

Soil Treatment Technology

Oxy-Clean Advanced™



Aerobic biodegradation of contaminants in saturated soils and groundwater has been documented for over 30 years. Biodegradation rates for compounds such as benzene and phenol can be accelerated by as much as ten fold by creating aerobic conditions in the saturated zone. Since the early 1990s injectable peroxygen compounds have been applied to soils and groundwater to accelerate the degradation process. ERE has developed several formulation blends to address a range of remediation problems.

Biodegradation: Magnesium Peroxide vs. Oxy-Clean Advanced™

The biodegradation process is initiated by the reaction of the Oxy-Clean Advanced™ with water or moisture in the soil. The ultimate product of the chemical reaction is oxygen. When magnesium peroxide is used, oxygen is generated directly in the reaction. Oxy-Clean Advanced™ reacts much more effectively and actually forms hydrogen peroxide as an intermediate reaction product that continues to react with water and ultimately generates oxygen.

Chemical Oxidation

All of ERE's Oxy-Clean Advanced™ chemical products form hydrogen peroxide in the reaction process. This attribute results in more aggressive remediation because of the higher oxidative value for hydrogen peroxide versus oxygen. Additionally, the reactions can be enhanced either by catalyst addition or other manipulation techniques within the treatment zone.

Speed of Reaction

The speed of the reaction is dependent upon several factors. With magnesium peroxide, an intercalation agent (potassium phosphate) can drastically slow the generation and release of oxygen into the groundwater. Rates as slow as one year for the release of 90% of the available oxygen have been documented. This is usually manifested in a two-step release profile with 10% releasing within the first two weeks and a linear release for the duration of the time.

In the case of Oxy-Clean Advanced™, the generation and release of the oxygen into the groundwater can be manipulated by increasing the particle size of the granules. The initial commercial product used in the early 1990s exhibited a 30 day release profile with about 50% of the oxygen releasing during the first 5 to 10 days. As the particle size is increased, the release period can be increased to as much as 280 days.



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Oxy-Clean Advanced™ Release Parallels Oxygen Demand Profile

The release profile for the slower release, Oxy-Clean Advanced™ actually parallels the oxygen demand profile observed for biological reactions (half-life kinetics). More oxygen is generated during the initial half-life periods as compared to later periods when the mass of oxygen needed is reduced significantly. Oxy-Clean Advanced™ can be blended with faster oxygen release or hydrogen peroxide generation in the range of days to a few months. It can also be formulated for oil spill cleanups, tank excavation projects or sites with high dissolved organic concentrations. Oxy-Clean Advanced™ can be manufactured with up to 18% available oxygen as compared to 10% maximum oxygen content of the magnesium products.

Rate Limiting Factors

While oxygen is typically the rate limiting reaction component, other reactants can also control the reaction. If the organic contaminant mass is limited, it may be necessary to also add a readily degradable compound to maintain a sufficient bacteria population to allow the contaminants of concern to be degraded to the targeted regulatory limit. In some cases primary nutrients such as nitrogen or even micronutrients can limit the optimum rate of reaction.

Demand for Oxygen Blends

There is a need for a number of oxygen blends to address the variable objectives of remedial action plans and site conditions. ERE has created several formulations to address a range of remedial conditions.

Available Blends

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| • Oxy-Clean Advanced™ 10SRN | 10% Slow Release With Nutrients |
| • Oxy-Clean Advanced™ 10SR | 10% Slow Release |
| • Oxy-Clean Advanced™ 10SRC | 10% Slow Release With Carbon Source |
| • Oxy-Clean Advanced™ 14FRS | 14% Fast Release Soluble |
| • Oxy-Clean Advanced™ 16C | 16% Blended With Catalyst |
| • Oxy-Clean Advanced™ 18SR | 18% Slow Release |

Target Applications

- Fast release products - oil spills, excavations or sites with initially high dissolved phase organic concentrations
- Slow release product - dissolved plume area
- Blends - depending on site data, blends with nutrients, micronutrients or readily degradable organic compounds would be applied

Treatable Contaminants

- Gasoline Compounds: BTEX, MTBE
- Chlorinated Compounds: TCE, DCE, VC
- Other Organics: Crude Oil, PAHs

Benefits

- Easily applied via direct push rigs or construction equipment
- Does not bridge/harden
- Delivers more oxygen at a lower cost, compared to the competition



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