In a recent article, Hwang et al. [1] reported on the mechanism of nitrate (NO$_3^-$) reduction by nanoscale metallic iron (nano-Fe$_0$). A particular attention was paid to the fate of nitrogen species during nitrate reduction. This article with 20 peer-reviewed references is very informative. However, the objective of the study is questionable as it challenges the state-of-the-art knowledge on the mechanism of aqueous contaminant removal in the presence of Fe$_0$ (e.g. in Fe$_0$/H$_2$O systems) [2-4]. The view that Fe$_0$ is a reducing agent has been challenged three years ago [2].

Hwang et al. [1] referenced 15 peer-reviewed articles dealing with remediation with metallic iron (Fe$_0$ and nano-Fe$_0$). From these, one is a critical review published in 2008 [5], showing that the article of Hwang et al. [1] is principally well-referenced. From the remaining 14 research articles published between 1997 and 2008, only 3 did not directly deal with NO$_3^-$, suggesting that the authors have focused their attention on articles dealing with nitrate while preparing and presenting their work. Additionally, all 3 remaining articles not dealing with NO$_3^-$, used nano-Fe$_0$. Accordingly, Hwang et al. [1] used a commended approach to prepare and present their work. The question that arises is why the product of such an intellectual effort is not satisfying?

The problem is the origin. In fact, based on a false premise, researchers working on Fe$_0$ for water treatment have created a sort of modern knowledge system which used (or misused) scientific arguments, as will be shown below. Clearly, Fe$_0$ is not a reducing agent for contaminant removal including NO$_3^-$, and the objective of water treatment is not contaminant...
chemical transformation (e.g. reduction) but contaminant removal. A chemical transformation
(oxidation or reduction) may render a contaminant more removable but is not a stand alone
removal mechanism. In the case of NO$_3^-$, for example, completely reducing NO$_3^-$ to NH$_4^+$ will
not produce clean water, unless NH$_4^+$ is removed down below the MCL value (maximum
concentration limit). There are five possible mechanisms for contaminant removal in Fe$^0$/H$_2$O
systems: adsorption, co-precipitation, precipitation, size-exclusion and volatilization. Apart
from precipitation, all other removal mechanisms are applicable to NO$_3^-$ removal in batch
systems. It is important to notice that, in a real world system, e.g. nano-Fe$^0$ in the subsurface
reactive zone, there will be no possibility to homogenize the system by stirring the solution as
Hwang et al. [1] did. Moreover, whether nitrate is reduced or not, it is progressively
enmeshed by very reactive iron hydroxides and continues to be fixed while hydroxides are
further transformed (crystallisation) [6]. Nitrate enmeshed in the matrix of iron corrosion
products cannot be leached by water and are stable under environmental conditions. Adsorbed
nitrate can be leached; it could also be reduced by adsorbed Fe$^{II}$ and adsorbed H/H$_2$ from Fe$^0$
oxidative dissolution. The fate of reduced forms of NO$_3^-$ is the same. The hitherto
presentation has questioned the importance of quantifying the extent of NO$_3^-$ reduction by
nano-Fe$^0$. Furthermore, it demonstrates that mass balance without iron oxide dissolution is not
possible in real systems. A better approach could be to work under relevant conditions (e.g.
non-disturbed or stirred at very low speed) and evaluate the extent of desorbable N species.
In conclusion, the false premise, that contaminants are reduced in Fe$^0$/H$_2$O should be
abandoned for rapid progress in the optimisation of the proven efficient technology of using
Fe$^0$ for water treatment. Given the huge number of available publications on water treatment
with Fe$^0$, it is obvious that individual researchers or research groups could not always be
aware on the state-of-the-art knowledge. The situation is even worse for researchers from
small research centres and low-income countries (mostly in the developing world). It is the
responsibility of editors and other promoters of science to create the conditions to efficiently
reach the large scientific community, a proven efficient tool is a special issue on recent
progresses. Eleven (11) years after the special issue on the “the current state of practice and
research in the area of reactive barriers” [7], a second special issue seems urgently necessary
to “provide impetus to further studies in this evolving subject”. [7]

Cited References


[2] C. Noubactep, Processes of contaminant removal in “Fe^0–H_2O” systems revisited: The

[3] C. Noubactep, A critical review on the mechanism of contaminant removal in Fe^0–H_2O


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