

Evaluation of Indirect Geochemical Indicators for In-Situ Bioremediation of Petroleum Hydrocarbons

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Platform Presentation

Enhanced bioremediation is a useful groundwater technology for many sites containing petroleum hydrocarbons where source removal has occurred, but residual petroleum hydrocarbon concentrations in groundwater are still too high for site closure. Although enhanced aerobic bioremediation is a slow process, it can significantly reduce site closure schedules from decades for natural attenuation in an anaerobic environment to a few years with the addition of dissolved oxygen. Several passive and semi-passive oxygen delivery systems have been developed over the past decade. The iSOC gas infusion system works in wells as small as 2-inch diameter and has been used on over 250 sites. The gas diffusion system allows for oxygen to dissolve slowly at about 15 cc/min or 0.77 cubic feet per day per monitoring well.

For in-situ enhanced bioremediation of petroleum hydrocarbons, direct contaminant concentrations are useful to evaluate the success of the project. However, as water levels change over the complete hydrologic cycle, other indirect indicators provide confirmation data for microbial activity and geochemical conditions. Indirect indicators include dissolved oxygen, heterotrophic plate count, specific aerobic degraders, macronutrients ammonia nitrogen and ortho-phosphate, total inorganic carbon, total organic carbon, total dissolved solids, speciated alkalinity, pH, oxygen reduction potential, chemical oxygen demand (COD) and biological oxygen demand (BOD), ferrous iron, sulfate and nitrate. A gas infusion case study using the iSOC technology from Mapleshade, New Jersey was evaluated for indirect indicators, which verify that enhanced bioremediation was responsible for the hydrocarbon degradation (benzene > 96%, MTBE = 89% and TBA = 54%) that occurred over a 6-month period. In this case, an average of 221.6% increase in total inorganic carbon between pre-treatment and post-treatment samples in 9 wells shows the degradation was related to the iSOC treatment, and not related to seasonal changes in the hydrologic contaminant cycle.

For in-situ enhanced aerobic bioremediation of petroleum hydrocarbons, providing dissolved oxygen in the groundwater is necessary prior to significant contaminant degradation. Nonetheless, measuring dissolved oxygen has always been problematic and a potentially major source of error. A former gasoline underground storage tank case study from northern California is reviewed in detail. Pre-treatment levels of dissolved oxygen ranged from 4.10 mg/l to 5.76 mg/l in the central core of the hydrocarbon plume (8,400 to 23,000 µg/l TPH-g) and 5.61 to 6.84 mg/l in the wells without a reportable concentrations of TPH-g or BTEX compounds. The evaluation relied on a variety of indirect indicators in combination to obtain a clear understanding of the subsurface conditions. Based on a combination of indirect indicators, the dissolved oxygen data were questioned and the original interpretation was completely reversed, changing the course of remediation from monitored natural attenuation to a planned enhanced bioremediation program using an iSOC system. Careful evaluation of the indirect indicators can provide valuable information on in-situ enhanced bioremediation projects.

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