Innovative Environmental Technologies, Inc.

Iron Powder (IP)/Zero Valent Iron

In recent years, trichloroethane (TCE) and other chlorinated solvents have been responsible for the serious contamination of soils and groundwater. Many treatment methods have been considered and evaluated in the field for the remediation of chlorinated solvents in soils and groundwater with varying successes. Over the past several years, the reductions of 14 kinds of chlorinated solvents with iron powder (IP) have been demonstrated. Further, the degradation of these solvents can be enhanced with reductants that show weak acidity, such as hydrogen sulfide or via the inclusion of organic hydrogen donors, vitamins and oxygen scavengers.

Application Summary:

The use of a minimum quantity of highly refined IP is needed to achieve reduction of TCE. 95 to 99% reduction of TCE in aqueous solutions within 20 days with a weight ratio of between 120 mg IP/200 mg of TCE and 250 mg IP/200 mg TCE. This difference is due to specific surface areas of IP materials, contact time, other competing oxidants and inorganic aqueous conditions.

IP must be in direct contact with the targeted dissolved phase solvent. The use of large weight ratios results in percentage reductions of TCE with time, being dependent only on the concentration of the remaining TCE and the IP: TCE ratio.

The reaction mechanism is as follow:

1) $Fe^0 \longrightarrow Fe^{2+} + 2e^-$

2) $C_2HCl_3 + 3H^- + 6e^- \longrightarrow C_2H_4 + 3Cl^-$

The mechanism requires that the dissolved chlorinated organic come in contact with the surface of the IP. It is at the surface of the IP where the oxidation process occurs and thus where the available electrons from the oxidation are available for transfer to the target organic. It is therefore imperative to achieving this physical contact.

By understanding the pseudo-first order kinetics and by applying these principles in the field, effective in-situ treatment of impacted groundwater is possible.

Kinetics of IP: $\mathbf{\ln C/C_o = -k_1 t}$

$\mathbf{k_1 = k_2[Fe]}$