Removal of fluoride and hardness in water using zeolite modified dendro biochar composite

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Abstract: Fluoride removal has been researched much, however, hardness removal has been given less attention and simultaneous removal of fluoride and hardness has not been studied in the literature. Hence, the objective of this study is to synthesize a biochar composite with zeolite to remove the fluoride and hardness from the aqueous medium concomitantly. Batch adsorption studies were conducted to investigate the effect of pH (4–10), contact time and initial concentration of fluoride (0.5–5 mg/L) and hardness (50–500 mg/L) on the adsorption using 1 g/L of zeolite modified dendro biochar (ZDBC) at 25 °C. The zero-point charge (pHpzc) of ZDBC was also analysed by drift method. The optimum fluoride adsorption was achieved at pH 6, while maximum hardness adsorption occurred in the alkaline pH. Kinetic experiments demonstrated a two-step adsorption process and were well fitted with the pseudo first order, pseudo second order model and intraparticle diffusion with R^2>0.95. Among different adsorption isotherm models, Hill model was well-fitted with fluoride adsorption data based on R^2 of 0.94. The Elovich kinetic model (R^2=0.90) along with Langmuir (R^2=0.92) and Temkin (R^2=0.90) isotherm models showed the best fit to the hardness adsorption data. The maximum fluoride and hardness adsorption capacities predicted by isotherm models were 1.32 and 160.14 mg/g, respectively. According to the fitted models, fluoride adsorption followed chemisorption, physisorption, and pore diffusion mechanism and hardness adsorption followed chemisorption. Therefore, ZDBC could be a potential adsorbent for concurrently removing fluoride and hardness from aqueous media.

Keywords: Batch adsorption, CKDu, Hardness, Isotherm reaction, Kinetic model