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Synthesis and Characterization of Cellulose Acetate Titanium (Iv) Tungstomolybdate Nanocomposite Cation Exchanger for the Removal of Selected Heavy Metals from Aqueous Solution

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Abstract

Cellulose acetate titanium (IV) tungstomolybdate nanocomposite cation exchanger was synthesized by sol-gel method by incorporating cellulose acetate polymer into inorganic exchanger, titanium (IV) tungstomolybdate. Different techniques including FTIR, XRD, TGA SEM and BET were used to characterize the exchanger. The Cellulose acetate titanium (IV) tungstomolybdate (CATTM) behaved as a good cation exchanger with ion exchange capacity of 1.64 meq g-1 for Na+ ions. The sequence of ion exchange capacity for alkali metal ions was found to be K+> Na+> Li+ and that for alkaline earth metal ions was Ba2+ > Ca2+ > Mg2+These orders revealed that the ions with smaller hydrated radii acquired larger ion exchange capacity. The pH titration curve indicated that the material obtained as such is a bi functional strong cation exchanger as indicated by a low pH (~2.25) of the solution when no OH- ion was added. Thermal analysis of the material showed that the material retained 55% of its ion exchange capacity up to 600°C. Adsorption behavior of metal ions in different solvents with varying concentration has also been explored and the sorption studies revealed that the material was selective for Cr(III) and Pb(II) ions. The analytical utility of the material was investigated by performing binary separations of selected metal ions in a column based on the distribution coefficients of the metals. Cr(III) and Pb(II) were selectively removed from synthetic mixtures of Cr(III)-Co(II), Cr(III)-Cd(II), Pb(II)-Co(II) and Pb(II)-Cd(II). Antimicrobial activity of the synthesized titanium (IV) tungstomolybdate compound was evaluated and showed a considerable antibacterial activity against Staphylococcus aureus, Streptococcus agalactiae, Escherichia coli and Shigella flexneri. The inorganic counterpart has also exhibited a promising antifungal activity against Aspergillus niger and Fusarium oxysporum.

The cation exchanger for nano-titanium (IV) tungstomolybdate was synthesized through a homogeneous precipitation method.. Synthesis parameters have been optimized to achieve the highest ion exchange capacity (IEC) possible. The as-synthesized nanoexchanger was thoroughly defined by XRD, XRF, TEM, STEM / HAADF / EDS, FTIR and BET. Titanium (IV) molybdophosphate (TMP) serves as a bi-functional and solid acid cation exchanger with IEC of 2.41 meq. g−1 for Na+ions. High distribution coefficient values indicated that an exchanger may be used for selective adsorption of Pb2 + ions (Kd = 10767 mL.g−1) and Cr3 + ions (Kd=11800 mL. g−1). Pb2 + and Cr3 + ions from waste containing other metal ions. The exchanger also displayed a positive affinity to the radionuclide $UO2^{2+}$ (Kd = 7043 mL.g−1 in 0.1 M DMSO). The distribution analysis of the exchanger in various solvent systems showed a positive separation potential between the exchanger and the metal ions of analytical interest from the mixture for toxic heavy metal ions.

Nowadays, rapid industrialization, urbanization, population growth and climate change have played a role in the contamination of water supplies. The shortage of fresh and clean water is expressed as a major danger to many countries. Water purification methods have been the subject and concern of many scientists and government agencies in recent years. Scholars around the world are focusing on nanotechnology-centric water purification / treatment methods for the safe and reliable sanitation of water bodies. Due to the high surface area , high chemical reactivity, excellent mechanical strength and cost-effectiveness of nano-scale composite materials, they have an enormous potential for water purification. Owing to special binding actions (chelating, absorption, ion exchange), nanoparticles are intelligent to extract bacteria, viruses and inorganic and organic pollutants from waste water. Nanocomposite materials play an important role in water purification, such as nanocomposite metal, nanocomposite metal oxide, nanocomposite oil, nanocomposite polymer and nanocomposite membranes.

Nanocomposite Pectin-thorium (IV) tungstomolybdate (Pc / TWM) was formed using the sol-gel process using a mixture of biopolymer pectin and its inorganic counterpart thorium (IV). The nanocomposite was characterized by X-ray diffraction (XRD), scanning electron microscopy (SEM), thermogravimetric analysis (TGA), transmission electron microscopy (TEM) and Fourier transforming infrared spectroscopy (FTIR). In order to examine the ion exchange behaviour of the nanocomb material, the distribution coefficient, thermal stability, pH titration, elution and concentration behaviour. The PC/TWM exchange capacity was higher than the inorganic count (1.10 mequiv/g). The Pc/TWM nanocomposite ion exchanger was thermally stable, maintaining 59 percent of its ion exchange power up to 400 ° C. The pH titration study revealed the bi-functional nature of Pc / TWM. The antibacterial and photocatalytic activities have been studied in order to explore the environmental applicability of the Pc / TWM nanocomposite content. 76% of methylene blue dye was photocatalytically degraded after five hours of exposure. This also completely inhibited Escherichia coli at a concentration of 400 µg/ml of Pc/TWM nanocomposite.

For the selective separation of Pb2 + Polyanilin Zr (IV) was used for the Behaviour and some important chemical applications in the area of ion exchange, ion exchange membrane and solid state electrochemistry. The literature shows the behaviour, which was studied for the synthesis, ion exchange behaviour, anad for the purpose of study by a variety of three-component ion exchangers, namely zirconium (IV) iodooxalate, zirconium (IV) phosphosilicate, zirconium (IV) phosphoborate and Zirconium (IV).This paper focuses on the synthesis, characterisation and study of the ion exchange properties of Zr (IV) iodate polyaniline as a new ion exchanger.