Florida Department of Environmental Protection

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Tallahassee, Florida 32399-2400

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Michael W. Sole
Secretary

July 29, 2008

Brent Anderson, President
O2 Tube Technologies, Inc.
711 West Main Street
Batavia, Illinois 60510

Re: O2 Tube Electrolysis

Dear Mr. Anderson:

The Bureau of Petroleum Storage Systems hereby reaffirms its acceptance of the O2 Tube electrolysis method and apparatus for oxygenating groundwater. This reaffirmation supersedes the original acceptance that was issued on January 23, 2003 and serves to update your contact information. There are no changes to the technical and regulatory aspects of the original acceptance of the technology, which is patented as a "Method and Apparatus for Oxygenating Ground Water", U.S. Patent 6,758,959 B2.

The Bureau recognizes O2 Tube electrolysis as a viable method for the in situ generation of oxygen needed for the bioremediation of petroleum contaminated groundwater and soil in Florida. There are no objections to its use provided: (a) the considerations of this letter are taken into account and (b) a Remedial Action Plan is prepared in accordance with Chapter 62-770, Florida Administrative Code (F.A.C.), for approval by the Department.

O2 Tube electrolysis itself does not involve the injection of chemicals, and it does not involve the addition of microorganisms to the subsurface. If, however, a user of the system would like to augment it by adding nutrients, buffers or other substances to the subsurface, then such additions must be in accordance with Chapter 62-528, F.A.C., for underground injection control, particularly Part V, for Class V, Group 4 aquifer remediation projects. The augmenting substances, depending on their chemical composition, may require permission for a temporary injection zone of discharge via Rule 62-522.300(2)(c), F.A.C., and/or via variance before they can be injected. If microorganisms are to be added, then they must be non-pathogenic and preferably not genetically engineered. Please see Enclosure 1 for additional regulatory considerations.

As you indicated in your literature, O2 Tube Technology utilizes electrolytic cells placed downwell (minimum of 4" diameter well) to dissociate water into oxygen and hydrogen. The water enters the cell from the bottom, passing through the electrolysis section where oxygen bubbles form on the anode plates. A pneumatic draft pump re-circulates the water (moving the oxygen into solution in the groundwater). The hydrogen is off-gassed through a vent pipe. The control and air panels each require a 110-volt, single-phase outlet and a 10-amp circuit breaker. Enclosure 2 contains additional information about the system.

While the Department of Environmental Protection does not provide endorsement of specific or brand name remediation products or processes, it does recognize the need to determine their acceptability from an environmental standpoint with respect to applicable rules and regulations, and the interests of public health and safety. Vendors must then market the products and processes on their own merits regarding performance, cost and safety in comparison to competing alternatives in the marketplace. In no way, however, shall this regulatory acceptance letter be construed as Department certification of performance. Additionally, the Department emphasizes a distinction between its regulatory "acceptance" and approval. Products and processes are accepted but they are not approved.

Also, it is not a requirement that a particular remediation product or process have an official acceptance letter in order for it to be proposed in a site-specific Remedial Action Plan. The plan, however, must contain sufficient information about the product or process to show that it meets all applicable rules and regulations.

Those who prepare Remedial Action Plans are advised to include a copy of this letter in the appendix of plans they submit, and call attention to it in the text of their document. In this way, technical reviewers throughout the state will be informed that you have contacted the Department of Environmental Protection to inquire about the environmental acceptability of O2 Tube.

The Department reserves the right to revoke its acceptance of a product or process if it has been falsely represented. Additionally, Department acceptance of any product or process does not imply it has been deemed applicable for all cleanup situations, or that it is preferred over other treatment or cleanup techniques in any particular case. A site-specific evaluation of applicability and cost-effectiveness must be considered for any product or process, whether conventional or innovative, and adequate site-specific design details must be provided in a Remedial Action Plan. You may contact me at (850) /877-1133, extension 3722, or at the letterhead address, MS 4590, if there are any questions.

