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Saline solutions cleaning of MF membranes fouled with microalgae-based synthetic emulsion

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Introduction

Membrane filtration is a promising separation technology to recover biomolecules from microalgae, i.e. lipids and proteins. Few works deal with membrane regeneration after filtration, which still requires large volumes of alkali solutions associated with important costs. Corbatón-Báguena et al. (2015) have successfully used NaCl solutions to clean ultrafiltration membranes fouled with whey proteins. The aim of this work was to test this innovative procedure on membranes fouled with an emulsion representative of microalgae lipid extracts.

Material and methods

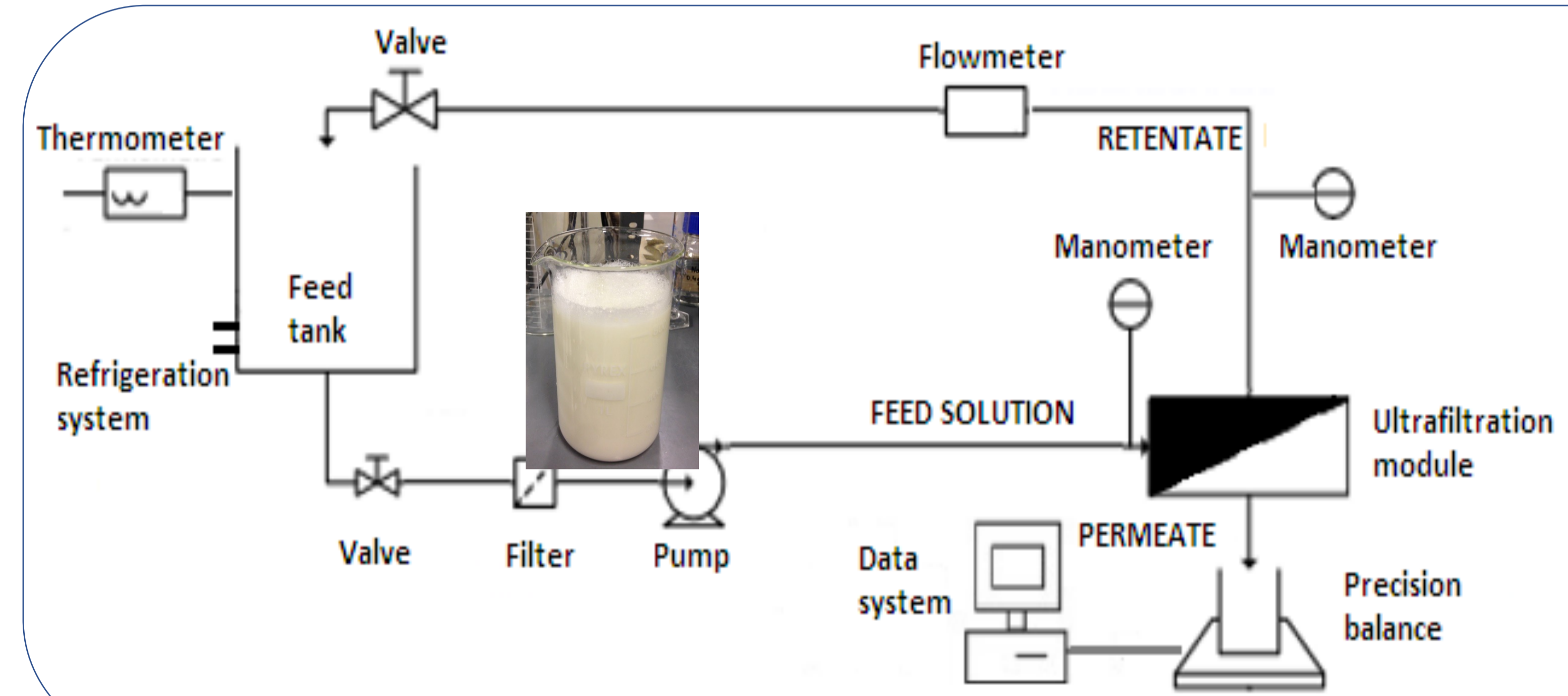
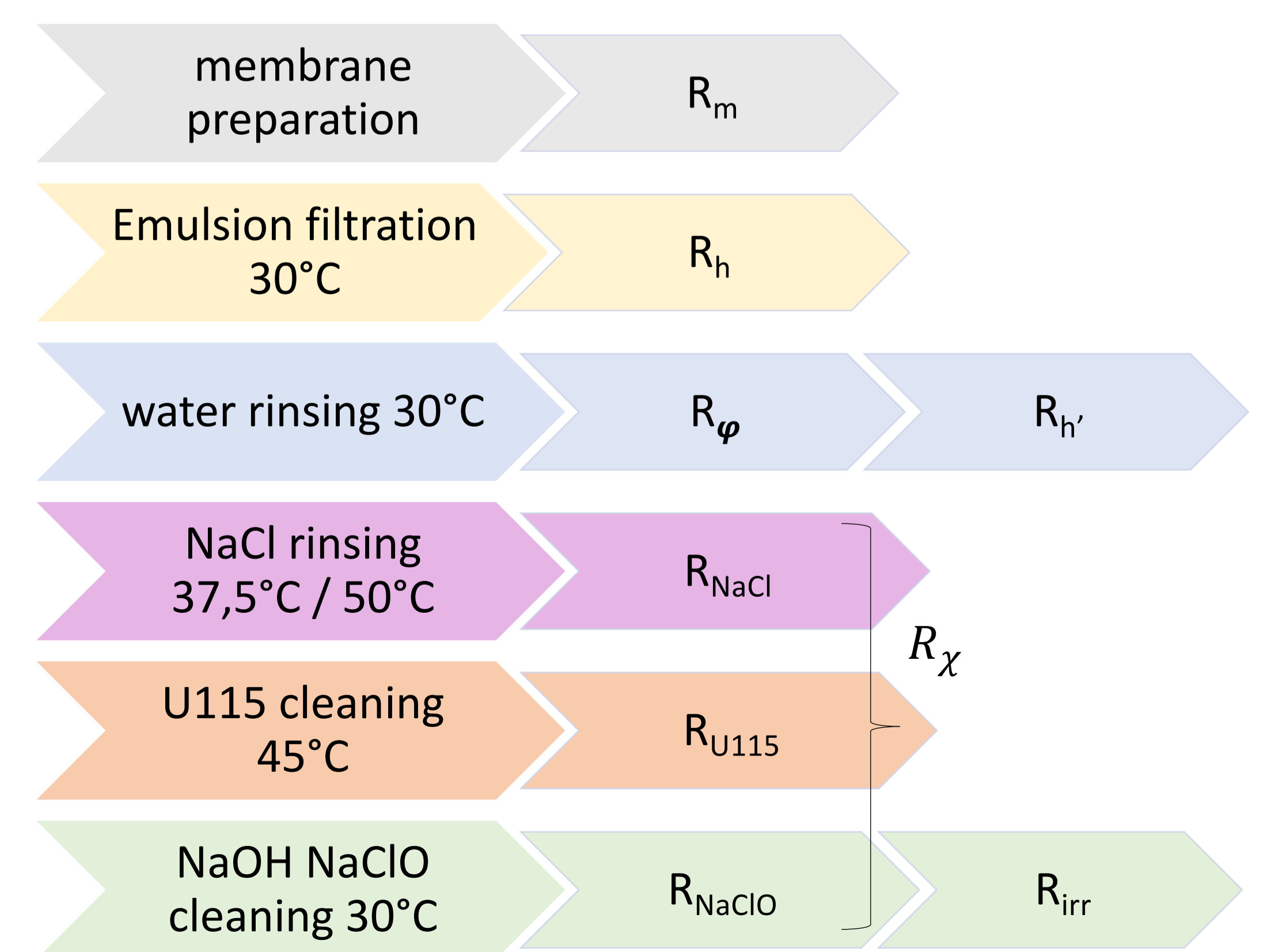


