Synthesis of Acrylic-based β-Cyclodextrin polymer: A potential adsorbent system for pharmaceutical residual from water

Mohamed Magdi Ahmed <mohamed.ahmed@tul.cz>, Michal Řezanka

Abstract

In this work, we report the synthesis of acrylic-based β-cyclodextrin (β-CD-Ac) monomers and their free radical polymerization. β-CD-Ac was synthesized by reacting β-CD and acryloyl chloride and subsequently was polymerized using azobisisobutyronitrile (AIBN). Both monomer and polymer products were characterized via 1H-NMR and Solid-State NMR, respectively. The crosslinked polymer was prepared as a potential adsorbent system to tackle the problem of pharmaceutical residuals in the water. Hence, the capacity of the system was tested against the Metoprolol drug and was evaluated as a function of kinetics, the mass of adsorbent, PH, and concentration.

Introduction

Metoprolol (MTP), a frequently employed sympathetic blocking agent (as depicted in Figure 1), serves as a therapeutic agent for the management of elevated blood pressure and a spectrum of cardiovascular disorders. The pervasive presence of MTP in aquatic ecosystems can be attributed to its inherent resistance to hydrolysis and extensive utilization, rendering it a recurrent environmental contaminant. As a consequence of its deleterious implications for both ecological well-being and human health, it is imperative to effectuate the removal of this pollutant from wastewater streams prior to their discharge into ecosystems or aquatic bodies [1–4]. Hence, an adsorption system based on *β-CD polymer is developed for the removal of MTP from water.*

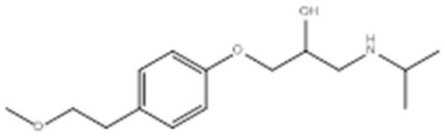

Figure 1. Metoprolol Structure

Methodology

β-CD monomer was prepared following the procedure described in the work by Slavkova et al. [5] which then polymerizaed via free radical polymerization. Both products of the monomer and polymer reaction were characterized by Solid-State NMR. Consequently, the adsorbent system was tested against MTP drug and was evaluated as a function of kinetics, the mass of the adsorbent, PH, and concentration. Finally, the data from adsorbent batches were analyzed and fitted to adsorption models of kinetics and isotherm.

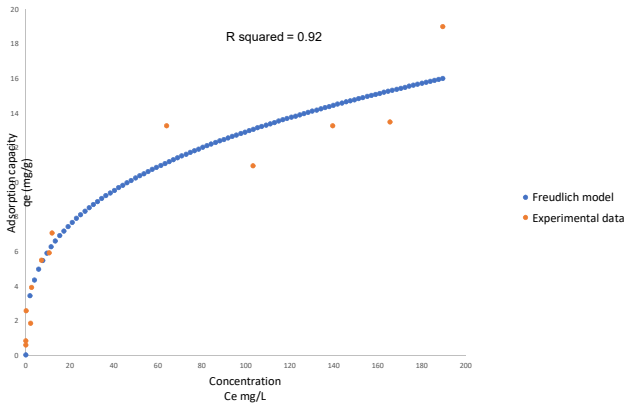

Figure 2. Adsorption isotherm study

Results and discussion

The PH studies showed that the adsorbent system has a wide working PH, reaching removal efficiency of about 100% from 6 – 11 PH. The isotherm was fitted best to the Freundlich model, suggesting multilayer adsorption and a heterogeneous adsorption system (Figure 2). The adsorption capacity in kinetics studies reached equilibrium at 20 min with about 23 mg/g, and was fitted to the pseudo-second order adsorption model which indicates that the nature of the adsorption is more of a chemisorption rather than physisorption (Figure 3).

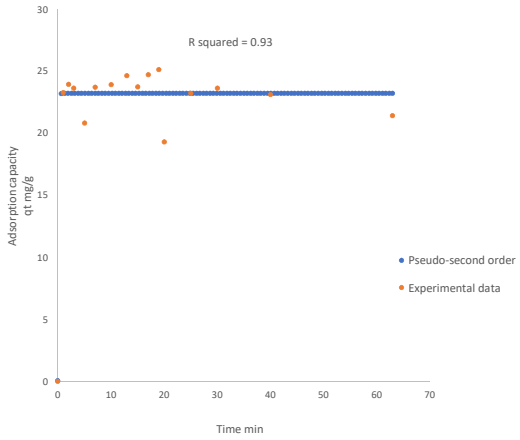

Figure 3. Adsorption kinetics study

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References

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