Sincerely,

Rick Ruscito

Rick Ruscito, P.E.
Ecology and Environment, Inc.
Bureau of Petroleum Storage Systems
Petroleum Cleanup Section 6

Rebecca S. Lockenbach
FDEP Section Leader
Bureau of Petroleum Storage Systems
Petroleum Cleanup Section 6

Enclosures: (1) Regulatory Information
(2) Supplemental Information

c: T. Conrardy, P.E. – FDEP, Tallahassee

History:

1/23/03-O2Tube--PPL#199--INN_095
7/29/08 O2Tube - PPL#359 - INN_162

ENCLOSURE 1

REGULATORY CONSIDERATIONS

1. Addition of Nutrients, Buffers, or Bacteria: This acceptance is based on use of O2 Tube electrolysis only. If bacteria are used to augment existing microbial populations, then that bacteria must be non-pathogenic and preferably not genetically engineered. If nutrients and/or buffers, etc. are to be injected they must meet the underground injection standards of 62-528, Florida Administrative Code (F.A.C.). Depending on the chemical composition of the amendments, it may be necessary to obtain permission for a temporary injection zone of discharge by way of Rule 62-522.300(2)(c), F.A.C., and/or by way of variance before they can be injected.

2. Groundwater cleanup standards: The onus shall be on users of O2 Tube electrolysis to ensure that all applicable groundwater standards will be met at the time of project completion for petroleum and other contaminants that may be present, and any byproducts produced as a result of chemical or biochemical reactions initiated by the O2 Tube system. The following chapters of the Florida Administrative Code are cited: Chapter 62-550, F.A.C., for primary and secondary water quality standards; Chapter 62-520, F.A.C. for groundwater classes and standards, and minimum criteria; Chapter 62-522, F.A.C., for groundwater permitting and monitoring requirements; Chapter 62-528, F.A.C., for underground injection control, particularly Part V, for Class V, Group 4 aquifer remediation projects; Chapter 62-770, F.A.C., for petroleum cleanup criteria; and Chapter 62-777, F.A.C., also for minimum groundwater criteria.

3. Utilization of wells: If a remediation site happens to have an abundance of monitoring wells, then the Department has no objection to the use of some wells as application wells for O2 Tube electrolysis (provided well construction meets O2 Tube requirements for application wells). However, no "designated" monitoring well, dedicated to the tracking of remediation progress (by sampling) shall be used as an application well. This will avoid premature conclusions that the entire site meets cleanup goals. By making sure that designated tracking wells are not also used for treatment, there will be more assurance that the treatment process has permeated the entire site and that it did not remain localized to the area immediately surrounding each injection well.

4. Pilot study: For bioremediation, per rule 62-770.700(2), F.A.C., a pilot study proposal shall be submitted for review, and a pilot test shall be performed prior to designing a treatment system. If conditions or the situation at a site do not warrant a pilot study, then a proposal explaining the rationale for the decision not to perform a pilot study shall be submitted for review.

5. Groundwater monitoring:

   a. Active remediation petroleum monitoring: During the period of active remediation, groundwater shall be monitored in accordance with the requirements set forth in Section 62-770.700, F.A.C.

   b. Post remediation petroleum monitoring: At least one (1) year of quarterly post remediation groundwater monitoring shall be conducted at a minimum of two (2) wells,

one located in the area of maximum petroleum contamination, the other down-gradient of the area of maximum petroleum contamination, pursuant to Section 62-770.750, F.A.C.

6. Safety: The onus shall be on users of O2 Tube to ensure that all applicable codes and regulations governing electrical and wiring safety and flammable and combustible liquids are followed.

7. Abandonment of wells: Upon issuance of a petroleum Site Rehabilitation Completion Order, or a declaration of "No Further Action", O2 Tube treatment wells shall be abandoned pursuant to Section 62-528.645, F.A.C. If O2 Tube was augmented by the injection of nutrients, buffers or microorganisms during the remediation effort, then the Underground Injection Control Section of the Department shall be notified so that the injection wells can be removed from the inventory-tracking list.

