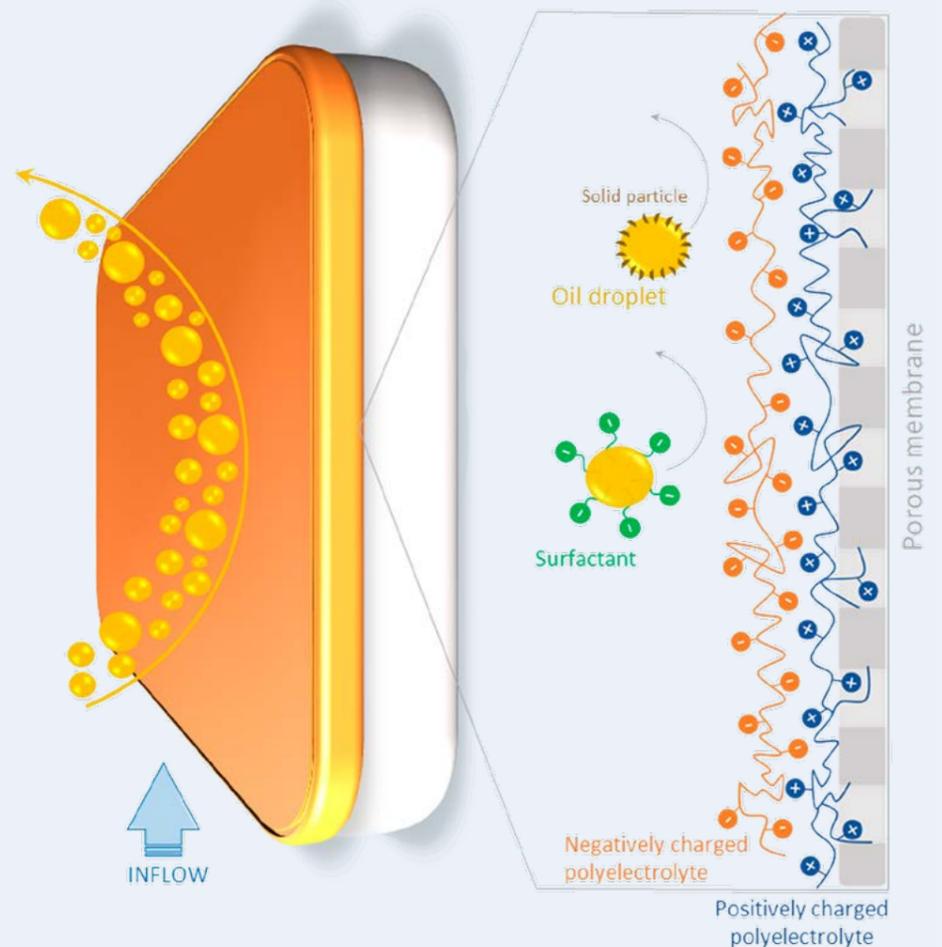

Fig 1. Schematic illustration of a low fouling fouling NF membrane prepared by polyelectrolyte layer-by-layer deposition on ultrafiltration membrane.

Research goals

Fundamental understanding of membrane fouling in PW treatment will lead to the development of a NF membrane with good separation and permeability performance optimized towards a low fouling propensity in produced water treatment. We will control the separation properties, the membrane chemistry and the membrane geometry, while studying membrane performance against artificial PW to reach the following project goals:

- To demonstrate the conditions under which polyelectrolyte multilayer (PEM) based NF membranes can be successfully applied in PW treatment;
- Good fundamental understanding on the effect of membrane surface chemistry and membrane geometry on membrane fouling during PW treatment;
- To translate this understanding into an optimized PEM based NF membrane, that does not require pre-treatment for its operation.

[1] Igunnu E.T. and Chen, G.Z., "Produced water treatment technologies", International journal of low-carbon technologies, 0, 1-21, 2012;

[2] Bilstad T. and Espedal, E. "Membrane separation of produced water", Water Science and Technology, 34, 239-246, 1996.

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