

Use of acrylamide based hydrogels for pre-concentration of trace level chromium ions

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The determination of trace level (ppb) metal ions by low sensitive flame atomic absorption spectroscopy (FAAS) requires sample pre-concentration procedures. In this study, Poly (acrylamide-co-maleic acid) hydrogel (PAMMA) was prepared by free radical polymerization in the presence of cross linking agent (N,N'-methylenebisacrylamide), initiator (ammonium persulphate) and accelerator (N,N,N,N-tetramethylethylenediamine) to study the pre-concentration potential of chromium ions.

The swelling behavior and adsorption capacities were studied at various maleic acid levels at different pH values. The prepared hydrogels showed good swelling behavior that was highly dependent on the pH of the medium. The maximum swelling ratio of 108 was observed at pH = 7.

The affinity of trivalent chromium (Cr^{3+}) and hexavalent chromium (CrO_4^{2-}) for PAMMA hydrogels were studied at pH 4 where hydrogels were partially deprotonated. The results indicated that affinity of trivalent chromium was significantly higher than that for hexavalent chromium ions. Therefore poly (acrylamide-co-maleic acid) hydrogel was selected to pre-concentrate trivalent chromium. The critical factors such as pH, ionic strength, acrylamide-maleic acid ratio and cross-linking density were also studied for the optimization of adsorption capacity of prepared hydrogels for trivalent chromium absorption. Maximum adsorption capacity was observed when the acrylamide: maleic acid molar ratio was 7:4. With the increase of crosslinking density, the adsorption capacities decreased. The adsorption capacity also dropped with ionic strength. It was found that the absorption capacity dropped from 42.3 to 26.3 mg g^{-1} when ionic strength was increased from 0.01 to 1.

The optimum uptake of Cr^{3+} was found to be at pH 5 and the equilibrium contact time was reached at around 4 hours. Adsorption mechanisms were studied by both Langmuir and Freundlich isotherm models at room temperature (29 °C) and it was found that the adsorption behavior was better explained by Freundlich isotherm. The kinetic studies of trivalent chromium indicated that the rate of adsorption followed pseudo second-order kinetics at room temperature.

Pre-concentration factors of Cr^{3+} at optimum conditions in different initial concentrations were studied at non-competitive conditions. Very good linear correlation of the prepared trivalent chromium solutions at ppb levels and the pre-concentrated solutions was found. The linear correlation co-efficient (r^2) of 0.998 indicates that poly (acrylamide-co-maleic acid) hydrogel can be used to pre-concentrate trivalent chromium in the range of 40 - 70 ppb into 2-10 ppm range.

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