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Preparation and characterization of gum karaya hydrogel nanocomposite flocculant for metal ions removal from mine effluents

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ABSTRACT:

This research paper reports the removal of heavy metal ions from mine effluents using the gum karaya (GK)-grafted poly(acrylamide-co-acrylic acid) incorporated iron oxide magnetic nanoparticles (Fe3O4 MNPs) hydrogel nanocomposite [i.e., GK-cl-P(AAm-co-AA)/Fe3O4 hydrogel nanocomposite] and inorganic coagulants such as polyferric chloride (af-PFCl), Al2(SO4)3, FeCl3 and Mg(OH)2. The Fe3O4 MNPs were incorporated in the matrix of the hydrogel polymer of Gk-cl-P(AAm-co-AA) through the free radical graft co-polymerization technique using N,N'-methylene-bis-acrylamide as the cross-linking agent. The graft co-polymerization of the P(AAm-co-AA) with Gk and the successful incorporation of the Fe3O4 MNPs within the hydrogel polymer matrix was evidenced using different characterization techniques such as FTIR, XRD, SEM and TEM. The performance of coagulants was evaluated by considering parameters such as turbidity removal, pH correction, metal removal and settling time. It was observed that the monomeric inorganic coagulants had a relatively poor performance compared to the organic coagulant, i.e., GK-cl-P(AAm-co-AA)/Fe3O4 hydrogel nanocomposite. Most of the coagulants achieved maximum turbidity removal in the range of 67–99.5 %, but the hydrogel nanocomposite showed the greatest reactivity by achieving the fastest floc formation rate and shortest optimum sedimentation time of 5 min (100 % removal in 5 min). The removal of metal followed the order Pb2+ > Cr6+ > Ni2+ with an optimum settling time of 15 min; more often, Ni2+ was poorly removed (=23.2 % removal after 15 min) from acidic mine water samples. Therefore, the synthesized hydrogel nanocomposite has shown great potential as a flocculant and adsorbent for the removal of suspended particles as well as heavy metal ions and can be used to improve the quality of mine effluents prior to discharge in the environment.