



Distinct kinetics and mechanisms of mZVI particles aging in saline and fresh groundwater: H₂ Evolution and surface passivation

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Application of microscale zero-valent iron (mZVI) is a promising technology for in-situ contaminated groundwater remediation. However, its longevity would be negatively impacted by surface passivation, especially in saline groundwater. In this study, the aging behaviors of mZVI particles were investigated in three media (milli-Q water, fresh groundwater and saline groundwater) using batch experiments to evaluate their potential corrosion and passivation performance in different field conditions. The results indicated that mZVI was reactive between 0-7 days exposure to water and then gradually lost reactivity over the next few hundred days. The patterns of kinetic curve were analogous among the three different media. In comparison, during the early phase (0-7 d), mZVI in saline groundwater showed a faster corrosion rate with a k value of 1.357, which was relatively higher than k values in milli-Q water and fresh groundwater. However, as the corrosion process further developed, the fastest corrosion rate was observed in milli-Q water followed with fresh groundwater and saline groundwater. These changes in reactivity provided evidence for different patterns and formation mechanisms of passive layers on mZVI in three media. The SEM-EDS analysis demonstrated that in the saline groundwater, a compact and even oxide film of carbonate green rust or Fe oxide (hydroxyl) species was formed immediately on the surface due to the high concentration and widely distributed bicarbonate and hardness, whereas in the fresh groundwater and milli-Q water, the passive layer was composed of loosely and unevenly distributed precipitates which much slowly formed as the iron corrosion proceeded. These findings provide insight into the molecular-scale mechanism of mZVI passivation by inorganic salts with particular implications in saline groundwater.