ABSTRACT

Fluoride and other heavy metals, like, arsenic, lead, cadmium, copper, zinc and nickel are some of the pervasive and persistent pollutants in drinking water. Concentration of harmful contaminants in groundwater increases due to depletion of water resources from the underground water table accompanied by weathering of underneath rocks. Also, anthropogenic causes, like, hydraulic fracturing and discharge of untreated industrial effluents result in increase of their concentration.

The current study aimed at delivering cost effective solution tools (both adsorbents and membrane) for removal of fluoride and harmful toxic metals. In case of defluoridation of drinking water, raw bone meal (common constituent of phosphate fertilizer) has been procured and processed by a low energy intensive partial carbonization. Carbonization time and temperature were fixed with respect to defluoridation capacity. After carbonization, this was again chemically treated using aluminium sulfate and calcium oxide and an adsorbent was synthesized having high uptake capacity. Combined adsorbent was used for defluoridation of synthetic and actual groundwater. Secondly, mixed matrix membrane was also prepared for defluoridation purpose. Activated alumina was doped in cellulose acetate phthalate polymer to prepare flat sheet membrane, while carbonized bone meal powder was doped in polysulfone to prepare hollow fibers.

Arsenic removal by more open ultrafiltration grade mixed matrix membrane was performed. Two separate inorganics were used for specific removal of arsenic. In first study, powdered treated laterite was doped in polyacrylonitrile to prepare flat sheet membranes. In the subsequent study, powdered iron ore slime (IOS), a by-product of steel industry was incorporated in polysulfone based hollow fibers.

Removal of selective heavy metals from groundwater, like lead, cadmium, copper, zinc and nickel was effected using treated laterite (surface pH 9) as an adsorbent. Characterization of treated and raw laterite along with optimization of operating conditions during batch study (equilibrium and kinetics) has been performed. Effect of multicomponent mixture in the uptake capacity of different heavy metals by adsorbent has also been studied. Fixed bed performance of different adsorbents towards removal of fluoride and heavy metals, from synthetic and groundwater solutions was also studied. Applicability of different dynamic models used to for prediction of performance has also

been evaluated. Most importantly, scale up studies were also performed to predict the quantity of adsorbents required for higher breakthrough life.

Keywords : Fluoride removal; arsenic removal; Heavy metal removal; adsorbent; fixed bed study; mixed matrix membranes; scale up analysis.