In the present work, a steady state process simulator for the integrated process has been developed, in order to analyze and predict performances of a small pilot-scale unit to be installed and operated within a hot-dip galvanizing plant. A parametric analysis of the model is performed varying hydrochloric acid and iron concentration in the pickling tank. In this way, usual operations of withdrawing of partially exhausted solutions and refilling with fresh acid is avoided allowing to continuously operating under the optimal pickling conditions.

Keywords: Process simulator; Hydrochloric acid recovery; Diffusion dialysis; Membrane distillation

Acknowledgments

This work has been funded by EU within the ReWaCEM project (Resource recovery from industrial waste water by cutting edge membrane technologies)–Horizon 2020 program, Grant Agreement no. 723729. www.rewacem.eu

References

[1] M. Tomaszewska et al., Recovery of hydrochloric acid from metal pickling solutions by membrane distillation, Separation and Purification Technology 22-23 (2001), 591-600.
[2] J. Luo et al., Diffusion dialysis-concept, principle and applications, Journal of Membrane Science, 366 (2011) 1-16.

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Experimental investigation and modelling for sulphuric acid recovery by diffusion dialysis

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Sulphuric acid is known to be one of the key inorganic acid and has been widely used in chemical reaction and metal industries for surface treatments as in the copper electroplating process. During these processes, large amounts of waste sulphuric acid solution are generally generated, containing high concentrations of metals and acid. The possibility of recover and reuse the sulphuric acid in the process could avoid environmental contamination and reduce costs of the disposal. 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, two single-cell diffusion dialysis modules, equipped with commercial anion exchange membranes, with different dimensions, were employed. The first consisted in a laboratory-scale DD unit (10 x 10 cm^2) operated in a batch configuration to study the effect of process parameters on the efficiency of H_2SO_4 recovery. The latter consisted in a large-scale DD unit (80cm long) operated in a continuous configuration to simulate the process operation at the industrial scale. Acid recovery has been evaluated at different operative conditions. In both the cases, the effect of the presence of copper salt on the acid recovery was also evaluated.

In addition, the mathematical model for the DD process, developed and validated with experimental data previously obtained for HCl case [3], has been adapted and validated with experimental data obtained in this work.

Membrane behaviors to H_2SO_4 diffusion were compared with results obtained for HCl [3]. Opposite to the HCl case, H_2SO_4 diffusion permeability tends to decrease when increasing the solution concentration and the presence of copper reduces sulphuric acid recovery.

Keywords: Sulphuric acid recovery; Copper electroplating solutions, Diffusion dialysis

Acknowledgments

This work has been funded by EU within the ReWaCEM project (Resource recovery from industrial waste water by cutting edge membrane technologies) – Horizon 2020 program, Grant Agreement no. 723729.

References

[1] Luo et al., Diffusion dialysis processes of inorganic acids and their salts: the permeability of different acidic anions, Separ. Purif. Technol. 78 (2011) 97-102.
[2] Xu et al., Recovery of hydrochloric acid from the waste acid solution by diffusion dialysis, J. Hazard. Mater. 165 (2009) 832-837.
[3] Gueccia, R., Randazzo, S., Chillura Martino, D., Cipollina, A. and Micale, G., Experimental investigation and modelling of diffusion dialysis for HCl recovery from waste pickling solution, in preparation

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Modelling hybrid systems for seawater desalination: electromembrane processes (RED, ARED and ED) coupled with RO

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The need to reduce energy consumption in seawater reverse osmosis processes has pushed research towards the development of new hybrid systems in which, for example, other membrane processes can be used to pre-treat seawater. Electrodialysis and reverse electrodialysis can act as a dilution step before seawater enters the RO unit, thus leading to an important energy saving in RO. In this work, two coupled models are proposed for the RED-RO and ED-RO system. Each process model was validated before being used for a sensitivity analysis in which the effect of the integration on the cost saving in the overall process was assessed. The analysis was performed by changing (R)ED voltage and RO pressure and considering three different scenarios: a standard scenario, an optimist scenario with a lower membrane cost and a pessimistic scenario with a lower electricity cost and comparing the result with the a standalone RO process. Negative values of "*Cost Saving*" were found when an excessive dilution step was performed before the RO, while competitive scenarios were found by optimizing the dilution extent, especially for the RED-RO case.

Keywords: Reverse osmosis, Hybrid systems, Electromembrane processes, Coupled model, Cost saving