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Development of zero-valent iron nanoparticles for groundwater remediation

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Soil pollution arises due to the presence of contaminants, toxic chemicals, etc. These chemicals, when present more than the threshold limit, affect plant growth and also groundwater. These impurities contaminate the groundwater and make it unsuitable for use. Zero-valent iron is a biodegradable emulsion and is reported to be successful in groundwater remediation. This is due to the high specific area of the zero-valent iron nanoparticles. Their high surface area that is associated with their high reactivity makes these zero-valent iron nanoparticles a good agent capable of transforming or degrading the contaminants in soil and water. Zero-valent iron nanoparticles are non-toxic and inexpensive. These nanoparticles are found to be more effective than macroscale zero-valent iron or iron filings under similar environmental conditions. The preparation of zero-valent iron nanoparticles involves mixing ferric chloride with water/ethanol mixture along with sodium borohydride solution in a flask reactor. The reaction is as follows:

2FeCl3 + 6NaBH4 + 18H2O   =   2FeO + 6NaCl + 6B(OH)3 + 21H2

The synthesised nanoparticles can be dried in an oven at 323 K overnight. For storage, a thin layer of ethanol can be added to preserve the iron nanoparticles from oxidation. A systematic characterisation of zero-valent iron nanoparticles can be performed using a scanning electron microscope, transmission electron microscope, optical microscopy and atomic force microscopy. In spite of the advantages as a decontaminant agent, zero-valent iron nanoparticles also have some disadvantages including a lack of stability, rapid passivation and limited movement, as they tend to aggregate rapidly in water solution. In order to overcome these disadvantages, polymer-coated zero-valent iron nanoparticles can be used for this application and this gives better results. Thus, zero-valent iron nanoparticles can be used for environmental remediation as they have the ability to sequester a variety of contaminants in soil and groundwater.

Keywords: Iron nanoparticles, Zero-valent iron, Groundwater remediation, Environmental remediation, Biodegradable emulsion

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