Contents lists available at SciVerse ScienceDirect

Chemical Engineering Research and Design

journal homepage: www.elsevier.com/locate/cherd

Sorption of Zn(II) and Pb(II) ions in the presence of the biodegradable complexing agent of a new generation

*Justyna Jachuła, Dorota Kołodyńska, Zbigniew Hubicki**

Department of Inorganic Chemistry, Faculty of Chemistry, Maria Curie-Skłodowska University, Maria Curie-Skłodowska Sq. 2, 20-031 Lublin, Poland

ABSTRACT

The macroporous chelating ion exchangers containing different functional groups i.e. Purolite S-920, Purolite S-930 and Lewatit TP-208 have been used in the sorption process of Zn(II) and Pb(II) ions. The effect of the presence of biodegradable, environmentally friendly aminopolycarboxylate chelating agent, trisodium salt of methylglycinediacetic acid (MGDA) on its sorption capacity was also examined. The investigations were carried out by the static method. Besides the effect of initial concentration of Zn(II) and Pb(II) and the complexing agent the research concerns the influence of solution pH, phase contact time on effectiveness of sorption. The equilibrium and kinetics of Zn(II)–MGDA and Pb(II)–MGDA complexes sorption were obtained and fitted using the Langmuir, Freundlich, Temkin and Dubinin–Radushkevich (D–R) models as well as the pseudo first and pseudo second order kinetic models. The intraparticle diffusion model was also used. The results showed that the sorption processes of Zn(II) and Pb(II) complexes with MGDA on Purolite S-920, Purolite S-930 and Lewatit TP-208 followed well the pseudo second order kinetics.

Keywords: Ion exchangers; Biodegradable chelating agent; Heavy metal ions; Trilon M

1. Introduction

Pehlivan and Altun (2006) and Rengaraj et al. (2002) state that sorption processes have been and still are the most often used method for treating wastewaters in industries and the most extensively studied ones. Ferreira et al. (1999) describes these processes by the following mechanisms: ion-exchange reactions, physical sorption, molecular sorption of electrolytes, complex formation between the counter ion and the functional group, hydrate formation on the surface or in the pores of the sorbent. Demirbas (2008), Son et al. (2001) and Kas et al. (2007) specify the main advantages of this process: recovery of metal value, less sludge volume produced and meeting of strict discharge specifications. Moreover, the deficiency in selectivity of the conventional ion exchange resins has led to the development of a new class of selective polymers i.e. chelating resins, which are described by Sahni and Reedijk (1984). Fundamentally, a chelating ion exchange resin consists of two components – a chelating group and a polymeric matrix. Thus, the properties of both constituent have to be considered during their designing and synthesis i.e.: strong, selective metal binding properties, ability to form a 1:1 chelate with a metal ion, possession good swelling properties and compatibility between the polymer and the medium. A number of chelating resins containing such functional groups as iminodiacetic acid, amidoxime, aminophosphonic acid, oxine, thiols and pyridine complying with these criteria are now commercially available.

In this paper the three commercial macroporous chelating ion exchangers were tested: Purolite S-920 with the thiouronium functional groups as well as Purolite S-930 and Lewatit TP-208 with the iminodiacetate functional groups.

Arden (2001) determines that Purolite S-920 is designed for the removal of low concentrations of soluble mercury salts from waste streams and for the recovery of precious metal ions from rinse waters in the galvanic and electronic industries. Purolite S-920 is also used in hydrometallurgy for the separation of precious metal ions from acid solutions.

Purolite S-930 finds the use in the processes for extraction and recovery of metal ions from ores, galvanic plating solutions, pickling baths, and effluents even in the presence of calcium and magnesium. Important application includes

* *Corresponding author*. Tel.: +48 81 5375511; fax: +48 81 533348.
E-mail address: zbigniew.hubicki@poczta.umcs.lublin.pl (Z. Hubicki).
Received 24 August 2011; Received in revised form 22 December 2011; Accepted 27 January 2012
0263-8762/$ – see front matter
doi:10.1016/j.cherd.2012.01.015