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How can we improve reactivity and long-term performance of iron nanoparticles in (ground)water remediation processes?

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Iron nanoparticles (generally termed as nanoscale zero-valent iron particles – nZVI) represent one of the most extensively investigated type of nanomaterial with high perspective for its utilization in technologies of environmental restoration. During last twenty years, the nZVI particles have been often used for reductive in-situ groundwater remediation contaminated primarily with chlorinated hydrocarbons, hexavalent chromium, other organic substances and potentially risk elements. For this purpose, various types of nZVI particles and nZVI-bearing nanocomposites have already been designed and subsequently produced for reductive and/or combined technologies of groundwater and wastewater treatment.

Generally, the reactivity and overall applicability of nZVI particles is competitive with conventional remediation technologies. However, the main drawback of the nZVI particles could be seen in their low selectivity and also in their limited migration/applicability in some particular cases (i.e., in sediments with low permeability etc.). Therefore, material properties (including mainly surface modifications, chemical modifications) and various types of combinations (e.g., combination of nZVI with other materials leading to formation of new nanocomposites, or combination with external factors like electric/magnetic field, microbial activity etc.) have been recently invented by the authors with the aim to enhance nZVI applicability. In this presentation, the most promising ways leading to improved nZVI reactivity (and overall performance in groundwater treatment processes) will be overviewed and the basic principles will be further confronted with laboratory-scale experiments, as well as with results from filed-scale pilot tests.