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Enhanced ROS Generation by Aqueous Nano-composites of Zero Valent Iron / Fullerene Particles

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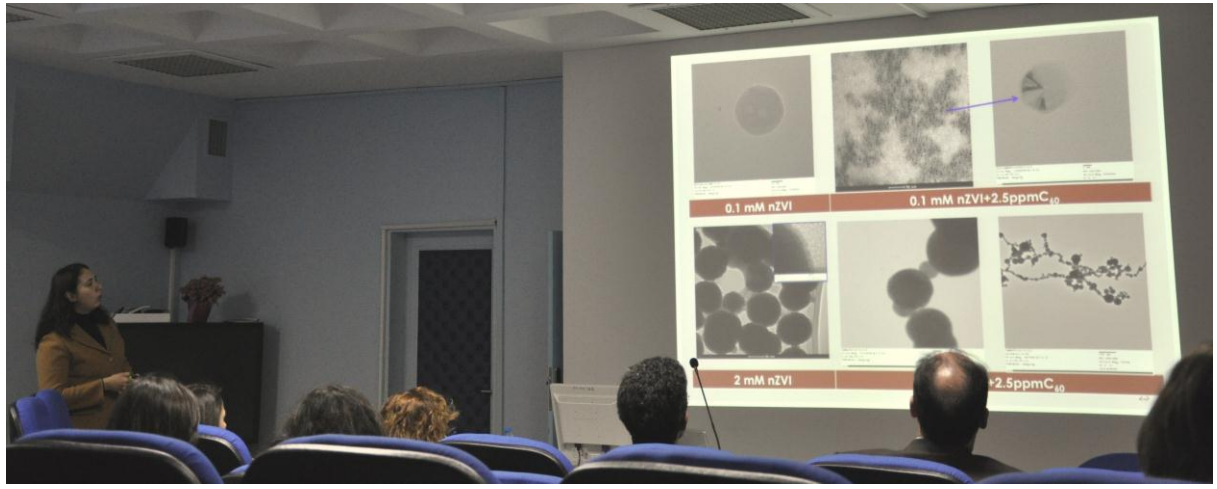
Fullerenes (C_{60}) and zero-valent iron nanoparticles (nZVI) have the potential for Reactive Oxygen Species (ROS) generation, which offer important benefits in environmental remediation and water treatment applications. The objective of this research is to investigate the enhanced generation of ROS, particularly singlet oxygen, superoxide and hydroxyl radicals, by synthesizing a novel 'nano-composite' made of fullerene and nZVI particles. Probe compounds (Benzoic acid, XTT, and FFA) were selected based on their known relative affinity for reactive oxygen species and were used to quantify the production of reactive oxidants. The results revealed that the hydroxyl radical generation could be tuned by changing the concentration ratio of nZVI to C_{60}. Superoxide anion was generated via sudden burst and was strongly affected by the presence of C_{60} particles, which confirmed the Type I pathway. Singlet oxygen generation was observed to be solely dependent on the C_{60} concentration under UV-A illumination. One of the most promising benefits of this novel nano-composite is believed to be the ability to control the reactivity of nZVI particles, probably via entrapping these particles in fullerene cage, thus minimizing the instantaneous oxidation and allowing for an extended reaction time.

The potential of the fullerene-nZVI nano-composite to release a considerable amount of ROS indicated that the system would serve as an innovative nanoparticle-based advanced oxidation process that could be used to remove hazardous contaminants and recalcitrant organic compounds from water, as well as to disinfect waterborne pathogens.


Reactive Oxygen Species : $^1O_2$, $O_2^{\cdot-}$, $OH^{\cdot}$
nZVI
$Fe^0(s) + O_2 + 4H^+ \rightarrow Fe^{2+} + 2H_2O$
or
$Fe^0(s) + O_2 + 2H^+ \rightarrow Fe^{2+} + H_2O_2$
e-
$Fe^{2+} + H_2O_2 + H^+ \rightarrow Fe^{3+} + H_2O + OH^{\cdot}$
$^1C_{60}$
ISC
$^{*3}C_{60}$
O_2
$^1O_2$
hv
$^0C_{60}$
$^{*3}C^-_{60}$
O_2
well established
?


Buckminster fuller
Buckyball
Fullerene- C_{60}


0.1 mM nZVI
0.1 mM nZVI+2.5ppmC_{60}
2 mM nZVI
+2.5ppmC_{60}