Figure 1: Filtration of an oil/water emulsion (2% lipids) in a Rayflow 100 pilot (PTM=0.43 bar, 30°C, 0.5-0.8 m/s) using a PES 0.1µm (MFK-618, KOCH)
The membrane was rinsed with:
1-water at 30°C
2-NaCl (0 – 5 – 7.5mM) (+water) at 37.5°C and 50°C
And then cleaned with:
-U115 at 45°C (+ water)
-NaOH, NaClO at 30°C (+water)

The hydraulic cleaning efficiency (HCE_i) related to each cleaning step was calculated using water flux measurements. 3 types of membranes (after membrane preparation, after fouling and water rinsing, and after NaCl rinsing) were characterized using electrokinetic methods, ATR-FTIR and AFM.



$$J_{step\ 0} = \frac{TMP}{\mu \times R_h}$$

$$R_h = R_m + R_\phi + R_\chi + R_{irr}$$

$$R_{h'} = R_m + R_\chi + R_{irr} = \frac{TMP}{J_{step\ 1} \times \mu}$$

$$HCE_i = \frac{R_{h'} - R_i}{R_{h'} - R_m} \times 100$$

Results

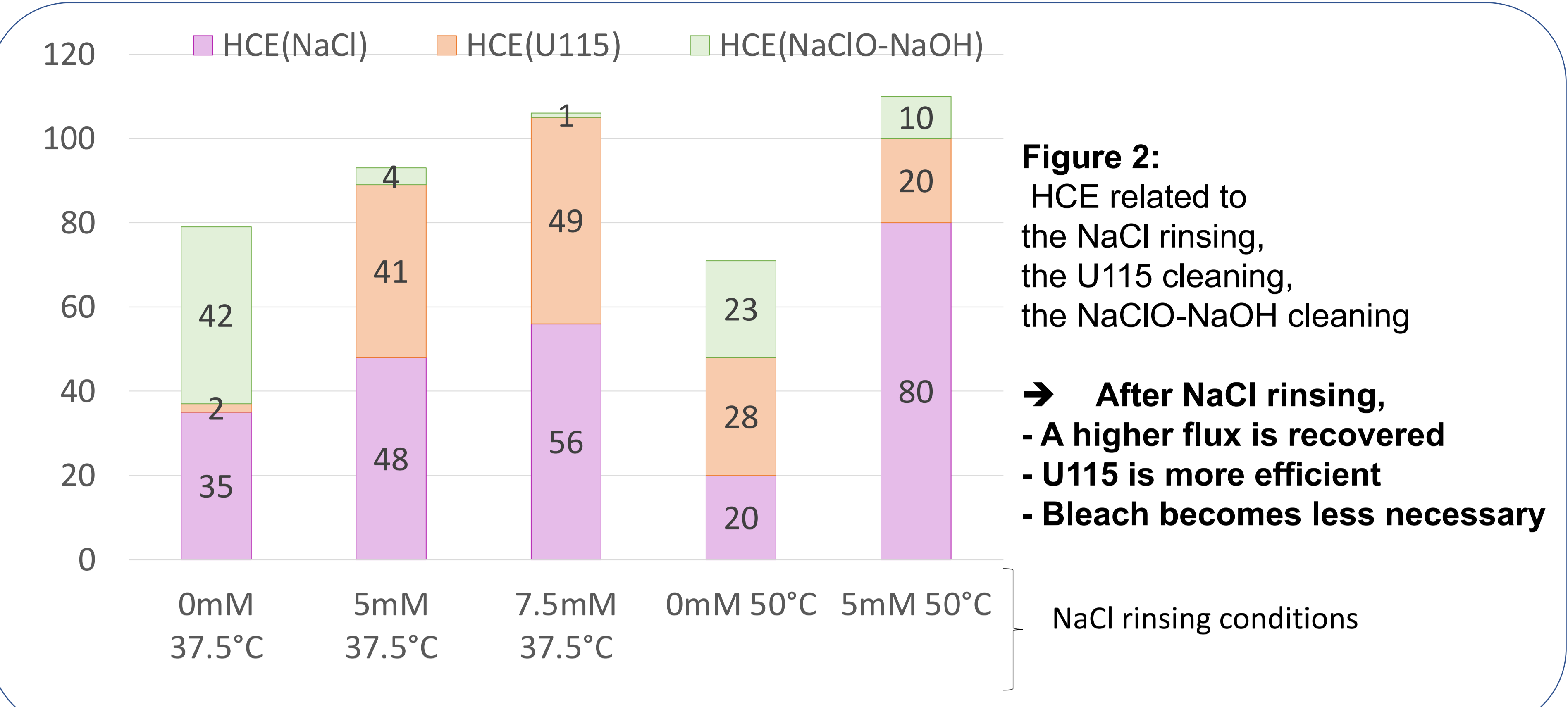
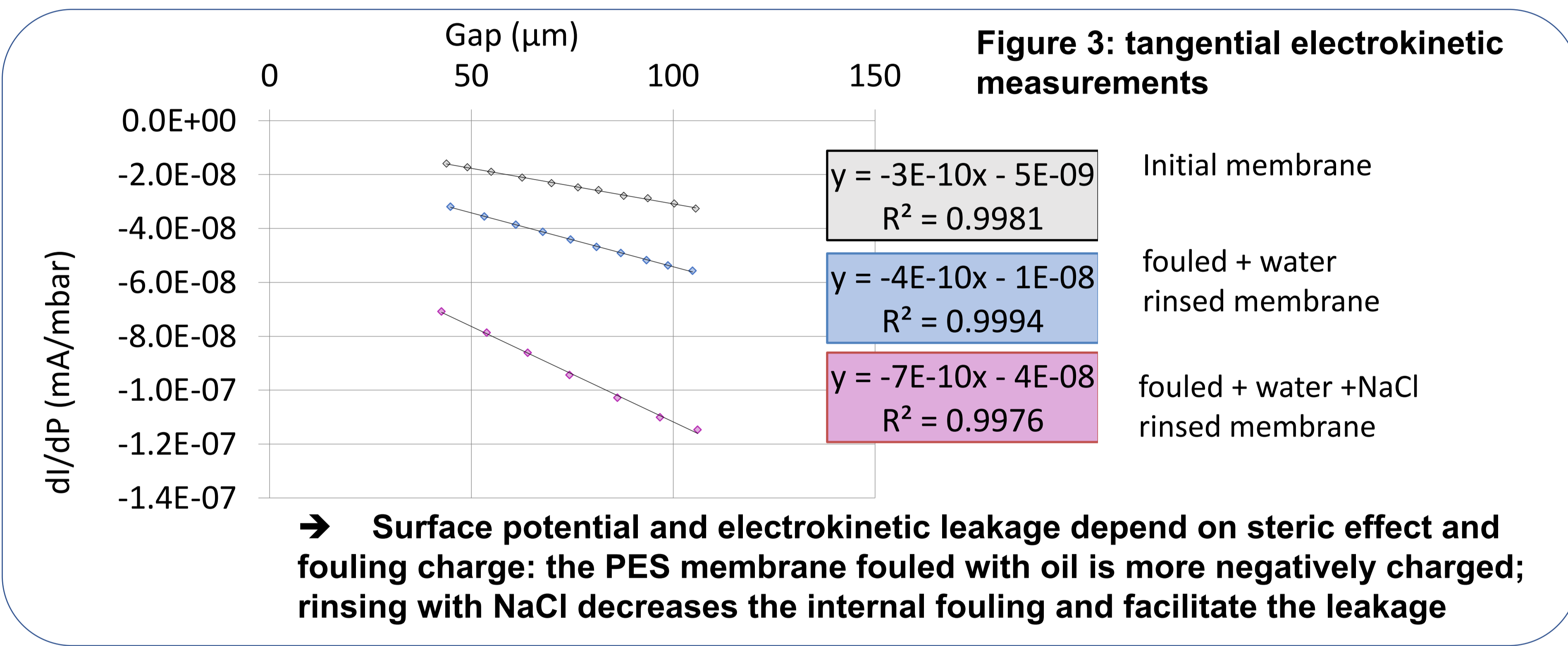


