IDHA - biodegradable complexing agent in the adsorption of rare earth elements

K. Burdzy[1], D. Kołodyńska[1]

[1]Department of Inorganic Chemistry, Maria Curie-Skłodowska University, Lublin, 20-031, Poland
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Presenting author email: katarzyna.araucz@poczta.umcs.lublin.pl

Nowadays each technological process must be carefully planned and optimized to minimize the negative impact of industry and human activity on the environment. Therefore, for many compounds commonly used in the past, new substitutes are sought that would have better properties, such as lower toxicity or higher biodegradability. An example is ethylenediaminetetraacetic acid (EDTA) - a widely used complexing agent, (e.g. in the process of metals removal from water) which, although not being toxic for living organisms, due to its strong ability to form persistent metal complexes, it causes the natural speciation of metals to be disturbed when entering the environment. A proposed alternative to this type of compound is iminodisuccinic acid (IDHA), the main advantage of which is biodegradability and environmentally friendly synthesis process, without generating off-gases or effluents.

The aim of the study was to determine the applicability of IDHA in the process of La(III) ions removal as a representative of rare earth elements with the use of strongly basic anion exchangers Amberjet 4200 and Amberlite IRA 458. There were investigated the following operational parameters of the process: the influence of the metal:ligand molar ratio (1:1, 1:2, 1:4), solution pH (2-12), process duration (1-240 min), initial concentration of metal ions (0.5×10^{-3}-8.5×10^{-3} M) and temperature (293-333 K). The results of the kinetic studies were fitted using the pseudo-first order, the pseudo-second order as well as the intraparticle diffusion model equations to evaluate the most effective one. The Langmuir, Freundlich and Temkin isotherms equations were used to determine the isotherm parameters. The studies proved that for the adsorbents, the optimal metal:ligand ratio is 1:2, and the pH value of the solution is 10. Moreover, the tested adsorption processes were very fast, the equilibrium was established after 30 minutes. The obtained results indicate that IDHA is characterized by good complexing properties towards La(III) ions, therefore it can replace the currently used poorly biodegradable synthetic compounds successfully.