

# A promising modified polyvinyl chloride for adsorption of boron: Preparation, adsorption kinetics, isotherm, and thermodynamic studies

Huda M. Younis<sup>1</sup>  | Amal A. Mohamed<sup>2</sup> 

<sup>1</sup>Department of Basic Sciences, College of Dentistry, University of Basrah, Basrah, Iraq

<sup>2</sup>Chemistry Department, Faculty of Science, Ain Shams University, Cairo, Egypt

## Correspondence

Huda M. Younis, Department of Basic Sciences, College of Dentistry, University of Basrah, Basrah, Iraq.

Email: [huda.younis@uobasrah.edu.iq](mailto:huda.younis@uobasrah.edu.iq)

## Abstract

A new promising N-methyl-D-glucamine modified polyvinyl chloride via methyl glycinate linker (PVC-MG-NMDG) was designed to extract boron from tourmaline ore from the Sikait area in the South Eastern Desert of Egypt, which assays 10.43% B<sub>2</sub>O<sub>3</sub>. Specifications for PVC-MG-NMDG composite were executed successfully utilizing sundry approaches, such as FT-IR, XPS, GC-MS, TGA, BET, EDX, <sup>13</sup>C-NMR, <sup>1</sup>H-NMR, ICP-OES, and XRD, which assure an acceptable synthesis of PVC-MG-NMDG. Optimized factors like pH, agitation time, primary boron concentration, composite dose, co-ions, eluting agents, and temperature have been improved. At ambient temperature, pH 9, 10 min of agitation, and 0.0138 mol/L boron ions (150 ppm), the PVC-MG-NMDG composite has a 25 mg/g maximal uptake. The extraction-distribution isotherm modeling suggests that the Langmuir model, with a theoretical value of 25.38 mg/g, more closely matches the practical value of 25 mg/g than the Freundlich model. The adsorption kinetics of boron ions by PVC-MG-NMDG were predicted with high accuracy using a pseudo-second order kinetic model, yielding a theoretical retention capacity of 27.93 mg/g. The extraction process was predicted, as shown by thermodynamic calculations, exothermic, spontaneous, and optimal extraction at low temperature; the thermodynamic factors controlling  $\Delta S$  (−0.04 kJ/mol),  $\Delta H$  (−13.74 kJ/mol), and  $\Delta G$  values rise from −1.82 kJ/mol at 298 K to −0.19 kJ/mol at 338 K. Boron ions can be eluted from the overloaded composite by 0.5 M H<sub>2</sub>SO<sub>4</sub> with a 95% efficiency rate. It was established that PVC-MG-NMDG composite reveals a worthy separation factor to most co-ions and gives a good separation power. Boric acid with a boron content of 17.23% and purity of 98.56% can be obtained through alkali fusion with NaOH flux and subsequent adsorption using a PVC-MG-NMDG composite.

## Highlights

- A New modified polyvinyl chloride (PVC-MG-NMDG) was successfully prepared.
- The characteristics of new composite were verified via different techniques.

Huda M. Younis and Amal A. Mohamed contributed equally to this study.