ABSTRACT

The present work aims at exploring the removal of different contaminants by engineering the interlayer space of layered double hydroxides (LDHs) in the context of purification and treatment of drinking water and industrial effluents using hybrid materials.

The engineering of these LDHs materials requires understanding of material properties, like, intercalation chemistry, self-assembly and functionalization aspects in order to synthesize materials that are more specific to a given contaminants. Therefore, four different materials, namely, nitrate intercalated nickel aluminium LDH (NiAl LDH), calcium aluminium LDH (CaAl LDH), graphene oxide (GO) intercalated magnesium aluminium LDH (GO_MgAl LDH) and palladium encapsulated crown ether intercalated cobalt aluminium LDH (*$Pd_{0.05}$-ECC-$L_{0.10}$@ In-situ CoAl LDH*) were synthesized by simultaneous understanding deduced form the intercalation chemistry.

The potential of NiAl LDH, CaAl LDH and GO intercalated MgAl LDH was investigated for remediation of cyanide, fluoride and lead from steel industrial effluent, contaminated groundwater and battery effluent, respectively. The synthesized NiAl LDH and CaAl LDH materials were successfully incorporated inside the polysulfone (Psf) polymeric matrix and porous mixed matrix beads (MMBs) are prepared in order to overcome the operational problems associated with nanoparticles. On the other hand, polyacrylonitrile (PAN) based MMBs were prepared upon impregnation of GO intercalated MgAl LDH in PAN. The efficacy of NiAl MMBs, CaAl MMBs and GO intercalated MgAl MMBs in the adsorption of cyanide from blast furnace effluent, fluoride form contaminated ground water and lead from battery effluent was explored, respectively. The maximum adsorption capacity for cyanide was 80 mg/g, 95 mg/g and 109 mg/g, respectively, at 303, 313 and 323 K. The adsorption capacity of the CaAl LDH MMBs for fluoride varied from 65 mg/g to 110 mg/g for increase in the temperature from 298 K to 323 K. The maximum adsorption capacity for lead was 174 mg/g, 187 mg/g and 209 mg/g, respectively, at 303, 313 and 323 K. The breakthrough column experiments were performed by passing the industrial cyanide effluent, contaminated ground water and battery effluent in fixed beds at varying bed heights, concentration and flow rates.

The performance of *$Pd_{0.05}$-ECC-$L_{0.10}$@ In-situ CoAl LDH* material was evaluated by adopting conversion of *p*-nitrophenol in to *p*-amino phenol as a model reaction. 0.35 g/l of catalyst and sodium borohydride ($NaBH_4$) was the optimum dose obtained in order to convert 50 µm of *p*-NP concentration. The synthesized catalyst shows greater selectivity for *p*-NP over other forms with a turn over frequency (TOF) value of 600 h^{-1}.

Keywords: *Layered double hydroxides (LDHs); Mixed matrix beads (MMBs); Engineered interlayer space; Adsorption; Cyanide removal; Fluoride removal; Lead removal; Discretization and Encapsulation; p-nitrophenol conversion*