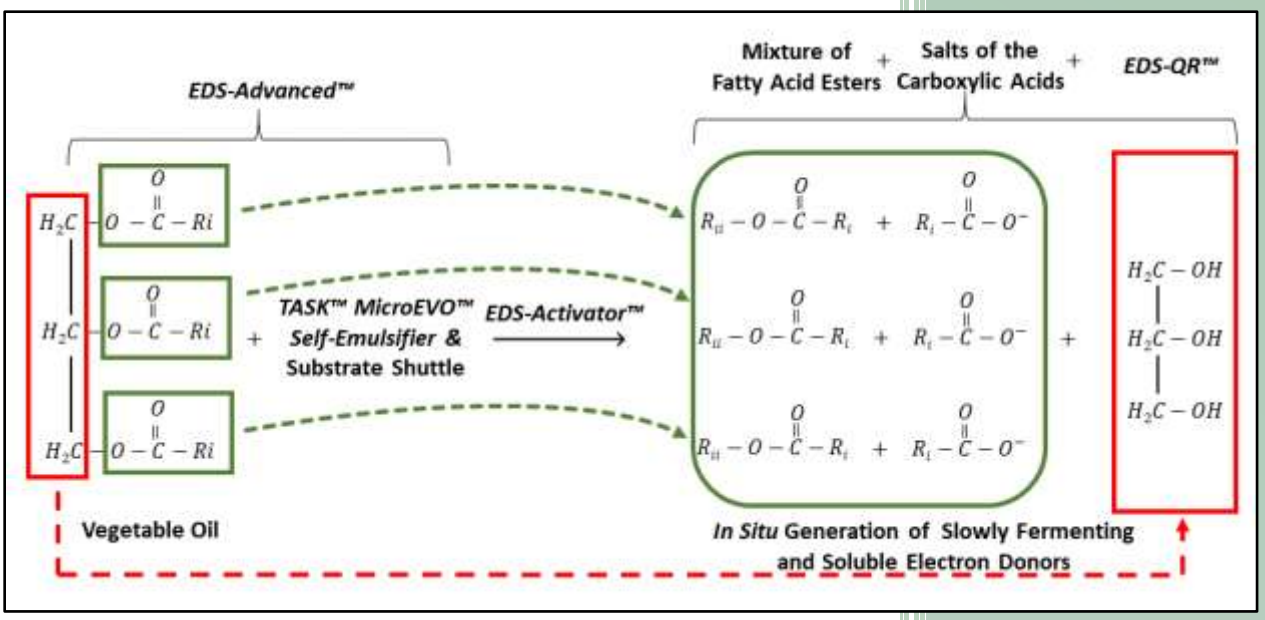
EDS-Advanced™

Catalyzed Reductive Bioremediation



Transesterification of vegetable oils, reaction of a triglyceride with a catalyst

Tersus Environmental
919.453.5577 • info@tersusenv.com
tersusenv.com

EDS-Advanced™

Catalyzed Reductive Bioremediation

With all the injectable remediation options available, it's worth understanding the advantages *EDS-Advanced*™ provides as a catalyzed reductive bioremediation technology!

Emulsified vegetable oil (EVO) slowly ferments and can act in the subsurface as an organic carbon and hydrogen source that stimulates organohalide-respiring bacteria that in turn mineralize chlorinated solvents. Indigenous microorganisms first consume and ferment EVO to generate hydrogen, fatty acids and other important nutrients and cofactors. The prevailing anaerobic conditions are ideal to reduce chlorinated solvents like PCE and TCE through dechlorination processes such as dehaloelimination. Then specialized bacteria such as *Dehaloccocoides mcCartii*, *Dehalobacter, or Dehalogenomonas* use subsurface-generated hydrogen when transforming reduced solvent compounds like 1,2-DCA, 1,1,2-TCA, cis and trans-DCE to Vinyl Chloride and innocuous Ethene.

Although emulsifying vegetable oil allowed overcoming limitations of pure vegetable oil injection and minimize field interventions by using a long-lasting electron donor, hundreds of EVO injection events over the past years has demonstrated that EVO effects are limited to the area in the immediate vicinity of the injection point. This is evident through low TOC values measured even tens of meters downgradient to injection points where only acetic acid predominates. A favorable fatty acid diversity seems to be limited to the injection points immediate vicinity (< 5 meters). Another inconvenience that becomes more evident when using permanent screened wells is biofouling. This phenomenon is typically attributed to biomass developing in the aerobic vicinity of injection wells due to hydrophobic oils creating a film (residual electron donor) that stimulates biomass growth. In many cases, biofouling or permeability losses could very well be attributed to geochemical incompatibilities between EVO and cations in the subsurface, or EVO's intrinsically high retention to soils.

