Nanoscale Zero Valent Iron (nZVI) Particles in Contaminated Groundwater Treatment [1]

Through the early 1990s, pump and treat and other ex-situ treatment methods were the most common methods for groundwater and soil remediation at contaminated sites. These ex-situ treatment methods are very costly and slow, resulting in more effective in-situ treatments involving Zero-Valent Iron (ZVI) treatments combined with permeable reactive barriers (PRB). ZVI granules are reactive with a number of hydrocarbons and VOCs including Trichloroethene (TCE), Perchloroethene (PCE), Carbon Tetrachloride (CT), nitrate and energetic materials (TNT, RDX). Although ZVIs are effective at reducing these agents, their effectiveness is limited as they have a difficult time migrating through dense liquids and soil.

To increase the migration and effectiveness of ZVI, researchers have reduced the scale of the granules to below 100nm. These nano-ZVIs (nZVI) are much more reactive per unit weight and migrate much further due to their smaller size and increase relative surface area. Current research into nZVI technology has led to nZVI particles attached to carbon platelets to increase their dispersion in aquifers.

nZVI particles are mixed with an inorganic slurry and then jet injected into contaminated groundwater via well sites. In the case of the Goodyear Airport Superfund Site in Arizona, the nZVI particles catalyzed targeted organo-chlorine compounds TCE and PCE with an efficiency
between 63 and 96 percent depending on the distance from the well in just one month after injection. Goodyear Airport site data shows that the injected nZVI particles had migrated as far as 45 feet down plume six months after injection. In general, nZVI is able to remediate large plumes of contaminants in a few years in what would have taken pump and treat operations decades.

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Product Name:

- PolyMetallix nZVI [12]

Development Stage:

- Available, but not Ubiquitous [13]

Key Words:

- Water [14]
- Iron [4]
- Decontamination [15]
- Passive In-Situ Remediation [16]
- Soil [3]

Mechanism:

- Active Nanostructure [17]

Source:

Applications: Catalysis by nanostructured materials [18]

Summary:
The nZVI slurry engages with chlorinated hydrocarbons and decomposes the chlorinated hydrocarbons through catalysis.

**Function:**
- Environmental Remediation

**Source:**
Emerging Nanotechnologies for Site Remediation and Wastewater Treatment Prepared by

**Material:**
- Iron

**Source:**
Emerging Nanotechnologies for Site Remediation and Wastewater Treatment Prepared by

Application of nanoscale zero valent iron (NZVI) for groundwater remediation in Europe

**Benefit Summary:**

The nZVI slurry will perform in-situ remediation of groundwater contamination at a large number of sites. Benefits can potentially be realized through energy and cost savings from the elimination of pumping operations that require both financial and energy resources.

**Benefit:**
- Environmental Quality

**Risk Summary:**
The MSDS for nZVI states that there are no short term adverse risks associated with the use of this product, but long-term life cycle analysis have not been completed to date. Working with and handling nZVI does pose some risks of burns and lung disease as a result of acute and long-term exposure respectively. Additionally, questions have been raised about the impact these nanoparticles have on soil microbial communities, but not enough research has been completed to date.

**Risk Characterization:**

- **Uncertain** [27]

**Risk Assessment:**

- **Ecological Risks** [28]

**Source:**


**Facility:**

- **Water & Air Systems** [30]

**Activity:**

- **Groundwater Remediation** [31]

**Substitute:**

- **Pump and Treat** [32]
Challenge Area:

- Waste Water Remediation [33]
- Health [34]
- Greenhouse Gas Emissions [35]

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