Materials Today: Proceedings xxx (xxxx) xxx

Contents lists available at ScienceDirect

Materials Today: Proceedings

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

Isotherm and kinetic of adsorptive Purolite S108 mixed matrix membrane for boron adsorption

Siti Norfaizah M. Noor, Nurul Hazirah Hasnol, Syed Mohd Saufi *

Faculty of Chemical & Process Engineering Technology, Universiti Malaysia Pahang, Lebuhraya Persiaran Tun Khalil Yaakob, 26300 Gambang, Kuantan, Pahang, Malaysia

ARTICLE INFO

Article history:
Available online xxxx

Keywords:
Mixed matrix membrane
Purolite S108
Adsorption isotherm
Adsorption kinetic
Boron removal

ABSTRACT

Excess boron in the water may cause adverse effects on humans, animals, and plants. An adsorptive mixed matrix membrane (MMM) containing Purolite S108 resin as an active filler was developed in the current study to remove boron from water. A flat sheet membrane was fabricated from a dope solution of 20 wt% polyethersulfone (PES), 5% polyvinylpyrrolidone, 1% Purolite S108 and 74% n-methyl-2-pyrrolidone using a phase inversion process. The membrane was characterized by Field Emission Scanning Electron Microscope (FESEM) and porosity. Both the pristine PES and Purolite S108 MMM membranes displayed an asymmetric structure with different macrovoid patterns at the bottom. The larger macrovoid at the bottom of the pristine PES membrane suggested a faster demixing rate during the membrane phase inversion process. In contrast, the Purolite S108 MMM showed a teardrop macrovoid that formed due to changes in the membrane material's surface energy or chemical composition. These changes created areas where the membrane was less wettable, causing water droplets to form instead of spreading out. Furthermore, the Purolite S108 MMM membrane exhibited slightly higher porosity than the pristine PES membrane, with porosity values of 43.27% and 38.05%, respectively.The adsorption isotherm and kinetic of the Purolite S108 MMM were evaluated using an aqueous boron solution. Three two-parameters adsorption isotherms were tested: Langmuir, Freundlich and Temkin. Purolite S108 MMM is best fitted to the Langmuir adsorption isotherm with the maximum binding capacity of 1.4349 mg B/g membrane. Pseudo-first order (PFO) and pseudo-second-order (PSO) models were tested in the kinetic experiment. The boron uptake by the Purolite S108 MMM followed a PFO kinetic model. The adsorption isotherm and kinetic data of the Purolite S108 MMM are essential for further optimizing the adsorptive membrane operation for boron removal.

Selection and peer-review under responsibility of the scientific committee of the 6th International Conference of Chemical Engineering & Industrial Biotechnology (ICCEIB 2022).

1. Introduction

Excess concentrations of boron in natural and wastewater require an efficient separation process to avoid boron toxicity. The WHO had limited boron concentration in drinking water to 2.4 mg/L [1]. High and long-term use of boron can cause cardiovascular, neurological, coronary, and reproductive health issues in humans [2,3]. Various technologies and methods have been introduced to remove boron from the water such as sedimentation [4], reverse osmosis (RO) [5], and adsorption [7,8]. Sedimentation using clay is one of the common methods used in water purification. Still, it is not an effective treatment for boron removal as it only eliminates a small amount of boron [4]. Single-stage seawater reverse osmosis (RO) membrane is ineffective in removing boron to the acceptable concentration level [5]. This is due to the size of boron being very close to the pore of the RO membrane, and boron is typically present as non-charged boric acid in the water [6]. The adsorption using chelating resin is widely used and has proven an excellent method for boron removal. Various resins were tested, such as Amberlite IRA743 [7], Diaion CBR05 [8], Purolite S108 [8].

Handling and operating the boron selective resin (BSR) is a tedious process as it usually exists in the slurry form. The resin can be packed into a cylindrical column as a packed bed configuration. However, it has a limitation regarding flow rate capability and problems associated with a high-pressure drop. An adsorptive membrane that combines adsorption and filtration in single

* Corresponding author.
E-mail address: smsaufi@ump.edu.my (S. Mohd Saufi).

https://doi.org/10.1016/j.matpr.2023.05.121
2214-7853/
Selection and peer-review under responsibility of the scientific committee of the 6th International Conference of Chemical Engineering & Industrial Biotechnology (ICCEIB 2022).