

RegenOx[®]

Advanced Chemical Oxidation

Chemical Oxidation of Petroleum Hydrocarbons in High Total Organic Carbon (TOC) Environments

Introduction

Contaminated sites where large amounts of natural organic matter are present are typically viewed as difficult to treat using in-situ chemical oxidation (ISCO) technology. Natural organic matter can be present in much higher concentrations than the actual contaminants, thus placing a large, unintended demand on the oxidant. This additional demand factor can significantly diminish the efficiency of the chemical oxidation process. RegenOx[®] in-situ chemical oxidation utilizes a unique surface-mediated oxidation process which favors the destruction of more readily accessible, dissolved phase contaminants over less soluble forms of TOC. As a result, RegenOx is not wastefully spent on oxidizing TOC and more RegenOx goes to oxidizing the contaminant. This surface-mediated oxidation therefore provides a selectivity and efficiency advantage compared with other chemical oxidants. In this bulletin, TOC and petroleum hydrocarbons analysis concepts are discussed, and an example is summarized where RegenOx was successful for petroleum hydrocarbon oxidation at a high-TOC site.

Total Organic Carbon (TOC) Analyses

The parameter “total organic carbon” (TOC) is a blanket measurement of organic compounds in a soil or water matrix, reported as the weight of the element carbon. Commercial analytical laboratories determine total organic carbon by a variety of methods, all of which involve oxidation of the organics and quantification of carbon as carbon dioxide. The resulting CO₂ is typically measured directly by an infrared detector or converted to methane (CH₄) and measured by a flame ionization detector. The amount of CO₂ or CH₄ in a sample is directly proportional to the concentration of carbonaceous material in the sample. A correction is typically made to account for any inorganic (carbonate) sources of carbon in the sample (USEPA, 2004).

Total Petroleum Hydrocarbon (TPH) Analysis with Silica Gel Cleanup

Silica gel cleanup is an additional procedure that removes partially oxidized compounds and/or polar organic compounds from the analysis of total petroleum hydrocarbons (TPH) by gas chromatography. This process removes most naturally-derived organics, which often have alcohol or carboxylic acid functionalities. In fuel-contaminated sites, the true chemical contaminants of concern are the non-polar aliphatic and aromatic constituents that are not removed in a silica gel cleanup step.

Effective Chemical Oxidation on a High TOC Site

RegenOx was recently successful in treating hydrocarbon-impacted soil and groundwater at a former gas station site with high levels of natural organic matter. TOC levels in soil were reported in the range of 6.2-9.1% (62,000 - 91,000 mg/kg), and the site was impacted with petroleum fuel from historic releases at the site. A pilot test using RegenOx in three separate application events resulted in large reductions of petroleum hydrocarbon concentrations in both the soil and groundwater. Groundwater monitoring well data showed TPH reductions of 71-97% after three months. Soil treatment data indicated reductions of 61-73%. Both groundwater and soil data analyses utilized the silica gel cleanup methodology to remove partially oxidized material. Further details can be found in Tables 1 and 2 below. The data indicates that RegenOx was able to degrade a significant portion of the contaminant in the high-TOC environment.

Groundwater TPH Data	Time (days)		Contaminant Reduction (mg/L)	% reduction
	0	122		
MW3	570 mg/L	16 mg/L	554	97%
DPVE4	11 mg/L	3.2 mg/L	7.8	71%

Table 1. Reductions in Groundwater TPH with silica-gel over time

Soil TPH Data w/SGC	Time (days)		Contaminant Reduction (mg/kg)	% reduction
	0	103		
WS2	2,300 mg/kg	900 mg/kg	1,400	61%
WS3	4,900 mg/kg	1,300 mg/kg	3,600	73%

Table 2. Reductions in Soil TPH with silica-gel cleanup over time

References

US Environmental Protection Agency, 2004, Method 9060A: Total Organic Carbon, pp.1-5.

US Environmental Protection Agency, 1974, Method 415.1: Organic Carbon, Total (Combustion or Oxidation), pp.1-3.

For more information on RegenOx or a free application design and cost estimate contact Regenesis at 949-366-8000 or visit www.regenesis.com.