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CLEANING OF PES ULTRAFILTRATION MEMBRANES FOULED BY SKIM MILK: EFFECT AND SYNERGY OF SEQUENCES OF SINGLE SOLUTIONS

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ABSTRACT

Ultrafiltration (UF) by spiral polyethersulfone (PES) membranes of low cut off (5-10 kg mol^{-1}) is widely used in dairy industry in order to adjust the protein content before the cheese making process. The high fouling resulting from milk filtration induces 2-3 hours daily cleaning step to restore membrane performances, limiting thus the productivity. The chemical cleaning (apart from disinfection), conducted at 50°C on empirical and non-optimised bases, is as follow: alkaline cleaning (pH 11.5, to remove organic matter) followed by acid cleaning (pH=1.6, to remove mineral matter). Moreover, this cleaning sequence can not prevent the decrease of 50% of the production flux often observed at industrial scale. Optimisation of the cleaning step can be performed according to various approaches, among them:

- Looking for a more efficient cleaning solution [1]
- Limiting the number of chemicals used [2]
- Optimising the alkaline/acid sequence with single solutions (synergy)

Our previous works have shown that the irreversible fouling is mainly due to proteins. Moreover quantification of proteins by FTIR-ATR on a plane PES membrane, after UF of skim milk in similar conditions as in the spiral membrane, showed that 24 (± 2) µg of protein per cm^2 remained after water rinsing. These proteins are the target of the cleaning.

In this study, a nitric acid solution at pH=1.6, a sodium hydroxide solution at pH=11.5 and a chlorinated alkaline one at pH=11.5 with 200 ppm of active Cl_2 were used. The efficiency of these solutions was determined for the cleaning (TMP=2 bar, 50°C, VRF=1, v=0.5 $m.s^{-1}$) of spiral PES membrane (6,5 m^2) fouled by skim milk during 150 min in the same filtering conditions.

Neither of these solutions allows to reach the membrane hydraulic property (0.90 of its initial flux) in only one step. For all of them, the flux values are nearby ($0.57 < J/J_0 < 0.62$, where J_0 and J are the flux to water of the membrane before and after UF of milk and following cleaning, respectively). The sodium hydroxide at pH= 11.5 hydrolyses only 2 bonds of proteins per hour. It is therefore the variation of the charge due to pH change that will explain the action of the sodium hydroxide. The chlorinated alkaline efficiency is slightly better, probably due to oxidation by Cl_2.

The cleaning with nitric acid leads to surprising results (J/J_0= 0.57) as there is no inorganic layer on the membrane and is discussed with respect to specific interactions of nitrate towards PES membrane.

In sequences, a first step with nitric acid does not increase the efficiency of the further alkaline step. Two successive alkaline steps allowed to reach the hydraulic cleanliness whereas two chlorinated alkaline steps lead to J/J_0= 0.99.

This flux results were discussed with respect to the amount of residual proteins on the membrane surface determined from FTIR-ATR.

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2 - M. Rabiller-Baudry, L. Bégoin, D. Delaunay, L. Paugam and B. Chaufer, *submitted to* Chemical Engineering Process (2005)