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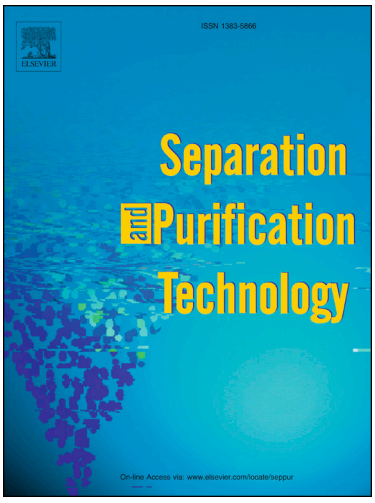

Separation of solutes with an organic solvent nanofiltration cascade: designs, simulations and systematic study of all configurations

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Separation of solutes with an organic solvent nanofiltration cascade: designs, simulations and systematic study of all configurations

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Abstract

Due to the lack of efficient membranes to achieve subtle separations in a single step, membrane cascades appear as an alternative to improve the separation of solutes, especially in the case of close rejections. However, there is still a need for their rational design. In this work, a systematic study of all configurations up to seven stages is proposed through a unique and versatile simulation architecture. Different recycling modes in between stages are detailed and developed. The same VRR is imposed at each stage, ranging from 2 to 10. The case study is the olefin hydroformylation catalytic reaction, for which the simulations aim at the separation of two components, one modelling all organic products to extract in the permeate and the other one modelling the catalytic system to recover in the retentate for its further re-use in the synthesis reactor. Input data for the simulations (rejections and fluxes) are obtained from preliminary experimental studies. The separation performances are evaluated through seven criteria, amongst which the outflows extraction/recovery and the membrane area. The analysis of the simulation results allows to determine the optimal configuration that fulfills most of the targeted criteria or to fine tune these separation criteria according to the potentialities or the limitations of the membrane cascades. Even though focusing *a priori* on specific criteria, a careful attention should be paid to all parameters to ensure realistic proposals of cascades or to revise the objectives for more realistic ones.

Keywords

Organic solvent nanofiltration, membrane cascade, simulation, hydroformylation

1. Introduction

Organic solvent nanofiltration (OSN, alternatively named Solvent Resistant Nanofiltration - SRNF - or Organophilic Nanofiltration - ONF) is a technology of high potential of application in fine chemistry (*e.g.* for the recycling of homogeneous metal catalysts) [1–8], pharmaceutical industry [9,10] and petrochemistry [11,12]. Many lab-scale studies have led to promising results for the extraction of a target molecule or the recovery of a solvent [13,14]. However, for most of multicomponent media, the

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