Ammonium removal by liquid–liquid membrane contactors in water purification process for hydrogen production

Edxon Licon\textsuperscript{a,\,*}, M\`onica Reig\textsuperscript{a}, Pilar Villanova\textsuperscript{a}, Cesar Valderrama\textsuperscript{a}, Oriol Gibert\textsuperscript{a,\,b}, Jose\’ Luis Cortina\textsuperscript{a,\,b}

\textsuperscript{a}Chemical Engineering Dept., UPC-Barcelona TECH, Av. Diagonal 647, 08028 Barcelona, Spain, Tel. +34 934016997; emails: edxon.eduardo.licon@upc.edu (E. Licon), monica.reig@upc.edu (M. Reig), pilar.villanova@gmail.com (P. Villanova), Tel. +34 934011818; email: cesar.alberto.valderrama@upc.edu (C. Valderrama), Tel. +34 934015877; email: oriol.gibert@upc.edu (O. Gibert), Tel. +34 934016570; email: jose.luis.cortina@upc.edu (J.L. Cortina)

\textsuperscript{b}CETAQUA Carretera d’Esplugues, 75, 08940 Cornell\`a de Llobregat, Spain

Received 15 July 2014; Accepted 2 October 2014

\textbf{ABSTRACT}

In this work, a liquid–liquid membrane contactor (LLMC) was evaluated to remove ammonia traces from water used for hydrogen production by electrolysis. Three operational parameters were evaluated: the feed flow rate, the initial ammonia concentration in the water stream, and the pH of solution. Synthetic aqueous solutions with ammonium concentration of 5–25 mg L\textsuperscript{−1} and a sulfuric acid solution (pH 2) were supplied to the LLMC in countercurrent and open-loop configuration with flow rates between $2.72 \times 10^{-6}$ and $22.6 \times 10^{-6}$ m\textsuperscript{3} s\textsuperscript{−1} and the pH values of the solution with ammonium between 8 and 11. A 2D numerical model was developed considering advection–diffusion equation inside a single fiber of the lumen with fully developed laminar flow and liquid–gas equilibrium in the membrane–solution interface. Predictions of the model were then validated against experimental data, which were found to be in good agreement. According to both, experimental data and numerical predictions, the hollow-fiber membrane contactor technology is a suitable alternative to remove ammonium from water and to feed the membrane distillation unit in order to fulfill water quality requirements for electrolysis-based hydrogen production.

\textit{Keywords:} Ammonium removal; Membrane contactors; Open-loop configuration; Numerical simulation

\*Corresponding author.

\textit{Presented at the IX Ibero-American Congress on Membrane Science and Technology (CITEM 2014), 25–28 May 2014, Santander, Spain}

1944-3994/1944-3986 © 2014 Balaban Desalination Publications. All rights reserved.