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Methods of preparation and modification of advanced zero-valent iron nanoparticles, their properties and application in water treatment technologies

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Zero-valent iron nanoparticles are commonly used in modern water treatment technologies. Compared to conventionally-used macroscopic iron or iron microparticles, the using of nanoparticles has the advantages given mainly by their generally large specific surface area (it drives their high reactivity and/or sorption capacity), small dimensions (it allows their migration e.g. in ground water), and particular physical and chemical properties. Following the applications of zero-valent iron particles in various pilot tests, there arose several critical suggestions for improvements of used nanomaterials and for development of new generation of reactive nanomaterials. In the presentation, the methods of zero-valent iron nanoparticles synthesis will be summarized with a special attention paid to the thermally-induced solid-state reaction allowing preparation of zero-valent iron nanoparticles in an industrial scale. Moreover, the method of thermal reduction of iron-oxide precursors enables to finely tune the critical parameters (mainly particle size and morphology, specific surface area, surface chemistry of nanoparticles etc.) of resulting zero-valet iron nanoparticles. The most important trends of advanced nanoparticles development will be discussed: (i) surface modification of nanomaterilas, (ii) development of nanocomposites and (iii) development of materials for combined reductive-sorption technologies. Laboratory testing of zero-valent iron nanoparticles reactivity and migration will be presented and compared with the field observations: the advanced zero-valent iron nanoparticles were used for groundwater treatment at the locality contaminated by chlorinated hydrocarbons (VC, DCE, TCE and PCE) and reacted nanoparticles were extracted from the sediments for their fate assessment.
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