ROLE OF AMORPHOUS AND NANOCRYSTALLINE IRON OXIDES IN ENVIRONMENT AND THEIR APPLICABILITY IN ENVIRONMENTAL TECHNOLOGIES

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Abstract

Iron oxides, hydroxides and oxyhydroxides commonly occur as mineral nanoparticles or nanominerals and play an essential role in environment. Amorphous and nanocrystalline iron oxides appear in natural water, soil, sediments and air where they can be found in the form of separate nanoparticles or aggregates, bound to other substances (microparticles or macroscopic materials) or as a part of living organisms (e.g., in bacteria, tuna fish, pigeon). One of the most important roles of natural iron-bearing nanoparticles lies in their high mobility through geological environment allowing transport of various elements (metals, organic substances) adsorbed on their extremely large surfaces. Moreover, nanocrystalline iron oxides are widely used in industry and various environmental technologies. Several examples of applications and properties of natural as well as synthesised amorphous and nanocrystalline iron oxides will be presented: (i) The raw nanocrystalline and X-ray amorphous natural ferrihydrite (surface area up to 270 m² g⁻¹) was tested as a potential catalyst for decomposition of hydrogen peroxide giving the first-order rate constants equal to 6.59 ± 0.05 min⁻¹, comparable to commercially available Fe-based catalyst. (ii) The same natural nanomaterial was successfully tested for the treatment of As(III) and As(V). (iii) Nanocrystalline Fe(III) oxyhydroxides, formed as a reaction product of K₂FeO₄ with weak-acid dissociable metal cyanides, represent an effective sink for metals released from decomposed cyanides. (iv) The cheap and reproducible thermally-induced solid-state reactions under controlled hydrogen atmosphere were employed in order to transform suitable Fe-based precursors (hematite, maghemite, goethite and ferrihydrite) into nanomaterials important for various water-treatment technologies.

Keywords: