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Development, Characterization and Performance Evaluation of a Weak Cation Exchange Hydrogel Using Ultrasonic Technique

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Abstract : Heavy metals (HMs) present an increasing threat to aquatic and soil environment. Thus, techniques should be developed for the removal and/or recovery of those HMs from point sources in the generating industries. This paper reports our endeavors concerning the development of in-house developed weak cation exchange polyacrylate hydrogel kaolin composites for heavy metals removal. This type of composite enables desirable characteristics and functions including mechanical strength, bed porosity and cost advantages. This paper emphasizes the effect of varying crosslinker (methylenebis(acrylamide)) concentration. The prepared cation exchanger has been subjected to intensive characterization using X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), scanning electron microscopy (SEM), X-ray fluorescence (XRF) and Brunauer Emmett and Teller (BET) method. Moreover, the performance was investigated using synthetic and real wastewater for an industrial complex east of Cairo. Simulated and real wastewater compositions addressed; Cr, Co, Ni, and Pb are in the range of (92-115), (91-103), (86-88) and (99-125), respectively. Adsorption experiments have been conducted in both batch and column modes. In general, batch tests revealed enhanced cation exchange capacities of 70, 72, 78.2 and 99.9 mg/g from single synthetic wastes while, removal efficiencies of 82.2, 86.4, 44.4 and 96% were obtained for Cr, Co, Ni and Pb, respectively from mixed synthetic wastes. It is concluded that the mixed synthetic and real wastewaters have lower adsorption capacities than single solutions. It is worth mentioned that Pb attained higher adsorption capacities with comparable results in all tested concentrations of synthetic and real wastewaters. Pilot scale experiments were also conducted for mixed synthetic waste in a fluidized bed column for 48 hour cycle time which revealed 86.4%, 58.5%, 66.8% and 96.9% removal efficiency for Cr, Co, Ni, and Pb, respectively with maximum regeneration was also conducted using saline and acid regenerants. Maximum regeneration efficiencies for the column studies higher than the batch ones about by about 30% to 60%. Studies are currently under way to enhance the regeneration efficiency to enable successful scaling up of the adsorption column.

Keywords : polyacrylate hydrogel kaolin, ultrasonic irradiation, heavy metals, adsorption and regeneration
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