Research group Membrane Materials and Processes

Investigating the impact of Pluronic as draw solution on LbL-membranes in FO

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Introduction

Forward osmosis (FO) systems benefit from the naturally generated water diffusion from a low osmotic solution (feed) to a high osmotic solution (draw) through a **semipermeable membrane**. This membrane consists of two crucial components: **the porous support layer**, which provides structural integrity and mechanical strength, and **the selective layer**, which provides selective permeation, allowing only water molecules to pass while rejecting draw solutes (Fig. 1) [1].

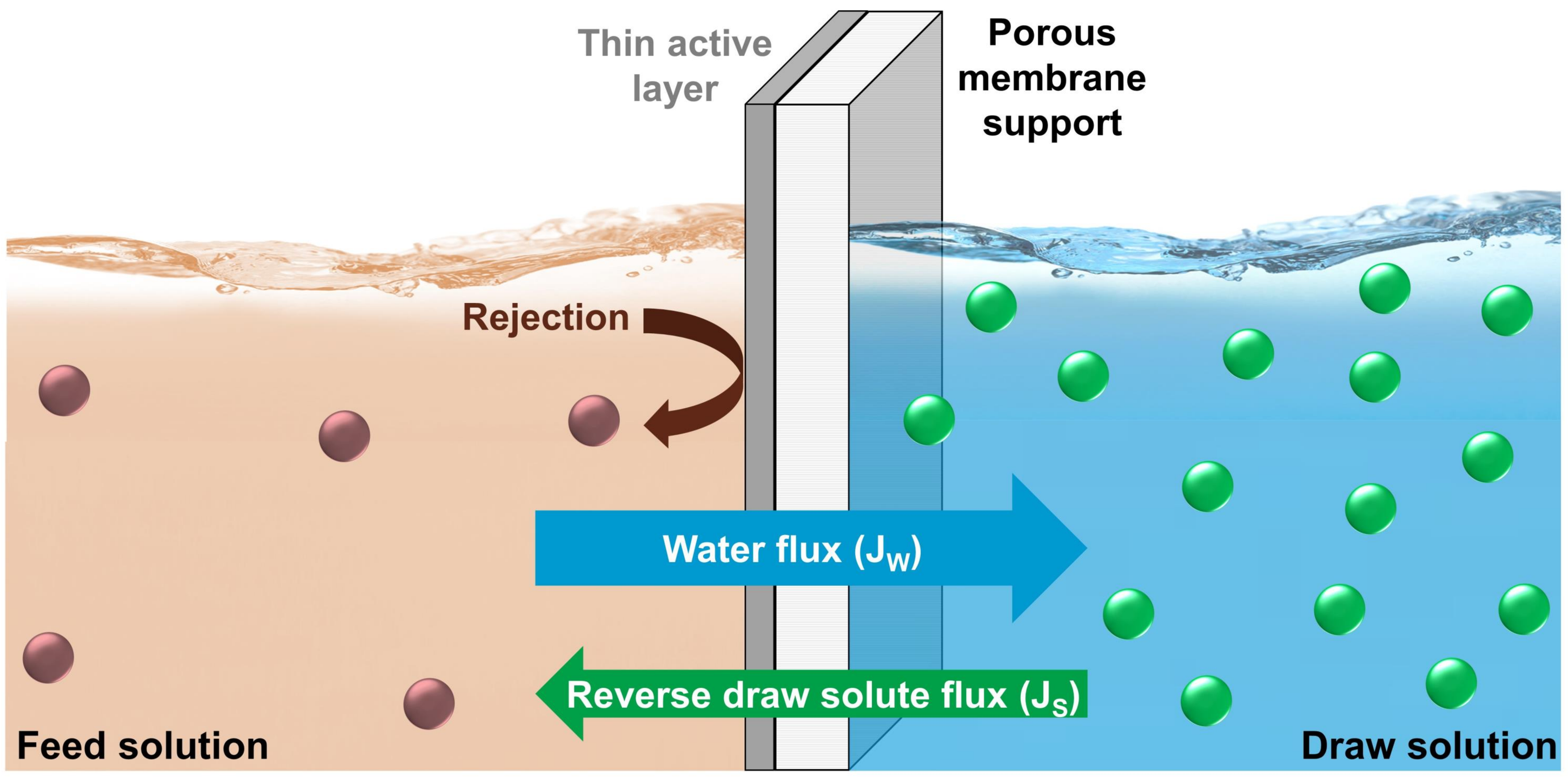

Figure 1.:Water transport and draw solute rejection mechanisms in the FO system

One of the main challenges in FO is the selection of an optimal draw solution (DS) that combines high osmotic pressure with low toxicity, and easy regeneration. **Pluronics**, non-ionic amphiphilic polymers, have been identified as promising candidates for the DS due to their high osmotic pressure, and thermo-responsive properties [2]. For the selective layer, the **Layer-by-Layer (LbL)** assembly technique, a relatively a new approach in FO is used to reduce J_S and still generate a high J_W.

