

ENHANCED BIOREMEDIATION OF GROUNDWATER USING IN-WELL METHODS—A WHITEPAPER

Overview:

This white paper provides a comparison of two groundwater treatment methods that are used to facilitate remediation of floating and dissolved petroleum hydrocarbons in groundwater. Both methods have some merit. However, **United Remediation Technology (UniRemTech)**'s **Wellboom™** can provide a faster and longer lasting solution due to its composition of absorption and in-situ bioremediation.

The Issue:

The release of petroleum hydrocarbons into the soil and groundwater poses several challenges for remediation and control. The objective is to remove enough product in both the dissolved and floating fractions of the release plume to achieve regulatory “no-further action” status. Physical methods such as pump and treat systems or active/passive skimming are expensive and have had limited success.

The Bioremediation Alternatives:

Bioremediation of both the dissolved and floating fractions of petroleum has been shown to be cost effective when leveraging the indigenous microbial flora. The indigenous flora can and will use the petroleum hydrocarbons either aerobically or anaerobically when sufficient quantities of terminal electron acceptors (specifically: oxygen; nitrogen; phosphorus; iron; and, sulfates) are present. Most impacted subsurface areas have a limited amount of these elements present, limiting the biodegradation process.

Enhanced aerobic biodegradation is limited by the available oxygen in the groundwater. Since oxygen is usually the limiting factor for aerobic bioremediation, methods of introducing oxygen to the subsurface have been successfully used in the recent years. The focus of this discussion is to compare chemical release methods to UniRemTech's encapsulation, growth media and air sparging method.

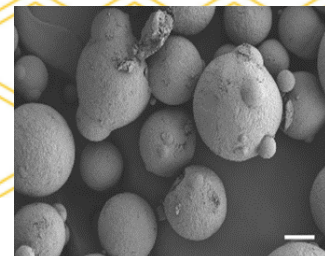
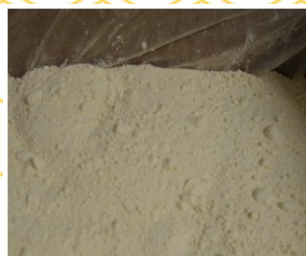
The Chemical Approach:

The “chemical approach” for bioremediation enhancement uses chemicals that can dissociate in the groundwater and/or soil and increase the available oxygen level in the groundwater. The selected chemical agent can be introduced using either a direct push injection of a slurry into the ground or introduced by a sock or canister containing the chemical oxidant via one of the impacted site's monitoring wells. The chemical most frequently selected is a buffered proprietary form of a food-grade metal peroxide compound. After being placed in the subsurface, oxygen is released over time as the peroxide agent slowly dissociates in the groundwater. Indigenous microbial flora will use the oxygen as an electron acceptor and metabolize the petroleum product in the plume. The amount of oxygen produced is dictated by the chemistry of the oxidant agent which can be upwards of 17% per unit weight. Once exhausted, a new quantity of the oxidant must be introduced to maintain the biodegradation process.

The UniRemTech Approach:

UniRemTech offers a unique approach to the enhanced in-situ bioremediation of petroleum hydrocarbons in soil and groundwater. The approach uses UniRemTech's remedial agent called PRP® deployed via its subsurface system, the Wellboom™.

PRP® is the registered brand name of UniRemTech's proprietary oil spill response sorbent created using a manufacturing application developed by the National Aeronautics and Space Administration (NASA) research. PRP® is a powder of formed, hollow wax microcapsules. The microcapsules average 50 microns in size and appear as a fine powder (see photos below).



PRP® Powder

Micro-

photograph of PRP®

Being a wax-based material, PRP® has a natural affinity for hydrocarbons and will immediately combine to encapsulate petroleum molecules. PRP® is also highly hydro-phobic and cannot be mixed or dissolved in water even after absorbing petroleum. PRP® is composed of a proprietary blend of natural ingredients. One of the principle ingredients is bees-wax that contains nitrogen, phosphorus and potassium. These elements are nutrients for microbes which allow them to metabolize the blend of PRP® and absorbed petroleum. The result is that the petroleum slowly disappears.

The Wellboom™ is a weighted fabric sock (see photo below) filled with PRP® that is allowed to float in the bore of a monitoring well. Although its designed purpose was to keep the well bore clear of floating product to facilitate well monitoring, field studies demonstrate that the Wellboom™ provides a platform for the indigenous microbial flora to colonize and biodegrade both floating and dissolved product along with the PRP® contained in the sock. Note that the Wellboom™ is weighted to optimize its location in the well bore to maximize contact with any floating product, as well as floating up or down with changes in the seasonal water table.



Passive Deployment:

Wellboom™ has been deployed in countless wells around the US in order to remove the residual dissolved and floating fractions of release plumes as part of the final stage of a remediation plan. Using this passive approach, Wellboom® has and continues to perform effectively. The socks are changed every 3-6 months and discarded.

Active Deployment: The Use of Sparging Air

Although biodegradation of petroleum products in the subsurface will occur under either aerobic or anaerobic conditions, aerobic reduction occurs much more quickly and is the preferred option. The deployment of metal peroxide socks or canisters is designed to meet this requirement; however, the indigenous microbes are left to grow only on the particles in the soil.

UniRemTech's treatment approach can work anaerobically, but is greatly enhanced with oxygen infused into the subsurface. Field applications using sparging of air have been very successful with in-situ biodegradation. Deploying air sparging with the Wellboom™ provides an area where microbial growth can be enhanced and allow further biological activity in the radius of influence of any given monitoring well. Subsurface treatment zones can be designed as part of the overall remedial response effort.

Although not applied to date, pairing metal peroxides to provide oxygen with Wellboom™ systems could also be teamed to work together in remote areas with no power access.

Conclusions:

Although each in-well treatment method works, the **Wellboom™** system provides a unique opportunity to enhance in-situ treatment of a petroleum product plume in groundwater. When paired with a secondary source of oxygen, the **Wellboom™** provides a growth matrix that can rapidly enhance the disappearance of petroleum in the subsurface.

About UniremTech

United Remediation Technology is a US-based company that produces products based on our proprietary PRP® powder for the purpose of cleaning up oil and fuel spills all over the world. They utilize all-natural ingredients and technology derived from NASA's space program so that petroleum spills can be handled in a safe and natural way with no harmful effects to the environment.

UniRemTech looks forward to discussing the use of our products with your project team. We are happy to provide further details of past successful deployments. Call us at 412-788-2444 or visit our website www.uniremnc.com for information on our products, applications and testimonials.

The Approach Comparison:

Key Features	Wellboom™	Metal Peroxides
Use in Monitoring wells	✓	✓
Sorbs petroleum in Subsurface	✓	X
Enhances Microbial Growth	✓	✓
Acts as a Microbial Growth Media	✓	X
Maintenance (Periodic Replacement)	3-6 months	3-8 weeks
Can Be Teamed with Other Treatments	✓	✓



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