



SRS[®]-Z_{V_I} (4 μm)

Combined Emulsified Vegetable Oil Substrate and 4 μm Zero Valent Iron for DNAPL, Freon 113, and Biobarrier Applications

Terra Systems "*injection ready*" **SRS[®]-Z_{V_I}** combines Terra Systems patented SRS[®] Emulsified Vegetable Oil Substrate with 4 μm zero valent iron (ZVI) and is added to the groundwater at complex and challenging remediation sites to rapidly generate reducing conditions. SRS[®]-Z_{V_I} provides the necessary carbon and hydrogen to support native or introduced microorganisms (*Dehalococcoides*) for the biodegradation of dense non-aqueous phase liquids (DNAPLs) like tetrachloroethene (PCE) and trichloroethene (TCE) and to support abiotic degradation by the ZVI.

Key Communication Points

- The 4 μm ZVI should be injected via DPT for optimal distribution and because of the smaller particle size provides very good distribution and contact with the contaminants of concern (COC), easier injectability for the driller and fewer injection points for the consultant, thereby lowering costs.
- Provides both abiotic and biotic reductive dechlorination processes.
- SRS[®]-Z_{V_I} is a combination of ZVI, biodegradable soybean oil, surfactants, sodium lactate, nutrients, and water that form a stable emulsion.
- SRS[®]-Z_{V_I} contains a proprietary shear thinning agent, which under pressure thins the SRS[®]-Z_{V_I} out for ease of injection and improved radius of influence.
- The exterior oil layer has similar hydrophobic properties as chlorinated compounds. Therefore, the emulsion attracts the contaminants for abiotic degradation.
- Terra Systems, Inc.'s manufacturing facility is configured to allow us to provide our customers with custom blended EVO/ZVI combinations without a cost premium.
- Includes sodium or potassium lactate to kick-start the anaerobic degradation process, nutrients and Vitamin B₁₂, a micronutrient, which *He et al. 2007* demonstrated is an important micronutrient to enhance dechlorination activity.
- It arrives at the site as a homogenous ***injection ready substrate*** and does not require mixing, which results in lower field labor costs from inefficient field mixing.
- Proven effective with high concentrations of chlorinated solvents, DNAPL, Biobarriers to prevent migration across property boundaries and Freon 113 treatment. Zero Valent Iron can promote the abiotic dechlorination of solvents including tetrachloroethene (PCE), trichloroethene (TCE), 1,1,1-trichloroethane (1,1,1-TCA), and Freon 113 (1,1,2-trichloro-1,2,2-trifluoroethane).
- Proven effective at military installations, dry cleaners, semiconductor manufacturers, fabricators and manufacturing firms that use and clean metal parts (air conditioners, dishwashers, etc.).



Table I: SRS[®]- Z_{VI} Emulsified Vegetable Oil with 10-12.5% 4 μm zero valent iron (ZVI) Substrate Specifications

Ingredient	Percent by Weight/ Attributes	Description
Food Grade U.S. Grown Soybean Oil	52-54%	Terra Systems operates its own state-of-the-art manufacturing facility for SRS [®] production and can custom blend substrate packages as site conditions require.
Zero Valent Iron in suspension	10-12.5%	Microscale Iron (4 μm)
Sodium Lactate	4-5%	Quick Release Substrate
Proprietary Food Grade Emulsifiers and Nutrient Package Containing Nitrogen, Phosphorus and Vitamin B ₁₂	6-7%	Food grade emulsifiers and nutrients are used.
pH	6.0 – 7.5	Neutral pH
Specific Gravity	8.81-9.03 pounds/gallon	Denser than water
Viscosity	440 - 1,942 centipoises	Highly viscous

How it Works

ZVI is a strong reductant that reacts rapidly with a variety of constituents including chlorinated compounds, nitrate, and oxidized metals such as hexavalent chromium. ZVI reacts directly with the chlorinated compounds and typically generates little daughter products like cis-1,2-dichloroethene or vinyl chloride. In groundwater, iron metal (Fe⁰) will consume oxygen and subsequently corrode to form dissolved hydrogen gas (H₂) and dissolved ferrous iron (Fe²⁺). The hydrogen generated from the corrosion of ZVI has been shown to serve as an electron donor that stimulates biological reductive dechlorination of chlorinated solvents. The soybean oil is also biodegraded to generate hydrogen to support reductive dechlorination. SRS[®]-Z_{VI} supports both biological and abiotic degradation for the best of both worlds.

Terra Systems Flexible Manufacturing Capability

Terra Systems, Inc.’s manufacturing facility is configured to allow us to provide our customers with custom blended SRS[®]-Z_{VI} packages without a cost premium. In general, the smaller the average ZVI particle, the more expensive the product.



130 Hickman Road – Suite 1 – Claymont – Delaware – 19703
Phone; 302-798-9553 – Email: mfree@terrasystems.net



Because of our manufacturing capability, Terra Systems has the broadest EVO/ZVI product line in the industry, which allows our customers to specify the percent and particle size of the ZVI based on their remediation goals.

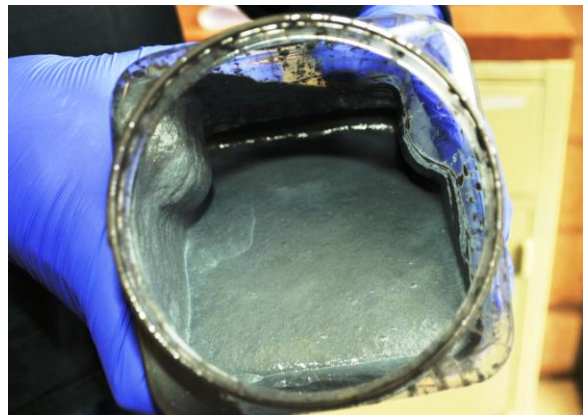
ZVI %/ZVI Average Particle Size	SRS [®] -ZVI 2 μm	SRS [®] -ZVI 4 μm	SRS [®] -ZVI <44 μm	SRS [®] -ZVI <125 μm
5 %				
↓				
40%				
Customer Specified				

2 μm ZVI: Can be injected via wells or DPT. Easiest to inject with improved radius of influence.

4 μm ZVI: Can be injected via DPT.

<44 μm ZVI: Can be injected via DPT. Can incorporate higher percentage of ZVI with less impact on cost.

<125 μm ZVI: Can be injected via DPT. Can incorporate higher percentage of ZVI with less impact on cost.



Packaging: Terra Systems patented SRS[®] - ZVI is shipped in 330-gallon IBC totes with 250 gallons in each tote.

Delivered Injection Ready: Terra Systems patented SRS[®] - ZVI is shipped ready-to-inject.

