Understanding and controlling membrane fouling in produced water treatment

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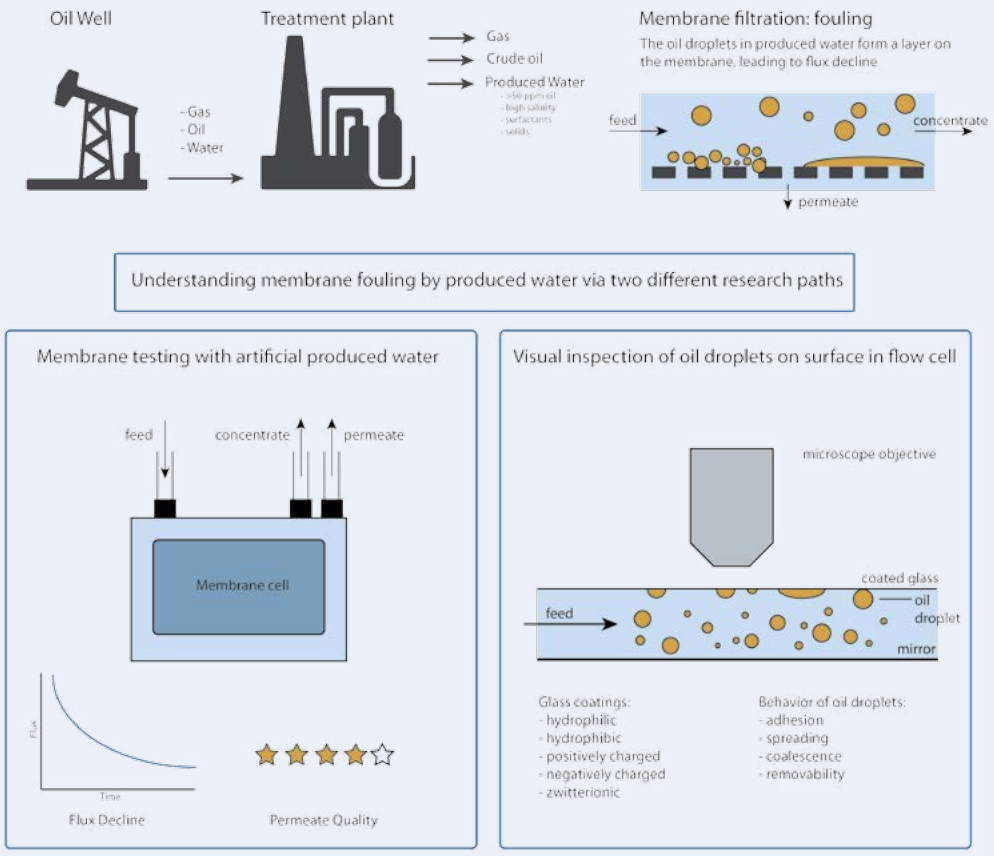
Motivation

Produced water is the largest waste stream generated by oil and gas production. It's a complex mixture of organic and inorganic compounds, that are present in both a dispersed and a dissolved state. Before this produced water can be re-injected, discharged or re-used as irrigation water or industrial water, the water has to be treated. A big challenge is posed by the smallest (<10 µm) and most stable oil droplets. Membrane technology is able to remove those oil droplets, but membranes suffer from fouling. This project focusses on understanding the fundamentals behind membrane fouling by the different components in produced water.

Scientific challenge

The oil droplets are one of the the key components in the fouling of the membranes. The stability of the emulsion plays an important role, because this determines whether the oil will attach to the surface as individual droplets, or if they coalesce to form a layer.
In order to understand the influence of the different components in the produced water and this interaction between the oil droplets and the surface, artificial produced water will be used in the experiments. This way, the concentration of the different components can be controlled and varied.

Instead of using real membranes, a glass model surface will be used. This glass slide can easily be modified with different chemistries, like hydrophilic, hydrophobic or zwitterionic end-groups [1]. This glass slide will be placed in a flow cell under a microscope, in order to study the adsorption behavior of the droplets in the emulsion .



The appearance of the oil droplets in the flow cell changes with adhesion and spreading, thus allowing us to study the interaction of the emulsion with the different surface chemistries (Figure 1).

The knowledge obtained with this model system can be translated to real membranes with the same surface chemistry. This way, we will develop a quick and easy screening method for new membrane surfaces.

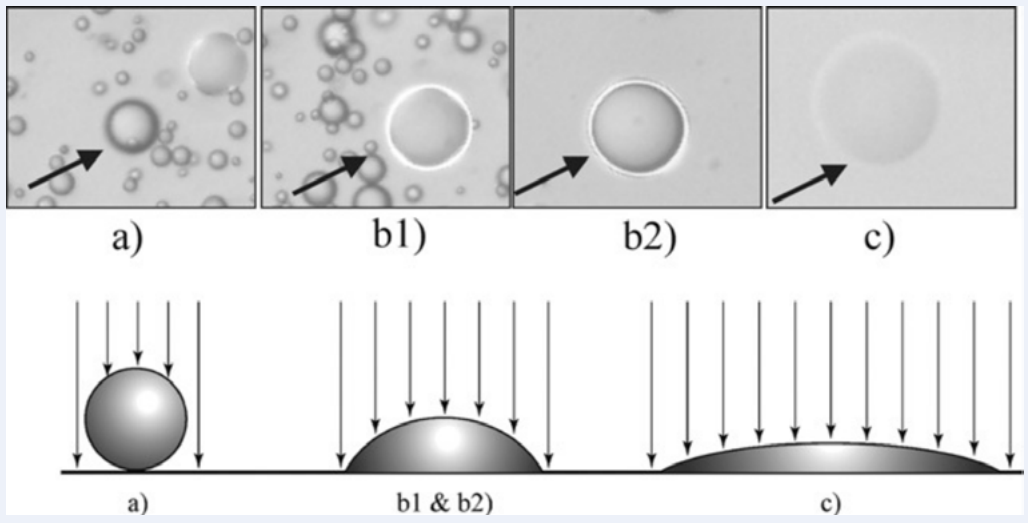


Figure 3: Microscopic appearances of a) an adhered droplet, b1 & b2) spread droplets with different contact angles, c) spread droplet with low contact angle (figures from [2]).

Research goals

- Understanding the interaction of stabilized oil droplets with different membrane surfaces
- Translating the obtained knowledge for the development of low fouling membranes for produced water treatment

References

[1] [M. Hadidi and A.L. Zydney, "Fouling behavior of zwitterionic membranes: Impact of electrostatic and hydrophobic interactions", Journal of Membrane Science, 452, 97-103, 2014

[2] D. Dresselhuis et al., "Direct observation of adhesion and spreading of emulsion droplets at solid interfaces", Soft Matter, 4, 1079-1085, 2008

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