Upcycling of Waste Tire Rubber into Copper (II) Adsorbents by Thermal and Acid Treatments

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Abstract

Copper (II) ion (Cu (II)) adsorbents were developed by upcycling waste tire rubber (WTR). It was achieved through heat treatment, acid treatment, and their combination (two-step treatments) For heat treatment, WTR was heated at 320, 370 and 400 °C (h320-WTR, h370- WTR and h400-WTR). WTR was refluxed with nitric acid for 30, 60 and 180 minutes (a30-WTR, a60-WTR and a180-WTR). In case of two-step treatment, it was sequentially treating WTR with heat and acid or vice versa (h/a-WTR and a/h-WTR). SEM observations revealed pore formation on treated WTR surfaces. Acid-treated WTR exhibited limited Cu (II) adsorption. While acid-heat treated WTR (a/h WTR) presented a more highly porous structure than that obtained from h/a WTR as confirmed by BET analysis. However, h400- WTR gave the highest adsorption efficiency, reaching 103 mg/g. These results indicate that only high porosity does not directly enhance adsorption performance. This study provides important insights to the relationship between modification sequence, pore structure, and adsorption efficiency. It demonstrates the potential of upcycling waste tire rubber into value-added adsorbents for heavy metal removal.

Keywords

Waste tire rubber, Copper (II) adsorption, Upcycling, Heavy metal ion removal, Thermal and Acid Treatments.