Experimental investigation and modelling of diffusion dialysis process for regeneration of acidic pickling solutions

S. Randazzo, R. Gueccia, A. Tamburini, A. Cipollina*, G. Micale

Dipartimento dell'Innovazione Industriale e Digitale, Università di Palermo – Viale delle Scienze ed.6, 90128 Palermo, Italy.
Corresponding Author. E-mail: andrea.cipollina@unipa.it

Abstract

Pickling is one of the key steps in metal finishing industries, where HCl solutions are largely used thus generating significant amounts of spent waste solutions containing high concentrations of metals and acid. The recovery of acid from such waste solutions is thus one of the most beneficial steps for reducing the environmental and economical impact of these processes. Among several separation methods, diffusion dialysis (DD) is becoming more and more attractive thanks to the recent important advances in ion exchange membranes (IEMs) field and because of its clean nature and operational simplicity, low installation and operating costs and low energy consumption [1,2].

In the present work, a single-cell diffusion dialysis module equipped with a FumaTech Anion Exchange Membrane (AEM), operated in a batch mode, has been employed in order to study the effect of some parameters on the efficiency of HCl recovery from waste pickling acidic solutions. In addition, a mathematical model, capable of simulate and predict this process, has been also developed and validated with experimental information.

The laboratory test-rig and procedures have been first evaluated and optimised by measuring salt and water fluxes with artificial NaCl solutions with different types of AEMs. Then, experiments with HCl solutions were carried out, at different compositions of diffusate and retentate streams, varying HCl concentration values in the range of 0.1-3 M. HCl and water osmotic fluxes were measured and their dependence on operating conditions was identified. Also the effect of the presence of selected iron salts were investigated in order to simulate the operation of the system when treating actual pickling solutions. In particular, the acid diffusion permeability as well as the water osmotic permeability tend to increase when increasing the solution concentration. In addition, an increasing HCl recovery is detected in the presence of iron chloride.

Keywords
Pickling solution, diffusion dialysis, hydrochloric acid recovery.

References
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