



Patented *Injection Ready* 60% SRS[®]-SD Small Droplet Emulsified Vegetable Oil (EVO) Substrate for Maximum Radius of Influence

United States Patent #RE40,448

Terra Systems patented "*injection ready*" **60% SRS[®]-SD** Small Droplet Emulsified Vegetable Oil Substrate is added to the groundwater to rapidly generate reducing conditions and provide the necessary carbon and hydrogen to support native or introduced microorganisms (*Dehalococcoides*) for the biodegradation of chlorinated solvents such as tetrachloroethene (PCE) and trichloroethene (TCE) to innocuous end products including ethene and ethane.

Key Communication Points

- The 0.6 um droplet size results in better substrate distribution for the client, easier substrate injectability for the driller and fewer injection points for the consultant thereby lowering costs
- Provides 73% fermentable carbon
- Has >98% biobased content
- 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.
- The nonionic emulsifier (does not have a charge) results in better distribution and bacteria contact for the client because the substrate does not readily stick to the positively charged soil particles.
- It arrives as a homogenous ***injection ready substrate***, which results in lower field labor costs from inefficient field mixing.
- Proven effective with PCE, TCE, TECA, DNAPL (Sabre Project), Perchlorate, TCA, Cr⁶⁺, TNT, Uranium and Nitrate.
- Proven effective at military installations (Andrews AFB, Dover AFB, Beale AFB, Ft. Gillem, Fort Dix, Camp Bullis, Aberdeen Proving Ground, etc.), dry cleaners, semiconductor manufacturers, fabricators and manufacturing firms that use and clean metal parts (air conditioners, dishwashers, etc.).

Table I: SRS[®]-SD Small Droplet Emulsified Vegetable Oil Substrate Specifications

Ingredient	Percent	Description	Benefit
Food Grade U.S. Grown Soybean Oil	60%	Locally sourced soybean oil.	Long lasting slow release source of carbon and hydrogen.
Food Grade Soluble Substrate	5.5%	Rapidly biodegradable soluble substrate	Fast release source of carbon and hydrogen to rapidly generate anaerobic conditions
Proprietary Food Grade Nutrients	<1%	Proprietary organic and inorganic nutrients such as yeast extract, nitrogen and phosphorus.	Nutrients have been demonstrated to support the growth of the anaerobic microbial population.

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INCORPORATED



Proprietary Food Grade Emulsifiers, Preservatives and other Organics	7.5%	Proprietary nonionic emulsifier and other organics	Maximum radius of influence due to small droplet size and nonionic emulsifier in moderate to fine sand, silt and clay aquifers
Vitamin B ₁₂	<1%	250 µg/L of Vitamin B ₁₂	He et al. 2007 demonstrated Vitamin B ₁₂ to be an important micronutrient to enhance dechlorination activity with 25 µg/L providing maximum stimulation
Median Oil Droplet Size (microns)	NA	0.6 µm	Maximum radius of influence due to small droplet size and nonionic emulsifier in moderate to fine sand, silt and clay aquifers
pH	6.5 - 7	6.5 - 7	Optimum microbial activity
Organic Carbon (wt%)	73%		60% soy bean oil and 13% from lactate, nutrients, emulsifiers and VB ₁₂
Zero Carbon Footprint	0%		Certified by The CarbonNeutral Co., SRS [®] has a carbon neutral footprint when it arrives at the job site.
Biobased Content	98%		Certified under USDA Biopreferred Program

Injection Ready Manufactured Emulsion

Terra Systems *Family* of patented SRS[®] emulsified vegetable oil substrates

- Arrives injection ready
- Nutrients are premixed into the SRS[®] during the manufacturing process - ensuring a homogenous substrate and avoiding the additional labor cost of mixing in the field
- Vitamin B₁₂ is premixed into the SRS[®] during the manufacturing process - ensuring a homogenous substrate and avoiding the additional labor cost of mixing in the field
- Sodium lactate, which kick starts the anaerobic process is premixed into the SRS[®] during the manufacturing process - ensuring a homogenous substrate and avoiding the additional labor cost of mixing in the field
- Arrives at the site with a zero carbon footprint
- Certified under the USDA Biopreferred Program with >98% biobased content

Result: A consistent emulsified vegetable oil substrate, which arrives *ready to inject* for maximum distribution in the aquifer.

It Avoids Field Mixing and Their Hidden Costs Such As:

- The cost of inadequate distribution due to variable droplet size and emulsion inconsistency
- The inability to accurately determine if you have 100% emulsification.





- The lack of QA/QC in the field

Terra Systems QA/QC

Terra Systems owns and operates a state-of-the-art US based "just-in-time" manufacturing plant with an in-house quality control laboratory for strict quality assurance of the emulsion, droplet size and pH. A Microscope with "Droplet Size Calculation Software" calculates the "mean" droplet size for each batch of SRS® before we transfer to a bucket, drum, tote or tanker for shipment to the customer. With every shipment, we include a QA/QC sheet for the actual batch that the customer receives. Included are:

- **Date Manufactured:** Freshly manufactured products have a longer shelf life in the field. Avoid buying substrates that have been stored for >1 month as fermentation can start and the pH will be negatively impacted.
- **pH:** We provide the pH of the product the day it is shipped
- **Droplet Size:** is a key measure of how effective the client can distribute the substrate in the sub-surface. The smaller the droplet, the more effective the distribution and ease of injection.
- **Lot#'s for all the ingredients:** This is especially useful if the driller accidentally hits a discharge pipe and the consultant needs to provide documentary evidence of what exactly was injected to the regulatory agency. All of our ingredients are GRAF (generally recognized as safe).

Terra Systems Manufacturing Quality Control Checklist		
I. Product Information		
Parameter	Value	
Customer or Site	Young-Rainey STAR Center, Largo, Florida	
Product manufactured	60% SRS®-SD	
Date manufactured	November 4th, 2019	
Lot#	A2701	
Customer packaging	275 Gallon IBC Totes	
Date shipped	November 8th, 2019	
II. Ingredients Information		
Ingredient	Lot#	Manufacturing Engineer
Soy Bean Oil	11182014	Erich H.
60% Sodium Lactate	M-1406-018	Erich H.
Emulsifiers	G270059 885648	Erich H.
Nutrients	CYE06060960	Erich H.
Vitamin B12	11765655	Erich H.
Water	-	Erich H.
III. Physical Parameters		
Parameter	Value	
Mean Droplet Size (µm)	0.61	
pH	7.2	
 Manufacturing Engineer		
 Production Supervisor		
11/7/2019 Date		
11/8/2019 Date		



Packaging: Terra Systems patented SRS[®] Family of EVO substrates can be shipped in 5-gallon buckets, 55-gallon drums, 275-gallon IBC totes, 275-gallon cardboard totes or bulk tankers.



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