Membrane preparation

In this work, polyacrylonitrile (PAN) membrane supports (GMT Membrantechnik GmbH, Germany) are pretreated with EtOH:water and then hydrolyzed with 1.7M KOH at 45°C to introduce a negative surface charge (H-PAN). Then, LbL coating of several bilayers (BL) is applied using 0.01 wt% polyelectrolyte (PE) solutions of **PDADMAC** and **PSS** (Fig. 2).

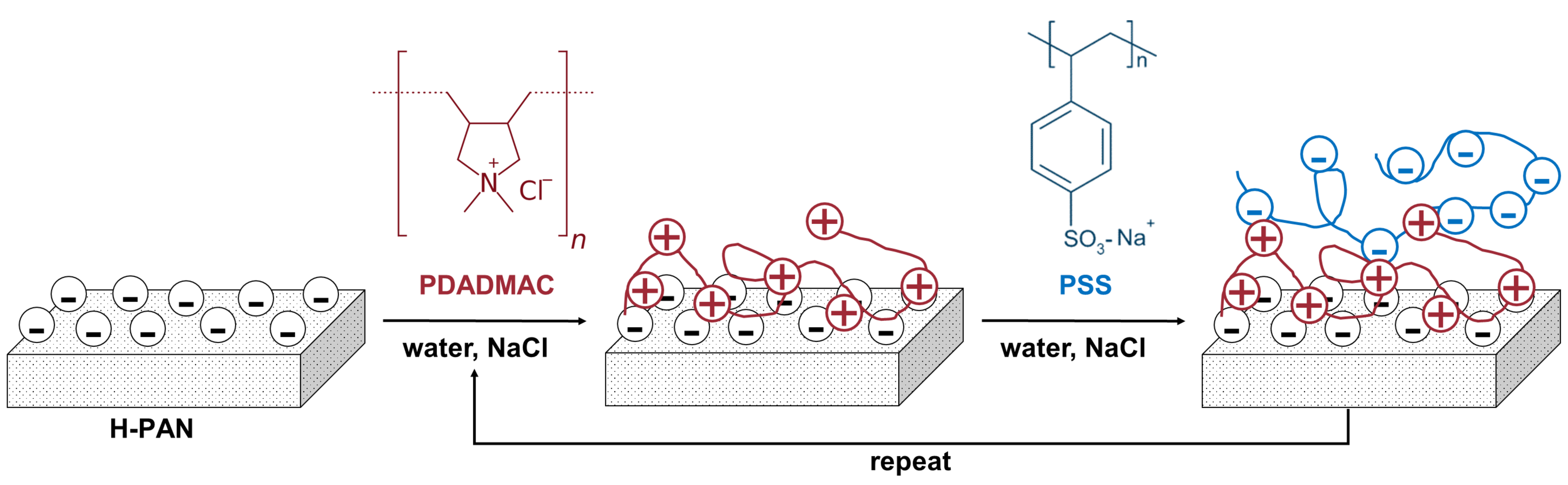

Figure 2. Application of the selective LbL coating on the H-PAN support.

Results

The layer formation and subsequent Pluronic adsorption are measured with reflectometry. It was found that the PE-adsorption increases more than proportionally with the salt concentration in the coating solution (Fig. 3a). The subsequent Pluronic adsorption increased with both the Pluronic concentration and the number of BLs, due to increased PE surface area (Fig. 3b).

