Ammonia Removal From Water By a Liquid-Liquid Membrane Contactor Under a Closed Loop Regime

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Abstract

Introduction: Removal of ammonia from water of a waste water treatment plant by a membrane contactor were simulated on transient state and compared with experimental data. This technology will be applied in the hydrogen and oxygen production by electrolysis via renewable energies as can be seen in Figure 1. The aim of this study relies on fulfill the process requirements in the electrolysis, since the efficiency of this step is inversely proportionally to conductivity. The ammonia concentration before membrane distillation step is usually between 1-5 ppm with not variations after this process, then, to use a liquid-liquid membrane contactor is proposed to reduce ammonium (NH+4) concentration before Membranes distillation step. The feed solution is in a tank entering the contactor (Liqui-cell X30 HF, Celgard, USA) which works in close loop configuration. An aqueous solution of NH+4 with a low concentration is in the lumen and sulfuric acid solution goes in the shell side, as is shown in Figure 2. The pH plays a very important role in the chemical equilibrium; for that reason is motorized during the experiments. Use of COMSOL Multiphysics: The model equations were developed considering radial and axial diffusion and convection in the lumen with laminar flow conditions since the inner radius of each fiber is in the order of 120 microns. The equations were nondimensionalized only in terms of the aspect ratio of the hollow fibbers in order to solve them using the PDE coefficient form interface. The recirculation is taken into account as a boundary condition, where a global equation that describes the concentration in the tank is solved. The pH of the solution in the tank was considered as a time dependent function, fitted from experimental results (Figure 3). Results: In Figure 4 is shown the evolution of the tank concentration under different experimental conditions in terms of flow rate and initial pH, as well as the predicted values. In the experiment 2 a poor removal of NH+4 was obtained because no buffer solution was added and pH was not constant. Next experiments were initial solution was buffered. The experiment 1 and 4 were performed under same conditions but the solutions were prepared on tap water and distillate water, respectively Some deviation were observed in tap water experiment, but a good agreement were observed between experimental and simulated values. Conclusions: The membrane contactor model proposed is suitable for prediction of ammonium removal in view the minimal deviations when compared to the experimental data. The most important parameters to control during the experiment are the flow rate and the pH, mainly the last one, due to the high dependence in the chemical equilibrium of ammonium reaction to ammonia. Finally, the use of COMSOL makes easier and faster to solve the equations proposed in the model for liquid-liquid contactor.

Reference

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Figures used in the abstract

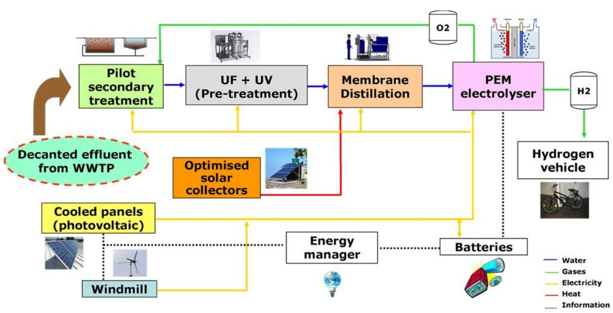

Figure 1: Pilot plant developed for Greenlysis project.

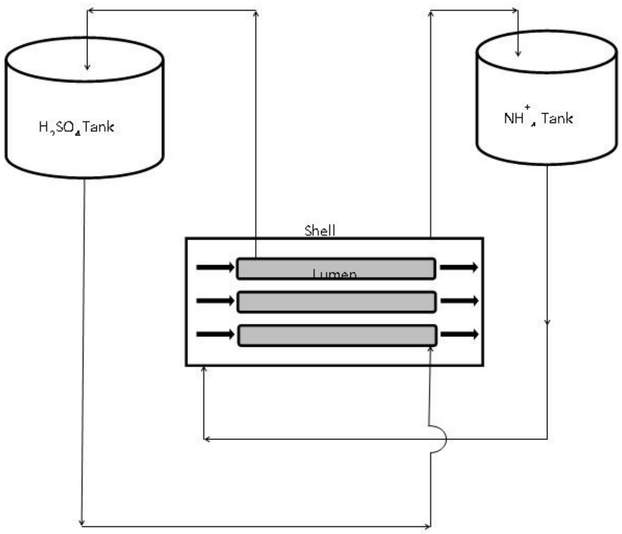

Figure 2: Experimental setup.

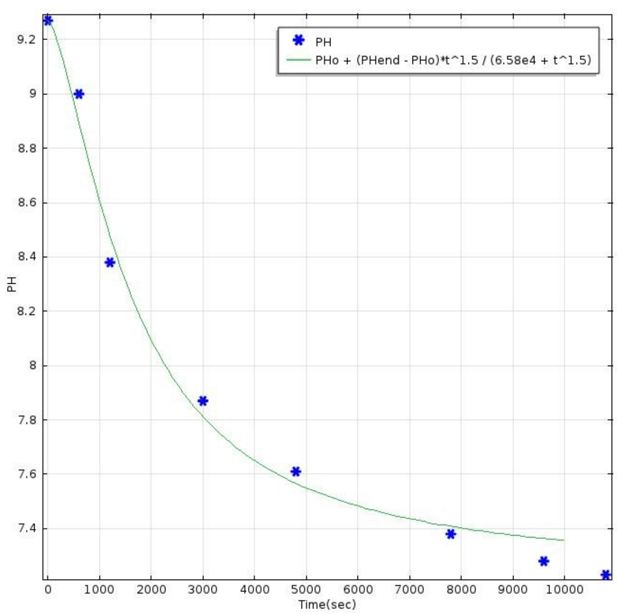

Figure 3: pH evolution for an experiment without buffer solution.

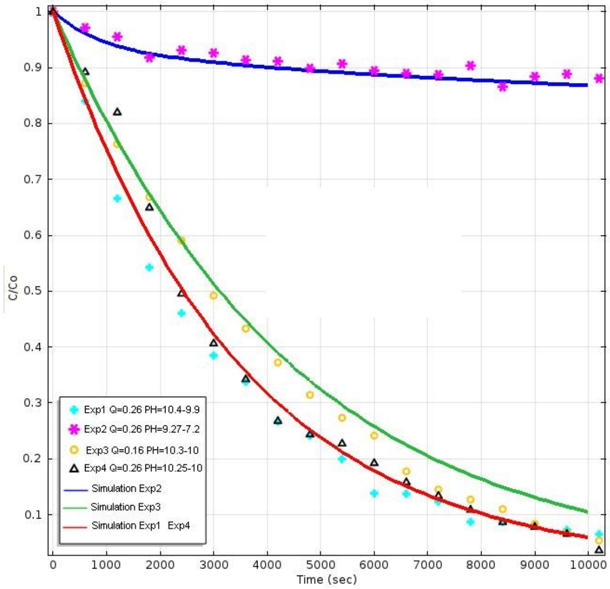

Figure 4: Normalized cconcentration evolution in the feeding tank.