Bioprocess and Biosystems Engineering (2022) 45:1125–1136
https://doi.org/10.1007/s00449-022-02726-8

RESEARCH PAPER

Fouling characteristics and cleaning approach of ultrafiltration membrane during xylose reductase separation

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Received: 26 December 2021 / Accepted: 1 April 2022 / Published online: 25 April 2022

Abstract

Many operating parameters of ultrafiltration (UF) are playing a crucial role when using a polyethersulfone membrane to separate xylose reductase (XR) enzyme from reaction mixtures during xylitol synthesis. The present study focuses on the separation of XR enzyme using a cross-flow ultrafiltration (UF) membrane. The filtration process was analyzed using the three effective variables such as filtration time, cross-flow velocity (CFV), and the transmembrane pressure (TMP), which were ranging from 0 to 100 min, 0.52 to 1.2 cm/s and 1–1.6 bar, respectively. Then, using the resistance in series model, the hydraulic resistance for alkali chemical cleaning during XR separation was estimated. During separation, increased TMP showed a positive-flux effect as a driving force, however, fouling and polarized layer were more prominent under higher TMP. Increased CFV, on the other hand, was found more efficient in fouling control. In terms of the membrane cleaning techniques, an alkaline solution containing 0.1 M sodium hydroxide was shown to be the most effective substance in removing foulants from the membrane surface in this investigation. Cleaning with an alkaline solution resulted in a maximum flux recovery of 93% for xylose reductase separation. This work may serve as a useful guide to better understand the optimization parameters during XR separation and alleviating UF membrane fouling induced during XR separation.

Keywords Fouling · Membrane recovery · Resistance in series model · Ultrafiltration · Xylose reductase

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List of symbols

C_f	Feed concentration
CFV	Cross-flow velocity
C_p	Permeate concentration
EMC	Electrophoretic membrane contactor
FTIR	Fourier transform infrared spectroscopy
HPTFF	High-performance tangential flow filtration
J	Flux
LCB	Lignocellulose biomass
M	Molarity
MF	Microfiltration
MWCO	Membrane molecular weight cutoff
NADPH	Nicotinamide adenine dinucleotide phosphate
NaOH	Sodium hydroxide
PEG	Polyethylene glycols
PVP	Polyvinylpyrrolidone
R_m	Membrane hydraulic resistance
TMP	Transmembrane pressure
TMP_{lim}	Transmembrane pressure-limiting value
TOC	Total organic carbon
UF	Ultrafiltration
XR	Xylose reductase