Desalination and Water Treatment
www.deswater.com
doi: 10.5004/dwt.2021.27507

232 (2021) 165–186
August

Understanding the electrokinetic behavior of the acrylic acid-based Fe(II) ion-imprinted polymer for its application in Fe(II) ions removal from aqueous medium with high selectivity

Tanveer ul Haq Zia[a,*], Daud Khan Ghazali[a], Behisht Ara[b], Kashif Gul[b], Muhammad Hassaan Qureshi[a], Nauman Ali[b]

[a]*Department of Chemistry, Sarhad University of Science and IT, Landi Akhun Ahmad, Hayatabad Link Ring Road, Peshawar (Khyber Pakhtunkhwa), 25000 Pakistan, Tel. +92-334 9011757; emails: tanveerics@gmail.com (T. ul Haq Zia), daudtoofaan@gmail.com (D.K. Ghazali), mhq2310@gmail.com (M.H. Qureshi)*
[b]*Institute of Chemical Sciences, University of Peshawar, Jamrud Road, Peshawar (Khyber Pakhtunkhwa), 25120 Pakistan, emails: bahishtara@gmail.com (B. Ara), kashifpkh@yahoo.com (K. Gul), nali75pk@upesh.edu.pk (N. Ali)*

Received 12 November 2020; Accepted 4 June 2021

ABSTRACT

Electrokinetic analysis was carried out to study the nature of the electrostatic potential ζ at the adsorbent surface as a function of surface charge density σ to understand the interaction between adsorbate and adsorbent. In the present study, precipitation polymerization was carried out in acetonitrile for preparing an ion-imprinted polymer [Fe(II) IIP] for Fe(II) ions by using acrylic acid as functional monomer, the crosslinking agent was N,N′-Methylenebis(acrylamide), 1,10-phenanthroline as chelating agent for Fe(II) ions and azobisisobutyronitrile as thermal initiator. The ion-imprinted polymer [Fe(II) IIP] which was obtained after performing the leaching for Fe(II) ions removal, displayed a greater affinity for selective recombination with the Fe(II) ions as a target analyte. The morphological analysis was performed by applying scanning electron microscopy while the Fourier-transform infrared spectroscopy was employed to illustrate the different functional groups which are present in the structure of the molecule. Similarly, the specific surface area was determined to be 473.44 $m^2\ g^{-1}$ for non-imprinted polymer (NIP) whereas 585.04 $m^2\ g^{-1}$ for Fe(II) IIP by employing the Brunauer–Emmett–Teller (BET) model. Furthermore, the Barrett, Joyner, Halenda model and *t*-plot method was used for evaluating the pore size distribution that illustrated the surface texture nature to be mesoporous for both adsorbents. Langmuir, Freundlich, Dubinin–Radushkevich and BET adsorption models were applied to the equilibrium adsorption data for understanding the adsorption process. It was found that the adsorbent has a heterogeneous surface as the Freundlich isotherm model was obeyed more closely by both the adsorbents. The maximum adsorption capacity of 4.176 mg g^{-1} was reported for NIP in comparison to 5.559 mg g^{-1} in the case of the Fe(II) IIP. For the metal ion pairs of Fe(II)/Co(II), Fe(II)/Cu(II), Fe(II)/Ni(II) and Fe(II)/Pb(II), the relative selectivity coefficient *k*′ was found to be 32.412, 1.129, 1.508 and 1.264, respectively. The adsorption kinetic data followed the pseudo-second-order kinetics more closely pointing to the multistep mechanism of adsorption depicting the substrate and analyte dependency. Also, the Van't Hoff plot was applied in order to determine the change in entropy (ΔS), enthalpy (ΔH) and Gibbs free energy (ΔG) as thermodynamic parameters.

Keywords: Fe(II) ions; Ion imprinting; Electrokinetic; Barrett, Joyner, Halenda and Brunauer–Emmett–Teller; Langmuir; Thermal initiator; Precipitation polymerization; Relative selectivity coefficient

* Corresponding author.