ENCLOSURE 2

SUPPLEMENTAL INFORMATION

1. Overall configuration: A down-hole unit consisting of a small draft pump and a single electrolytic cell is controlled by an aboveground controller with an air pump that operates on standard 110/220 voltages. Average energy use in one case study was 1.5 volts and 1.0 amps direct current (for a single unit).

2. Specifics of the down-hole electrolytic unit: The down-hole unit consists of a vertical assembly that draws in water in through the bottom of a tube with a re-circulation/draft pump that moves the water upward through an electrolytic cell that dissociates water into hydrogen (anode plates) and oxygen (cathode plates) and allows the release of the dissolved oxygen (DO) enriched water back into the surrounding substrate. The hydrogen is off-gassed through a vent tube. The typical 3-inch model produces 0.6 L of oxygen per approximately 2 amps each hour. The pneumatic draft pump is designed to create the low head (1.5 inches water) and high flow (50 gph) required for re-circulation in tight soils.

3. Application wells: The application well(s) should be at least 4 inches in diameter with #10 slotted PVC or stainless screen. The well should be screened at least 5 ft. above and 15 ft. below current water tables. Sand pack and grouting should be per Florida's standards. Hydrogen from application wells must be vented to a safe location using a 1.25-inch (minimum) vent pipe. A draft of air at 20 PSI created by a pump evacuates any excess hydrogen safely. Testing for LEL (Lower Explosion Limit) using a combustion meter produces no greater than 20% LEL regardless of the number of cells, their depth, or the site's lithology. The number and location of application wells is determined based on contaminant concentration, area of contamination, groundwater flow, depth and lithology.

4. Controller: The control and air panels each require a 110-volt, single-phase outlet fed by 10-amp circuit breakers. The controller includes an AC to DC power converter and regulator with a built-in programmable timer, voltage meter and amperage meter. Each unit is capable of operating four (4) electrolytic cells simultaneously and continuously. One air station containing a 1/3 HP air pump and airflow rotometers provides for simultaneous and continuous operation of four cells. The O2 Tube power requirements average between 2 and 4 amps per cell depending on contaminant concentration, area of influence, and DO requirements.

5. Oxygen generation: Dissolved oxygen concentrations in excess of 15 parts per million (ppm) have been measured in O2 Tube application wells. Elevated concentrations (increases of 2-4 ppm) were measured in wells more than 25 feet away from the application well. One case study showed an increase in DO from 0.5 ppm to 2.0 ppm in tight clay (10^{-5} ft/day) over a 700 ft^2 horizontal groundwater area (10 ft. up-gradient, 12 ft. side-gradient and 20 ft. downgradient) in less than 100 days.

6. Microbes: Indigenous microbial population counts usually increase in both the application wells and perimeter wells. In one case study using O2 Tube Technology to remediate tight clay, bacterial counts went from 10^3 #/ml to 10^7 #/ml over a six-month period.

7. Water Quality Conditions: An absorption sock filled with activated carbon may be used to limit the amount of "other" materials entering the unit. In one case study the amount of dissolved road salts entering the unit was minimized in order to reduce the amount of chlorine formed during dissociation. Groundwater should be tested for salts, iron, redox, bacterial counts, DO and pH. Salt information will determine whether a carbon filter sock is recommended. The iron, redox, DO and bacterial counts are used to estimate oxygen usage or if bacteria should be augmented into the site

8. Safety: All Electrical wiring and electrical utilization equipment shall be of a type specified by, and shall be installed in accordance with, NFPA 70, National Electrical Code.

   Vents shall be not less than 12 ft. (3.6m) above adjacent ground level, with outlets so directed and located that flammable vapors will not accumulate or travel to an unsafe location or enter buildings. Within 3 ft. of vent opening is Class 1, Div. 1 and from 3 to 5 ft. is Class 1, Div. 2.

   With respect to the generation of pure oxygen and hydrogen by the O2 Tube electrolysis cell, the literature provided by O2 Tube recommends meeting the requirements under NFPA 30 (Flammable and Combustible Liquids Code). The O2 Tube draft pump uses air as a driving force that will sweep the space in the well above the groundwater level out a vent pipe.