Monitoring of Air Injection Remediation Systems Using Carbon Dioxide Efflux Measurements

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Background/Objectives. Carbon dioxide (CO_2) efflux monitoring at ground surface is recognized as a valuable method to monitor biogases from subsurface natural source zone depletion (NSZD) of petroleum hydrocarbons. A logical extension of this monitoring method is to apply it to monitor active remediation sites that are using enhanced biodegradation technologies. These are sites where the magnitude of biogases generated is significant enough to discern from background and be quantifiable using surficial soil gas efflux methods. This presentation summarizes the results of applying CO_2 efflux monitoring at two sites that used air injection systems to enhance biodegradation of petroleum hydrocarbons.

Respiration tests have historically been used as a primary method to assess the effectiveness of air injection-enhanced bioremediation systems (AFCEE, 1992). This method estimates in situ aerobic biodegradation rates via stoichiometric conversion of oxygen (O_2) utilization or CO_2 production data. The rate data is collected in vapor monitoring probes installed within the aerated source zone. Periodically, the aeration system is shut down for a short time for in situ respiration testing. During the tests, the decline curve of O_2 concentration in soil gas is measured at various times. After correction for background O_2 demand, the slope of the decline curve is equated to the O_2 consumed by the aerobic microorganisms responsible for the bioremediation of petroleum hydrocarbons. The O_2 consumption is then stoichiometrically converted into a unit mass of total petroleum hydrocarbons (TPH) degradation. This bulk unit TPH mass loss rate is extrapolated in space (i.e., the volume of soil that is aerated) and time (i.e., the duration of aeration or excess O_2 presence) to estimate a sitewide remediation rate.

This approach using CO_2 efflux measurements represents a novel alternative to traditional methods such as respiration tests. The potential benefits of its use include a lower cost and less intrusive method that can generate similar results. For example, a reduction to some threshold difference between the baseline (NSZD alone) and operational efflux measurements can be used as an operational endpoint.

Approach/Activities. The two performance monitoring methods described above were deployed and compared at two sites using air injection (one bioventing and one biosparging) technology. Baseline and operational CO_2 efflux were measured on the sites and the effectiveness of the aeration systems were quantified by the difference between the pre-startup, baseline CO_2 efflux (derived from NSZD alone), to the CO_2 efflux after startup, during routine operation. The passive flux trap methodology was used on both sites.

Results/Lessons Learned. This presentation will present the results of the field demonstrations and highlight the importance of a renewed look at the method used to assess the performance of air injection systems. The importance of a performance monitoring program and operational endpoint will be stressed. Data to be presented include a comparison of traditional and novel monitoring results along with a comparison of baseline and operational efflux values. Statements will be made regarding the potential future application of efflux monitoring for aeration systems and use of this data for progress and endpoint monitoring.