Figure 2: HCE related to the NaCl rinsing, the U115 cleaning, the NaClO-NaOH cleaning
→ After NaCl rinsing,
- A higher flux is recovered
- U115 is more efficient
- Bleach becomes less necessary



→ Surface potential and electrokinetic leakage depend on steric effect and fouling charge: the PES membrane fouled with oil is more negatively charged; rinsing with NaCl decreases the internal fouling and facilitate the leakage

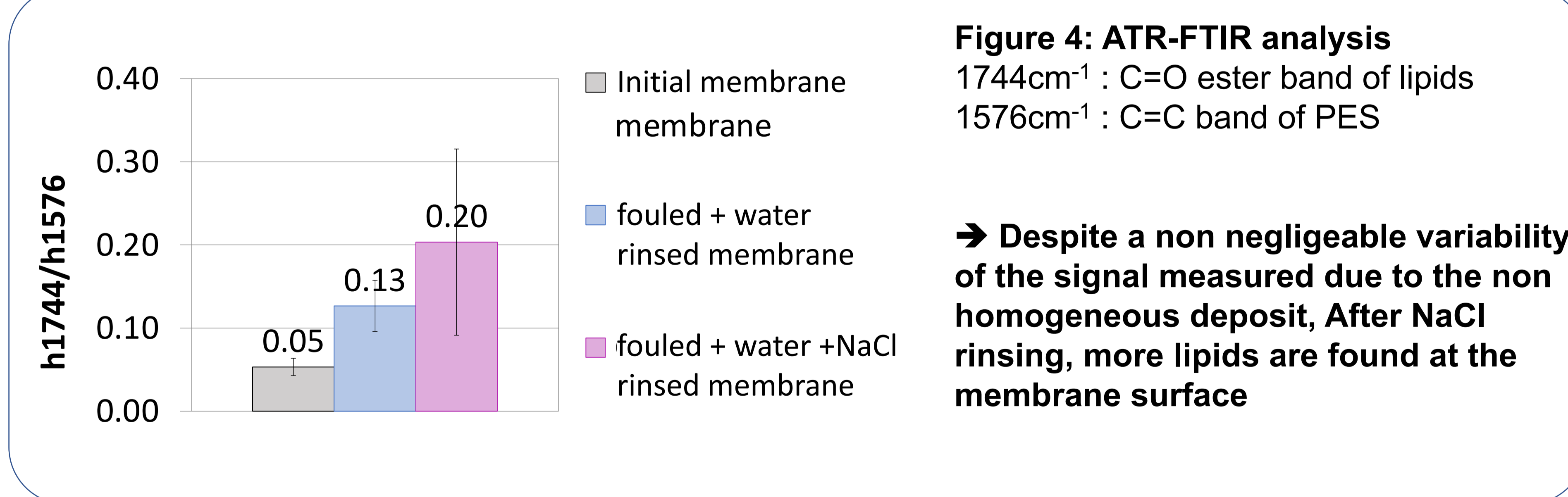


Figure 4: ATR-FTIR analysis
1744cm⁻¹ : C=O ester band of lipids
1576cm⁻¹ : C=C band of PES
→ Despite a non negligible variability of the signal measured due to the non homogeneous deposit, After NaCl rinsing, more lipids are found at the membrane surface

AFM analysis (not detailed) → After NaCl rinsing, the membrane surface roughness decreases

Conclusion

During rinsing with the NaCl solution, a part of the lipids responsible for internal fouling are removed and migrate onto the membrane surface. This phenomena leads to a higher water flux but also facilitates the surfactant action in the following step. This procedure could help reducing the cost of cleaning operations.