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Use of zero valent iron nanoparticle for in situ chemical reduction of hexavalent chromium in contaminated soils

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In the environment, chromium is mainly found in two oxidation states: Cr(VI) and Cr(III). Cr(VI) is relatively mobile in the environment and is extremely toxic, mutagenic [1,2], teratogenic [3] and carcinogenic [4,5]. In contrast, Cr(III) exhibits relatively low toxicity [6] and is a necessary nutrient for humans and animals [7,8]. Therefore, the reduction of Cr(VI) to Cr(III) is environmentally friendly, and can be used for the remediation of Cr(VI) contaminated sites. Thus, the in situ chemical reduction of hexavalent chromium by the nanoparticle of zero valent iron (nZVI) in contaminated soils near a galvanic zone in northern Italy characterized by an excessive presence of Cr(VI) and other heavy metals has made the object of our research. Experiments were performed on soil samples collected from an industrial site where a nickel contamination, caused by a long-term productive activity, was also verified. The influence of reducing agents amount with respect to chromium content and the effectiveness of deoxygenation of the slurry were discussed. The soil was fully characterized before and after each test, and sequential extractions were performed to assess chemico-physical modifications and evaluate metals mobility induced by washing. Results show that the reducing agent successfully lowered the amount of Cr(VI) in the soil below the threshold allowed by Italian Environmental Regulation for industrial reuse. Cr(VI) reduction by colloidal nZVI proved to be effective: the civil reuse of soil [Cr(VI) < 2 mg/kg] was only achieved using colloidal nZVI within 60 min adopting a nZVI/Cr(VI)) molar ratio of 30. The reducing treatment resulted in an increase in the amount of chromium in the oxide–hydroxide fraction,thus confirming a mechanism of chromium-iron hydroxides precipitation. In addition, a decrease of nickel (Ni) and lead (Pb) content in soil was also observed when acidic conditions were established.

Keywords: Hexavalent chromium, Contaminated soil, Chemical reduction, Nano zero-valent iron.

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