

SRS[®]-EZVI Emulsified Zero Valent Iron Substrate

Licensed from NASA

for DNAPL, Freon 113, and Biobarrier Applications

What Is SRS[®]-EZVI?

Emulsified zero valent iron (EZVI) can provide cost-effective solutions for a number of complex and challenging environmental remediation problems including dense non-aqueous phase liquids (DNAPLs) like tetrachloroethene (PCE) and trichloroethene (TCE). The technology is a combination of abiotic and biotic reductive dechlorination methods. Both methods have been proven to work in numerous remediation sites. EZVI is a combination of zero valent iron (ZVI), biodegradable soybean oil, surfactants, and water that form a stable emulsion particle (or micelles) that contain ZVI particles in water surrounded by an oil-liquid layer. The exterior oil layer has similar hydrophobic properties as chlorinated compounds. Therefore, the emulsion attracts the contaminants and pulls them into the interior reactive zone for degradation. Terra Systems, Inc. has licensed the EZVI technology from NASA. Terra Systems, Inc.'s manufacturing facility is configured to allow us to provide our customers with custom blended EZVI packages without a cost premium.

SRS[®]-EZVI Emulsified Zero Valent Iron Substrate Specifications

Ingredient	Percent by Weight/ Attributes	Description
Food Grade U.S. Grown Soybean Oil	35 - 42%	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	10 -17%	Nanoscale or Microscale Iron depending on the package ordered.
Proprietary Food Grade Emulsifiers	6%	Food grade emulsifiers are used.
pH	6.5 – 7.5	Neutral pH
Specific Gravity	9.34 pounds/ gallon	Denser than water
Viscosity	1,942 centipoises	Highly viscous
Organic Carbon	29.8% for 10% ZVI and 27.6% for 17% ZVI formulations	Theoretical carbon yield

¹ Particle sizes: Nanoscale iron is 100 to 200 nanometers and Microscale iron is about 3 microns

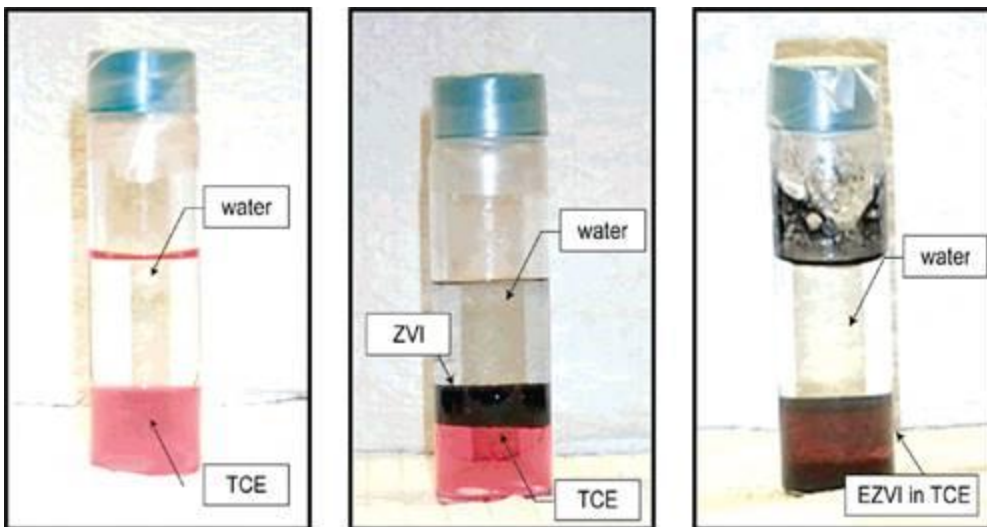
ZVI is a strong reductant that reacts rapidly with a variety of constituents including chlorinated compounds, nitrogen oxides, and oxidized metals such as hexavalent chromium. ZVI reacts directly with the chlorinated compounds and typically generates little daughter products like cis-1,2-dichloroethene or vinyl chloride. In groundwater, iron metal (Fe^0) will consume oxygen and subsequently corrode to form dissolved hydrogen gas (H_2) and dissolved ferrous iron (Fe^{2+}). 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.

Why Combine Emulsified Vegetable Oil Substrate and Zero Valent Iron?

- Terra Systems patented, nutrient enriched, proven slow release SRS[®] family of emulsified vegetable oil substrate is used extensively by the Air Force, DOD, Navy, EPA, drycleaners and private firms to remediate chlorinated solvent sites.
- SRS[®]-EZVI is formulated under NASA's EZVI patent.
- 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).
- SRS[®]-EZVI contains approximately 27.6 to 29.8 percent carbon.
- SRS[®]-EZVI arrives at the project site injection ready and does not require on-site mixing.

What Are the Best Applications SRS[®]-EZVI?

- High concentrations of chlorinated solvents are degraded to non-toxic end products
- DNAPL treatment
- Biobarriers to prevent migration across property boundaries
- Freon 113 treatment



Why Terra Systems, Inc.?

- Terra Systems holds United States Patent# RE40,448 for the use of emulsified vegetable oil for remediation of chlorinated solvents and is a licensee of NASA for EZVI.
- Terra Systems owns and operates a US based manufacturing plant with an in-house quality control laboratory for strict quality assurance and our products are manufactured using Terra Systems full time employees, not toll producers.
- Terra Systems has been in continuous operation for 21 years supplying aerobic and anaerobic remediation solutions to environmental consultants.
- The soy bean oil provided is grown in the United States and provides a slow release biodegradable carbon source, which promotes long-term biological activity.

Packaging: Terra Systems patented SRS[®] - EZVI is shipped in 275-gallon IBC totes.

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

Injection Method: Direct Push. SRS[®] - EZVI is not recommended for injection into screened wells.

