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ORIGINAL PAPER

Thermodynamic and kinetic study on ammonium removal from a synthetic water solution using ion exchange resin

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Abstract Ammonium removal from the wastewater treatment effluents is mandatory considering the imposed discharge limits and the recycling/reuse requirements. Ion exchange represents a viable alternative for the biological processes of ammonium removal, although concurrent processes make modeling complex. This study reports on the performance of a commercial cation exchange resin, PUROLITE C150H, for ammonium removal from synthetic aqueous solutions. Thermodynamic and kinetic process parameters are calculated using the Langmuir model (thermodynamic study) and the shrinking core model (kinetic study); the data are correlated with the surface properties of the substrate, outlining the adsorption mechanism. For initial ammonium concentrations of 25–150 mg NH_4^+/L, removal efficiencies of 80–90 % were obtained.

Keywords Wastewater treatment · Ammonium · Ion exchange · Surface diffusion · Biot number

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Introduction

Water availability and its sustainable use are among the central problems of the twenty-first century, the unequal demand and use at global level, as well as pollution and insufficient treatment before discharge being important concerns. The Water Framework Directive 2000/60/EEC and Urban Wastewater Treatment Directive (91/271/EEC) (Hochstrat et al. 2008; Cailean and Teodosiu 2012) support sustainable water usage and, by 2015, the final objective is to achieve "good ecological and chemical status" of the EU waters, while water recycling and reuse are to be implemented "whenever appropriate." Nevertheless, the legislation mainly sets principles and not means on how to implement these concepts (Bixio et al. 2006), therefore water resources management, including recycling and reuse processes, is still to be optimized and expanded.

Considering the water quality targets set when including recycling and reuse, the wastewater has to undergo furthermore treatment steps, besides the conventional treatment (Teodosiu 2002). Thus, conventional treatment (mechanical, chemical, and biological) should be completed with advanced treatment options (chemical oxidation processes, adsorption, membrane processes, ion exchange, etc.) to efficiently remove the target pollutants (priority/persistent organic pollutants, toxic inorganic pollutants, N and P compounds) that are not easily/completely removed by conventional processes (Barjoveanu and Teodosiu 2009). Cost-effective solutions are also evaluated for various types of wastewater treatment plants (Hamad et al. 2003). To be accepted and scaled up, these solutions have to be efficient, low cost, and with low amounts of toxic/polluting by-products.

In Romania, as in many other countries, the concept of water reuse is mainly applied in agricultural irrigations.

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