ULTRASONIC CLEANING OF ULTRAFILTRATION MEMBRANES FOULED WITH BSA SOLUTION

Authors: María José Luján Facundo, José Antonio Mendoza Roca, Beatriz Cuartas Uribe, Silvia Álvarez Blanco.

Affiliation: Institute of Industrial Safety, Radiophysics and Environment, Polytechnic University of Valencia.

NYM London 2012
September 21th 2012
INDEX

1. OBJECTIVE
2. INTRODUCTION
3. MATERIALS AND METHODS
4. RESULTS
5. CONCLUSIONS
6. REFERENCES
7. ACKNOWLEDGEMENTS
1. OBJECTIVE

★ The main objective is to investigate the effect of ultrasound on the cleaning of polymeric ultrafiltration membranes fouled by BSA (bovine albuminum serum) solution. For this, US is applied during the cleaning process and each test is carried out with and without US.

★ In addition, the following specific objectives were established:

- Characterize the polymeric membranes tested and feed solution used in the fouling step.

- Study the effect of pH and temperature of NaOH solution during the cleaning process.
2. INTRODUCTION

- **Ultrafiltration** (UF) is a separation process widely used in the industry for purifying and concentrating macromolecular (10³ - 10⁶ Da) solutions, especially protein solutions.

- In food industries, membrane fouling is mainly due to protein adsorption onto the membrane surface and the internal pore blockage [1]. In order to restore the membrane initial permeability it is necessary to **clean the membranes** so that the process could be economically feasible.

An improvement of the cleaning procedure may have a significant influence on the overall process efficiency.
2. INTRODUCTION

Chemical processes are the most often used, but consume large volumes of expensive chemicals products which can damage the membrane material and reduce the useful life of the membrane [2].

US technique has been tentatively introduced in the membrane cleaning process [3,4].

US could significantly enhance the permeate flux [5,6] and this enhancement was mainly caused by cavitation phenomenon. Cavitation is the formation and then immediate implosion of cavities in a liquid that are the consequence of forces acting upon the liquid. When ultrasound is transmitted through a liquid medium, alternate compression and expansion cycles of the medium occurs. The compression cycle can cause bubbles to collapse, with a release of energy, which causes cleaning of the membrane surface.
3. MATERIALS AND METHODS

3.1. MATERIALS: UF plant
3. MATERIALS AND METHODS

3.1. MATERIALS: UF plant

- US generator
- Membrane module
- US bath
3. MATERIALS AND METHODS

3.1. MATERIALS: membranes and feed solution

Two polymeric membranes from Microdyn Nadir were tested:
- UP005: polyethersulfone (PES) membrane with a pore size of 5 kDa.
- UH030: permanently hydrophilic polyethersulfone (PESH) membrane with a pore size of 30 kDa.

The organic foulant chosen to represent proteins was bovine serum albumin (BSA, purity > 98%, Sigma-Aldrich, Germany) solution with a concentration of 1% w/w and molecular weight of 66 kDa.
3. MATERIALS AND METHODS

3.2. METHODS

1.- Initial permeability measurement.

2.- Membrane fouling: fouling tests were carried out at 25 °C and transmembrane pressure of 2 bar.

3.- Cleaning experiments: the chemical cleaning step (with NaOH solution) was carried out at a fixed transmembrane pressure of 1 bar, during 30 minutes and cross flow velocity of 2.18 m/s. Ultrasound was coupled to membrane chemical cleaning in some of the tests at operating conditions of 20.5 kHz frequency and 300 W of nominal power.

4.- Final permeability measurement.

Evaluation of the cleaning efficiency: \[ \frac{P_f}{P_i} \cdot 100 \]
4. RESULTS

Regarding to the **evolution of flux with time** during BSA ultrafiltration:
4. RESULTS

According to US effect, results clearly show that when US is applied higher permeability recovery values than those obtained without US application at the same conditions of temperature and pH of the cleaning solution.
5. CONCLUSIONS

Experimental results from this study showed significant improvements of the permeability recovery using ultrasounds in the cleaning process.

The enhancement factor (permeability recovery with US/permeability recovery without US) using US is between 1.2 and 1.8 across the full range of our experiments.

According to the results analyzed from an experimental design carried out by STATGRAPHICS, pH and temperature of the NaOH solution were not significant parameters for the membrane permeability recovery in the ranges studied.
6. REFERENCES


7. ACKNOWLEDGEMENTS

✓ This work was supported by the Spanish Ministry of Science and Innovation (CTM 2010-20.186).

✓ Institute of Industrial Safety, Radiophysics and Environment, Polytechnic University of Valencia.
THANK YOU VERY MUCH FOR YOUR ATTENTION!!!