Breakthrough modelling of glucamine functionalized PVDF nanofibrous adsorbent in a fixed-bed column for separation of boron from water

Madana Leela Nallappan a, Mohamad Mahmoud Nasef b,*, Teo Ming Ting c, Arshad Ahmad d

aFaculty of Chemical Engineering, Universiti Teknologi Malaysia, 81310 Johor Bahru, Johor, Malaysia, email: madanaleela87@gmail.com
bChemical Engineering Department, Universiti Teknologi PETRONAS, 32610 Seri Iskander, Perak, Malaysia, Tel. +605-3657561; emails: mohamed.nasef@utp.edu.my, mahmoudeithar@cheme.utm.my (M.M. Nasef)
cRadiation Technology Division, Malaysian Nuclear Agency, 43000 Kajang, Selangor, Malaysia, email: tmting@nm.gov.my
dCenter of Hydrogen Energy, Institute of Future Energy, Universiti Teknologi Malaysia, 81310 Johor Bahru, Johor, Malaysia, email: arshad@utm.my

Received 1 January 2019; Received 24 April 2019

ABSTRACT

The performance of new nanofibrous chelating adsorbent, prepared by radiation induced grafting of glycidyl methacrylate onto electrospun poly(vinylidene fluoride) (PVDF) nanofibers followed by functionalization with \(N\)-methyl-\(D\)-glucamine, for removal of boron from aqueous solutions using a fixed-bed column was evaluated. The breakthrough curve was studied under various parameters including initial concentration, flow rate and bed height at pH 7. The column performance was evaluated with Yoon–Nelson and Thomas adsorption kinetic models. The maximum performance for boron adsorption was obtained at an initial concentration of 10 mg L\(^{-1}\), a space velocity (SV) of 15 h\(^{-1}\) and a room temperature of 28°C. The breakthrough capacity was found to be a function of both initial feed concentration and flow rate. Thomas model was found to best fit the dynamic behaviour of the column. The newly obtained adsorbent was proven to be capable of removing boron efficiently from aqueous solutions in continuous fixed-bed systems at high flow rates and has potential for industrial-scale application.

Keywords: Nanofibrous boron-selective adsorbent; Breakthrough curve; Adsorption kinetic models; Fixed-bed column

* Corresponding author.