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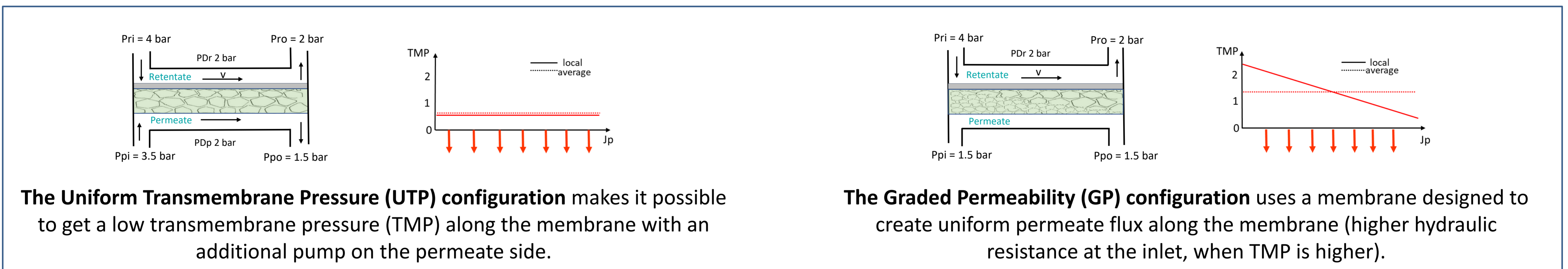
Performance comparison of two ceramic membrane concepts: Example of crossflow microfiltration of skimmed milk

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Objective

Microfiltration is largely applied in the food sector for the separation and concentration of proteins. Skimmed milk 0.1 μm microfiltration is implemented in the industry to separate casein micelles (retentate) from serum proteins (filtrate). The efficiency of the process, and especially the serum protein transmission, depends on the accumulation of casein micelles at the membrane surface. To overcome this problem, milk microfiltration is operated with specific ceramic tubular membrane configurations.

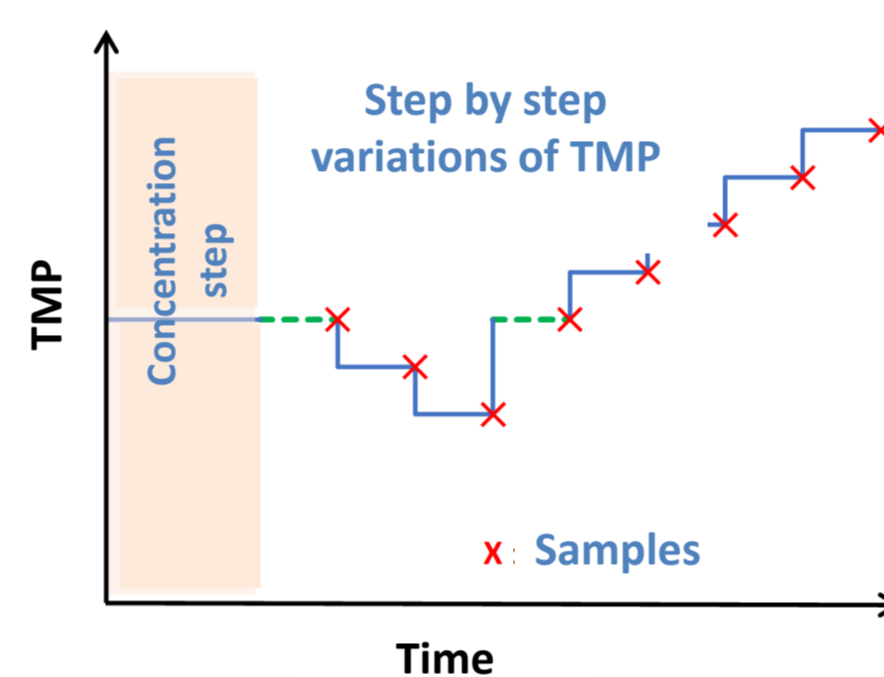


Pri et Pro : Retentate pressure at the inlet / outlet of the membrane (bar) ; Ppi et Ppo : Permeate pressure at the inlet / outlet of the membrane (bar) ; PDr / PDC: Pression Drop in the retentate / permeate (bar)

Compare the performances of the UTP and GP configurations in the case of milk 0.1 μm microfiltration operating in feed and bleed mode