Our team of surfactant specialists at Tersus has harnessed their expertise to develop *EDS-Advanced™,* an innovative patent method, US 11,577,231 B2 (referred to as the '231 patent), designed to tackle two of the primary challenges associated with EVO injection: the poor distribution of fatty acids in subsurface environments and the issue of biofouling. *EDS-Advanced™* stands out as a water-miscible, slow-fermenting, and aquifer-buffering electron donor.

Our Catalyzed Reductive Bioremediation technology is delivered as a three-part system, revolutionizing the realm of Enhanced Vegetable Oil (EVO) injection for subsurface remediation:

1. **EDS-ER™ (Water-Miscible Vegetable Oil):** This component forms the foundation of our system, serving as a water-miscible vegetable oil essential for effective EVO injection.
2. **Substrate Shuttle:** A critical element of our innovation, this water-miscible solvent efficiently dissolves the vegetable oil, resulting in a solution with the essential distribution properties required for an effective soluble electron donor.

3. **EDS-Activator™:** A catalyst marketed under the name EDS-Activator™. This catalyst plays a pivotal role in facilitating the generation of fatty acid alkyl esters, carboxylic acid salts, and glycerol (*EDS-QR™*).

The incorporation of the substrate shuttle into our solution marks a significant advancement in the realm of EVO injection. It leads to the creation of a solution that disperses more readily than traditional EVO in aquifers and subsurface environments through advection. The ease of distribution afforded by *EDS-Advanced™* translates into greater radii of influence (ROI) achievable from a single injection point. This, in turn, reduces the number of injection points required to adequately supply a contaminated aquifer with the necessary electron donor.

The synergy between *EDS-ER™*, a water-mixable vegetable oil-based organic substrate, and *EDS-Activator™*, a homogeneous alkaline catalyst, drives the cleavage of triglyceride molecules, resulting in the formation of fatty acid alkyl esters, carboxylic acids, and glycerol within the subsurface. These in-situ products exhibit superior mobility compared to traditional EVO, introduce a pH buffer to the system, and reduce susceptibility to clogging and biofouling. This unique combination allows for high-volume applications with fewer injection points.

Recent fieldwork conducted both in the United States and Australia has provided compelling evidence of *EDS-Advanced™*'s remarkable efficacy. It has demonstrated the ability to reduce up to 90% of contaminant mass within a mere 90-day post-injection, showcasing the tremendous potential of this innovative solution for subsurface remediation.

Advantages

The advantages of *EDS-Activator™* as an electron donor in remediation processes, particularly in situations involving the treatment of chlorinated volatile organic compounds (cVOCs) include:

1. **Improved Subsurface Distribution**: Even and effective distribution in the subsurface.
2. **Enhanced Radius of Influence**: Improved fatty acid distribution and Total Organic Carbon (TOC) when compared to EVO.
3. **Eliminates EVO Droplet Size Dependency**: No need to worry about EVO droplet size during injection.
4. **Reduces cVOC Inhibitory Concentrations**: Helps lower inhibitory concentrations of chlorinated volatile organic compounds (cVOCs) by sequestering Dense Non-Aqueous Phase Liquid (DNAPL).
5. **Minimizes Clogging and Biofouling:** Less prone to clogging and microbial biofouling during the remediation process.

Heat Enhanced Catalyzed Reductive Bioremediation

Our team of surfactant specialists at Tersus has taken our innovation a step further by introducing heat into the process. Given that the typical aquifer temperature hovers around 15°C, the addition of heat amplifies the efficiency of the process, as reaction temperature significantly influences transesterification reactions. Depending on temperature conditions, the time required for these reactions can be reduced from months to mere hours. Moreover, heat substantially enhances degradation rates, with Löffler et al. in 2013 identifying an optimal temperature range of 25-30°C for neutrophilic, strictly hydrogenotrophic Dhc strains.

Thermally enhanced bioremediation (TEB) has a well-documented track record at chlorinated solvent sites, particularly following the use of in situ thermal remediation techniques. When applied as a biological polishing technology after thermal treatment, TEB can prove to be a cost-effective method for addressing contaminant rebound in groundwater remediation. It becomes significantly more challenging to justify the expense of TEB as a standalone technology using traditional in-situ heating methods (e.g., ERH, TCH). Our experience has shown that the cost becomes prohibitive, especially considering the narrow optimal temperature range of 25 to 30°C. In contrast, our Heat Enhanced Catalyzed Reductive Bioremediation offers a substantial cost advantage in this market segment.

LEARN MORE

For further details or inquiries about EDS-Advanced™ and its applications, please do not hesitate to reach out. We are eager to discuss how this technology can address your specific needs and challenges.

Tersus Provides Site-Specific Remediation Programs and Performance Monitoring Plans To Meet Your Budget

Interested in a Site Evaluation? Scan the code to the right or visit tersusenv.com/support.

Interested in shopping online for amendments, supplements, and products to enhance conditions, accelerate clean-up, and reduce field-time? Please visit our online shop at surbec.com.

919.453.5577 • info@tersusenv.com
tersusenv.com