

Bioremediation of a Former Tank Farm

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Golder Associates Ltd. (Golder) and Golder Associates Innovative Applications (GAIA) Inc. have installed and operated an in situ treatment for the bioremediation of petroleum hydrocarbon impacted soil (volume of 1800 m³ and area of 735 m²) and groundwater.

Bioremediation is a proven remediation technology in which the natural biodegradation of contaminants (Figure 1) is enhanced by addition of amendments (electron acceptor and/or nutrients) to stimulate bacterial growth.

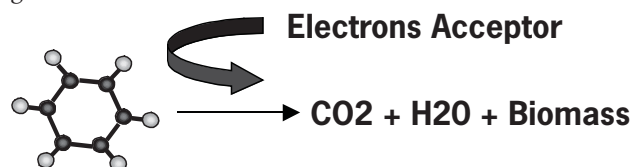


Figure 1. Schematic equation of biodegradation.

Oxygen is the most energetic electron acceptor and is used by micro-organisms to degrade petroleum hydrocarbons into harmless end-products. For successful implementation, bioremediation requires optimization based on site-specific bacterial needs. This requires measurement of concentrations of nutrients, dissolved organic carbon, and electron acceptors. Bioremediation was performed using a Super-Oxygenated Water injection system (SOW) designed by Golder along with oleophilic nutrients injection. This technology is a very cost-effective and efficient oxygen delivery technique which needs minimal maintenance, involves low construction costs, and has a very high transfer coefficient of gaseous oxygen into groundwater. The system produces dissolved oxygen concentrations on the order of 50-70 mg/L, which is 5-7 times greater than saturated concentration of oxygen concentration in natural waters. For the choice of oxygen delivery technique, a key selection parameter is the oxygen transfer efficiency. Systems, such as air sparging, transfer only 2% of the oxygen to groundwater, so it is an energy consuming technology compared to SOW, which has oxygen transfer efficiencies greater than 90% (97% is typical). The operating cost of SOW technology is low. Typically, one visit per month is sufficient, as Golder remediation systems have set point failure alarms and are designed to be linked to the Golder network by a phone line that allows remote access and control of

the key equipment. Energy requirements are low: a typical pressurized chamber system with an oxygen delivery capacity of 0,87 kg/h (25 scfh) requires a 3-hp compressor and an oxygen generator requiring 120 W/h.

SOW has been applied successfully as a final polishing soil and groundwater remediation technique. The SOW technology consists in injecting super-oxygenated groundwater (or water) into the aquifer at a given flow rate in this case, in order to establish an aerobic reactive zone creating advantageous conditions for bacterial growth, thus enhancing the biodegradation of contaminants. The system is composed of an oxygen generator, a recirculation system (extraction/injection wells, pump), a hydraulic barrier, and an SOW system with an injection capacity of 120 l/min of super-oxygenated water.

After only few months of operation, the oxygen concentration in the impacted plume increased to between 40 ppm, the hydrocarbon degrading bacteria counts increased from 3-4 order of magnitude, and the dissolved total TPH, PAH and BTEX concentrations in groundwater has dropped significantly.

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Éric Bergeron, Chemical Engineer, works as senior process engineer in the design group of the Golder Montréal Office. Mr. Bergeron has completed his undergraduate and postgraduate studies in Chemical Engineering at Sherbrooke University as chemical engineer. His thesis topic was the liquid waste plasma reforming. Before working for Golder, Mr. Bergeron has been in charge of the wastewater and air emission groups at Sodexen Inc. and more recently, Technical Director of Elite Technologies Inc. - Environmental division, a company specializing in instrumentation and stack sampling.

Mr. Bergeron has over 14 years of professional experience in studies related to wastewater and groundwater remediation. As remediation process engineer, he has worked on several projects involving soil heating, in-situ chemical oxidation, soil venting, zero-valent iron injection, air sparging and bioremediation. Mr. Bergeron has also been involved in continuous gas monitoring system design and vapor intrusion investigation.