Materials and methods

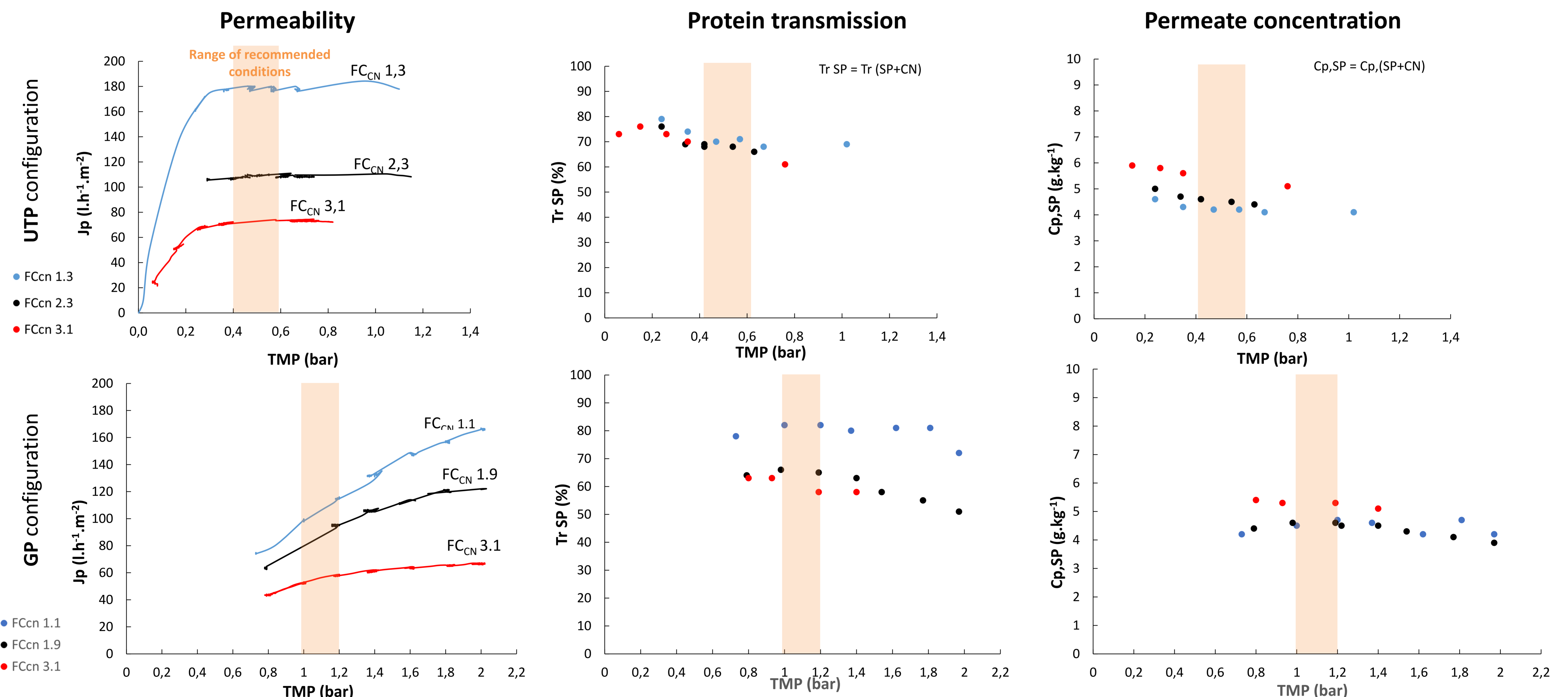
- Ceramic membranes** Pall 0.1 μm, 7P1940GL, 1.68 m², channel diameter 4 mm: UTP and GP configurations
- Parametric study**
 - Step by step variations of TMP: 0.2 - 2.0 bar
 - Casein micelles concentration factor (FC_{CN}): 1.0 - 3.1
 - Cross flow conditions:
 - UTP → v = 7.0 m.s⁻¹
 - GP → PDr = 2.0 ± 0.1 bar (7.8 - 7.0 m.s⁻¹ according to FC_{CN})
 - Temperature: 50 ± 2°C
 - Duplicates of several experiments were shown to be reproducible (< 5%)



Performance

- Permeation flux (Jp)
- Serum protein (SP) concentration in permeate (Cp,SP)
Cp,SP = NCN - NPN (Kjeldahl N x 6.38)
- Protein concentration in permeate (Cp,(SP+CN), CN : casein)
Cp,(SP+CN) = TN - NPN (Kjeldahl N x 6.38)
- Serum protein transmission $Tr SP = \frac{Cp,SP}{Cr,SP} \times 100$
- Serum protein+ CN transmission $Tr (SP+CN) = \frac{Cp,(SP+CN)}{Cr,SP} \times 100$

Results



Under recommended conditions:

- Jp_{GP} < Jp_{UTP} regardless of FC_{CN}

- Tr SP_{GP} > Tr SP_{UTP} at FC_{CN} ≈ 1.2 ± 0.1 due to higher cross flow velocity
- Tr SP_{GP} ≈ Tr SP_{UTP} at 1.9 < FC_{CN} < 3.1

- Cp SP_{GP} ≈ Cp SP_{UTP} regardless of FC_{CN}
- Systematic presence of casein in permeate

Main conclusions

Despite the fact that both configurations used membranes with similar filtering layers, the performances of the two ceramic membrane configurations show discrepancies. The optimal performances are not obtained under the industrially recommended conditions, which leaves room for significant improvements of existing filtration plants.

Perspectives: investigation of performances at high FC_{CN} 3.0 - 3.5; investigation of cleaning efficiency.