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Chemical Reduction of Nitrate by Zerovalent Iron Nanoparticles Adsorbed Radiation Grafted Copolymer Matrix

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Nitrate contamination of global water resources due to the globalization of modern agricultural practices is an emerging threat worldwide. In spite of the usefulness of nitrate and nitrogenous compounds as essential elements in life processes, nitrate is potentially hazardous when present in drinking water at sufficiently high concentrations. Due to its high solubility nitrate may actually be the most widespread and priority contaminant in drinking water. It acts as a precursor for several health hazards ranging from blue baby syndrome to gastric cancer. Treatment of nitrate containing water is challenging due to its stability. The reduction is the only possible way to fully remove nitrate contamination from ground water as it does neither form insoluble minerals that could be removed as precipitates nor does it significantly adsorb under aquifer conditions. The nitrate molecule is a good electron acceptor and hence an efficient electron donor is required for its reduction. nZVI can play a major role in this situation as it is a good electron donor with a high reactivity due to its extremely small size and strong reduction capacity. The results obtained in this work suggest that metallic-Fe can support chemical reduction of nitrate contaminated water. This research specifically focused on development of novel methodologies to reduce excess nitrate in drinking water utilizing nZVI stabilized radiation grafted copolymer matrix. nZVI was synthesized by borohydrate reduction of FeCl_3 and stabilized on a radiation grafted copolymer matrix. Acrylic acid (AAc) grafted non-woven polyethylene/polypropylene (NWPE/PP-g-AAc) fabric was used as the supportive copolymer matrix and Co-60 gamma radiation was applied. In previous research, this material has been extensively characterized. The chemical reduction of nitrate by nZVI adsorbed NWPE/PP-g-AAc (nZVI-Ads-NWP) fabric was examined in batch experiments at different pH values with the aim of optimizing ammonia production (ammonia being the major end product) for subsequent conversion to chloroamines upon chlorination. The pH of the solution showed a marked effect on nitrate reduction with enhanced efficiency in acidic conditions compared to the micro-scale iron particles. After about 24 h, at pH 3, almost 96% of nitrate was degraded. According to characterization data for the material, the surface of the nZVI due to the core-shell structure contains ferrous hydroxide and other protective layers. At low pH values, these protective layers can be readily dissolved exposing the pure iron particles for efficient chemical reduction of nitrate. Experimental results suggest that this reduction process is an acid-driven surface mediated process. The nZVI water interface has been fully characterized by the 1-pK Basic Stern Layer Model (BSM) and an Eley-Rideal like mechanism well described the nitrate reduction kinetics. In accordance with green technology, newly synthesized nZVI-Ads-NWP has great potential in designing a nitrate reduction process required in drinking water industry.

Country/Organization invited to participate

Sri Lanka

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