SDEWES2018.0275

# Modeling and Design of Membrane Integrated Processes for HCl and Metals Recovery from Pickling Solutions

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## Abstract

Hydrochloric acid pickling is a common practice in steel manufacturing industry. It is widely used as a chemical pre-treatment method for cleaning metal surfaces before other surface treatments. During the pickling process, acid attacks metal oxides on the metallic surface, thus dissolving them in the pickling bath. Thus, the efficiency of the pickling liquor decreases due to the accumulation of metal salts and the consumption of free acid in solution. Continuous regeneration of pickling solutions enhances pickling rate and process performance, but also minimises industrial waste water disposal and chemicals consumption. The recovery and recycling process of valuable substances (e.g. acid, metals and water) can be accomplished by coupling diffusion dialysis (DD) and membrane distillation (MD) technologies.

The process can be described in this way: more than 80% of the free acid exiting from the pickling bath is recovered and separated from the metals by passing through a selective anionic exchange membrane (in the DD), then, its concentration is properly increased by evaporation of water through a hydrophobic membrane (in the MD) in order to be recycled in the pickling bath. The metal salts trapped in the outlet solution from the diffusion dialysis are recovered as valuable products in a reactive precipitation unit by precipitating iron hydroxide as a solid phase and keeping zinc salt in the solution.

In the present work, a steady state process simulator for the integrated process has been developed, aiming at the performance analysis and prediction 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, refilling with fresh acid, as done in the normal operations, is avoided and operations are carried out under the optimal working conditions.