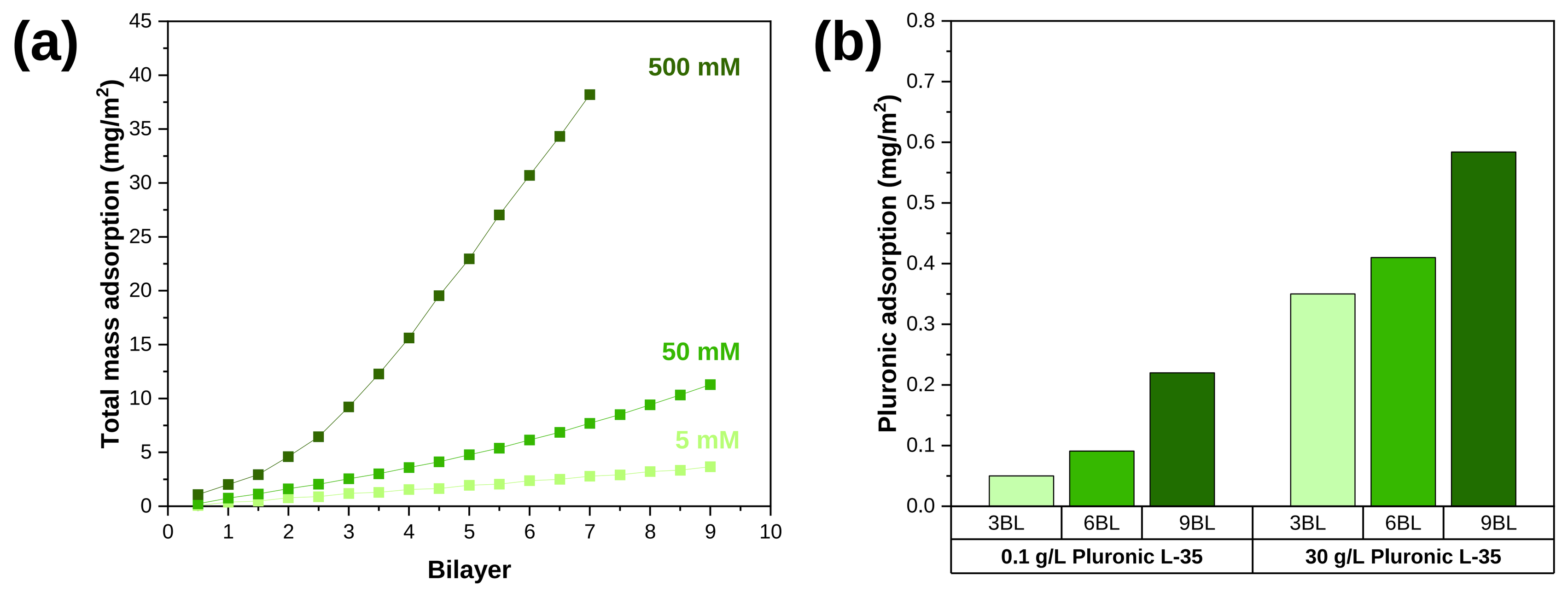

Figure 3. (a) LbL layer formation at varying salt concentrations and (b) adsorption of Pluronic at varying concentrations on the LbL samples prepared with 50 mM NaCl.

Membranes coated at lower salt concentrations showed **higher J_W** due to Pluronic adsorption with a **significant decrease in J_S**. In contrast, high salt concentration led to a very open structure with no selectivity (Fig. 4a). Moreover, the addition of more BL results in the trade-off between a higher J_W due to higher Pluronic adsorption but also decreased J_W due to higher permeation resistance because of thicker PE layers (Fig. 4b).

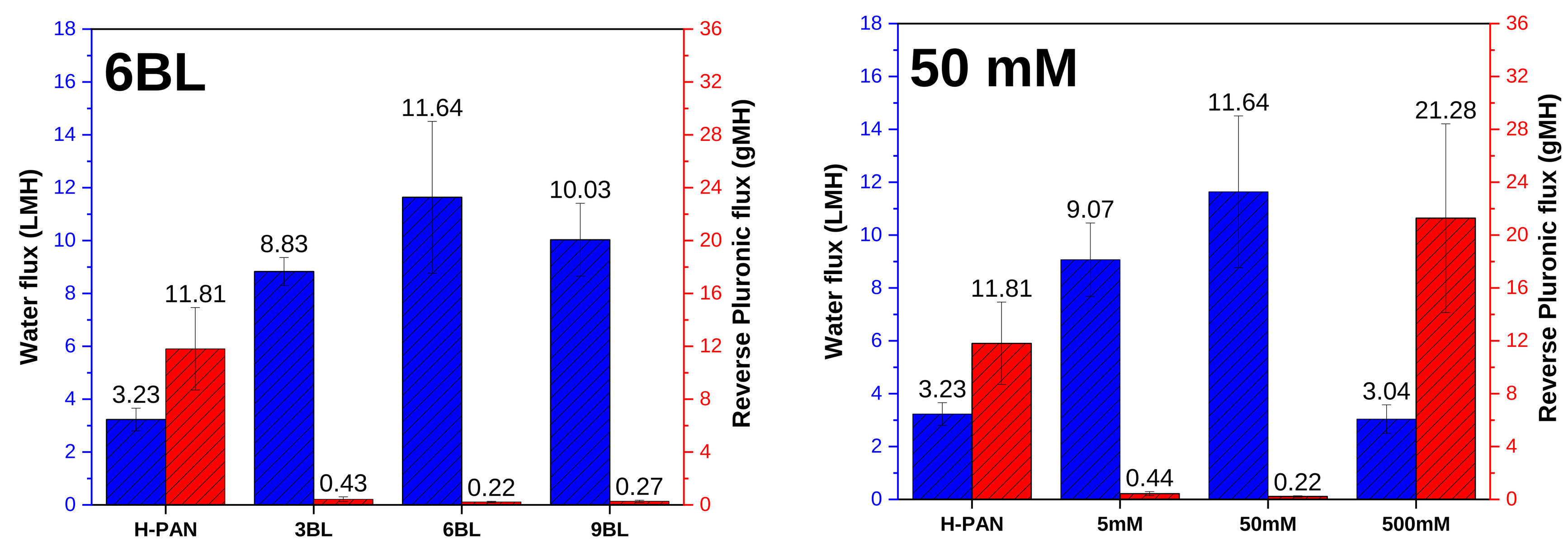

Figure 4. (a) Salt concentration and (b) number of BL effect on the FO performance.

Conclusion

LbL coated membranes prepared with lower salt concentrations showed enhanced J_W and increased number of BL showed improved Pluronic rejection. Highest selectivity and J_W observed with the membrane composition of 6BL, as the addition of more BLs did not provide additional selectivity.

Acknowledgements

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References

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[2] Y. Xu et al., Water Research, 221, (2022) 118768.

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