Chemical Indicators for In-Situ Bioremediation of Petroleum Hydrocarbons

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Platform Presentation

Although enhanced aerobic bioremediation of petroleum hydrocarbons is a slow process, it can reduce site closure schedules from decades for natural attenuation 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 groundwater monitoring wells as small as 2-inch in diameter. This system has been used on over 250 sites. The iSOC system allows oxygen (or other gases) to dissolve slowly at about 15 cc/min or 0.77 cubic feet per day per monitoring well. Detailed interpretation of conflicting chemical indicators can reveal much about site conditions and remedial progress.

For in-situ enhanced bioremediation of petroleum hydrocarbons, direct contaminant concentrations are useful to monitor the success of the project. However, as water levels rise and fall over the complete hydrologic cycle, other chemical indicators provide confirmatory data for microbial activity and changes in geochemical conditions. Chemical 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, biological oxygen demand, 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. 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 had pre-treatment levels of dissolved oxygen ranging 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 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 enhanced bioremediation. Careful evaluation of the chemical indicators can provide valuable insight on in-situ enhanced bioremediation projects.

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Presented at the National Ground Water Association, Houston Hydrocarbon Show, November 2004.