ORC TECHNICAL BULLETIN # 2.2.2.6

Oxygen Release Compound, ORC®

Bioremediation of Nitrochlorobenzene, Nitroaniline, Chloroaniline & Other Organics in Groundwater

Introduction:

A field-scale pilot study to evaluate in-situ treatment of nitrochlorobenzene, nitroaniline, chloroaniline and other organics was performed. The uppermost aquifer beneath a chemical plant contains residual concentrations of o-nitrochlorobenzene from a tank car spill, as well as other plant-related organic compounds of concern (COC), including 2-nitroaniline and o-chloroaniline. The aquifer consists of low permeability clays and silts, and produces only a few gallons of groundwater per day from a shallow recovery well previously installed for remediation. Soil removal was the principal mechanism to treat the tank car spill. Subsequent recovery of residual groundwater contamination has been ineffective for more than 10 years due to low aquifer yield, and the recalcitrant nature of the COC. Aerobic treatment of various COC in soil systems has been reported to be highly variable (Abou-Rizk et al., 1995; Myers et al., 1995; Zappi et al., 1995), and the goal of the pilot test was to establish that aerobic bioremediation of the COC were a viable option at this site.

Application:

Numerous remedial options were evaluated, and Oxygen Release Compound (ORC®) was identified as the preferred method to oxygenate the aquifer. ORC, manufactured by Regenesis Bioremediation Products in San Juan Capistrano, California, is a patented formulation of magnesium peroxide that slowly releases molecular oxygen when hydrated, thereby facilitating aerobic bioremediation of the COC. The treatment area was approximately 80 square meters and the depth of treatment was approximately 6 meters of aquifer profile. The ORC releases oxygen slowly over a period of 6 to 9 months, which corresponded to the scheduled testing period. The ORC design/loading rates were based on dissolved organic compound mass in the treatment area, as well as dissolved oxygen (DO) concentrations and oxidation-reduction potential (ORP) measurements. The ORC was injected in a grid pattern around the recovery well which continued to extract groundwater, thereby enhancing the rate of oxygen movement through the treatment area. Baseline COC sampling was performed prior to ORC injection, and the post-treatment monitoring protocol included DO and ORP in addition to the COC. A supplementary investigation is planned to measure the potential for the contaminants to partition from the adsorbed phase into the dissolved phase. A soil core will be obtained from the site during pending investigation efforts to facilitate this analysis.

Results:

Table 1 depicts the maximum percent reductions in COCs throughout the bioremediation process at this site. Figures 1-4 illustrate the concentration reductions over time in the COCs as measured in monitoring well F-2, which is located in the central portion of the pilot test area. Changes in 1,2-dichloroethane and 1,2-dichloropropane concentrations are illustrated in Figure 1. Changes in 2-nitroaniline and o-chloroaniline concentrations are illustrated in Figure 2. Changes in chlorobenzene and o-nitrochlorobenzene concentrations are illustrated in Figure 3. Changes in naphthalene, 2-chlorophenol and nitrobenzene concentrations are illustrated in Figure 4.

Conclusions:

The bioremediation process effectively reduced dissolved masses of o-nitrochlorobenzene, 2-nitroaniline and o-chloroaniline, and also reduced dissolved mass of other COCs. Rebound of the COC concentrations were observed after the oxygen from the initial ORC treatment was spent. The project will be expanded to include a long-term barrier design using ORC to continuously deliver oxygen to the aquifer, and eliminate the potential for off-site migration of dissolved COC.

References:

Abou-Rizk, J.A.M., M.E. Leavitt and D.A. Graves. 1995. In Situ Aquifer Bioremediation of Organics Including Cyanide and Carbon Disulfide. Applied Bioremediation of Petroleum Hydrocarbons. Vol. 3(6): 175-183. Battelle Press.

Myers, J.M., B.S. Banipal and C.W. Fisher. 1995. Biodedgradation of Oil Refinery Wastes. Applied Bioremediation of Petroleum Hydrocarbons. Vol. 3(6): 445-451. Battelle Press 1995.

Zappi, M.E., D. Gunnison and H. Fredrickson. 1995. Aerobic Treatment of Explosives-Contaminated Soils Using Two Engineering Approaches. Bioremdiation of Recalcitrant Organics. Vol. 3(7): 281-288. Battelle Press.

Compound	% Concentration Reduction
1,2-dichloroethane	92.0
1,2-dichloropropane	61.0
2-nitroaniline	95.0
o-chloroaniline	82.8
Chlorobenzene	63.5
o-nitrochlorobenzene	74.0
Naphthalene	91.0
2-chlorophenol	38.7
Nitrobenzene	54.5

Table 1

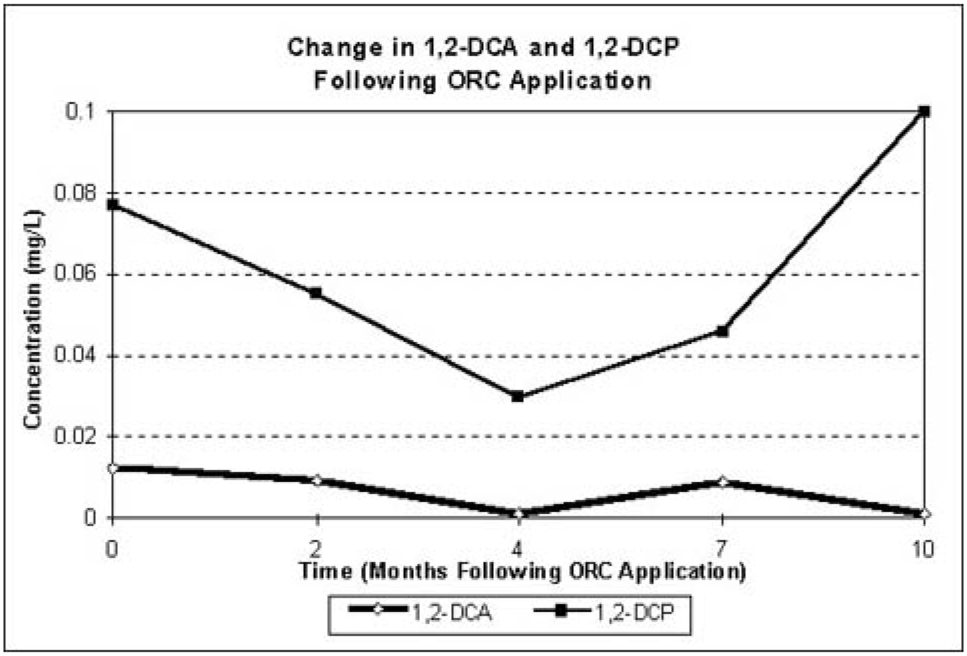

Figure 1

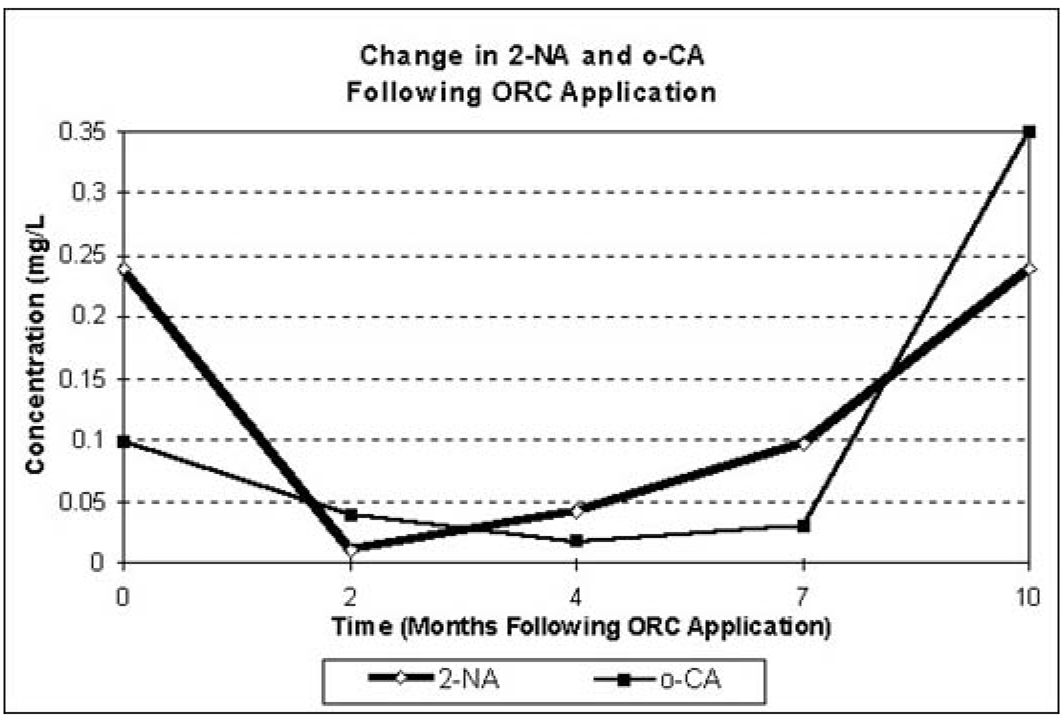

Figure 2

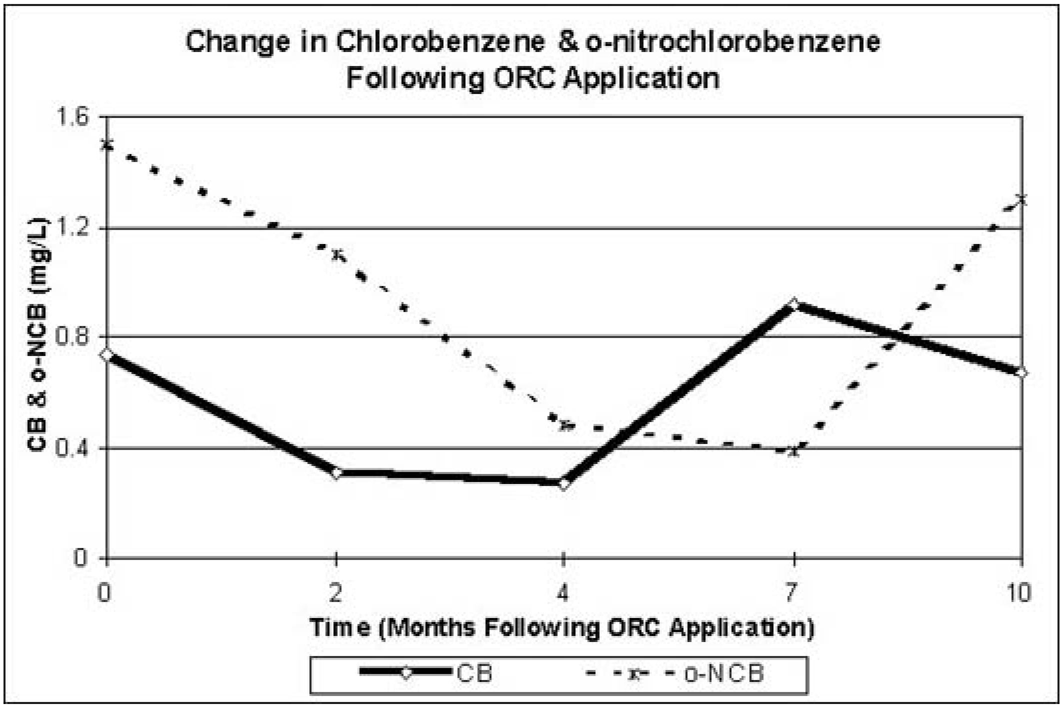

Figure 3

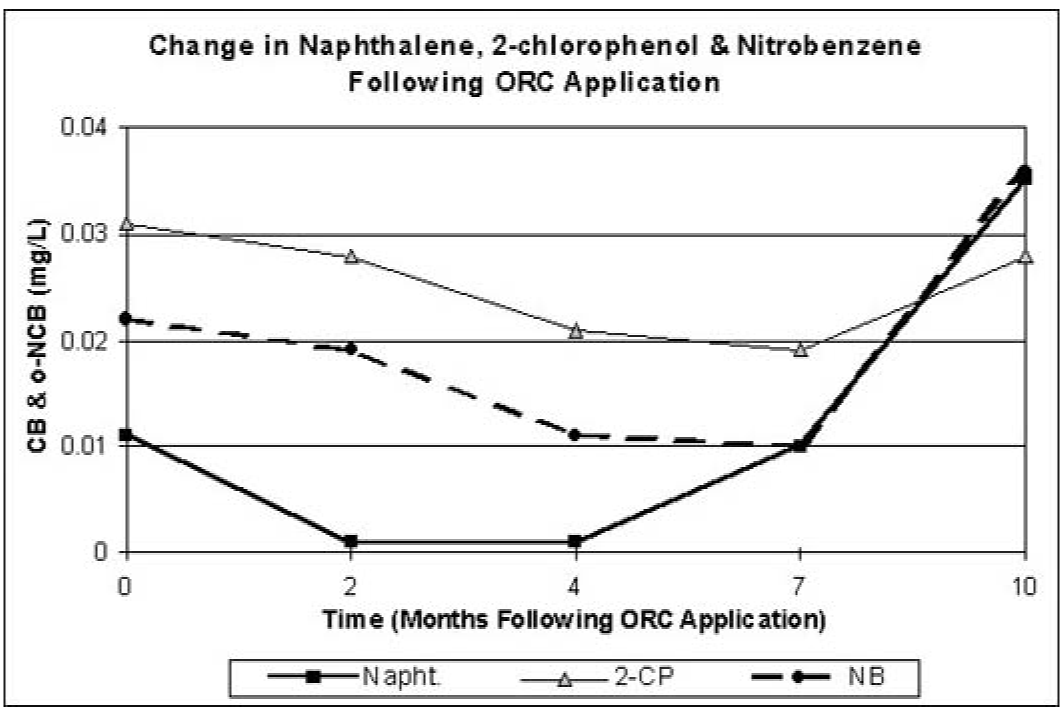

Figure 4

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