ABSTRACT

Geogenic and Anthropogenic noxious pollutants can jeopardize terrestrial and aquatic ecosystems through environmental partitioning in natural soil-water compartment, geothermal and marine environments. Although, many researchers have investigated the decontamination potential of different mesoporous engineered sorbents for a suite of contaminants, still the removal efficiency of sustainable bio-based materials towards metal/ metalloids needs special attention. Permeable reactive barrier is an emerging alternative method that has a low cost, high efficiency and longevity. This passive in situ groundwater remediation technology, developed decades ago is under current research with the aim of developing better reactive filler materials. These fillers should be cost-effective, easily available, and should remain effective for a working period of several years. The present thesis focuses mainly on the synthesis of new green materials to be tested at the batch scale for the removal of geogenic (arsenic) and anthropogenic contaminants (cadmium, cobalt, lead, nickel and chromium). The fillers used for the removal of geogenic contaminants include silane treated sand (STS) and rice straw biochar (RSBC); whereas for anthropogenic contaminants the fillers were Na-alginate beads encapsulating zero valent iron (ZVI) and activated carbon (AC). The maximum removal percentage for As was 75% and 70% for STS and RSBC respectively; for anthropogenic with ZVI-AC-Na alginate beads, the magnitude of removal followed was in the order of Pb > Cr > Cd > Ni > Co. Effective filler material for a suite of contaminants was finalized based on the characterization, removal percentage, kinetic and isotherm studies. A lab scale PRB aquifer set-up, with geotechnical properties tested, was developed for the continuous testing of the finalized filler materials. The initial PRB studies have shown promising results, equivalent to batch scale studies. The obtained results clearly validate the sustainable utilization of such bio-based waste material as a promising novel electron exchanging adsorbent (containing electron accepting/donating acidic oxygen containing functional groups) for removing metalloid contaminants from water. Further research is required to study the efficacy of the proposed adsorbent on real groundwater in the complex PRB system together with bacterial consortium to check its antifouling/biocidal activity.

Keywords: Permeable reactive barrier; *in-situ* remediation; groundwater; contaminants; reactive materials.