

STANDARD OPERATING PROCEDURE

Thirteen

IN SITU RESPIRATION TEST

Modified from
Groundwater Pollution Control Program Guideline #5
Minimum Design Requirements and Common Accepted Engineering Practices:
Soil Vapor Extraction and Bioventing Systems
Wyoming Department of Environmental Quality
Water Quality Division
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1.0 OVERVIEW – IN SITU RESPIRATION TEST

In addition to the air permeability test described in SOP 12, additional tests must be conducted at sites where bioventing is to be optimized over volatilization. In situ respiration studies are needed to determine the oxygen transport capacity of the soils and to estimate the biodegradation rates under field conditions. The test involves short-term injection of air or an air/inert gas mixture into a well or monitoring probe that is screened in the contaminated soil. Carbon dioxide, oxygen, and inert tracer gas (typically helium, when used) concentrations are measured in the injection well/probe periodically for one to five days. The measurements are then compared to baseline concentrations of the gases prior to injection. Baseline measurements are taken at the injection point and at a well/probe located in uncontaminated soils. Increases in carbon dioxide and/or decreases in oxygen concentrations are indications of microbial activity in soils surrounding the injection point. Although the use of an inert tracer gas is not required, it is highly recommended since it provides baseline information on air diffusion rates and confirms that no system leaks are present.

Laboratory microbial screening tests are used to corroborate the presence of naturally occurring bacteria capable of degrading contamination present on site. These tests are generally not required since microbial activity can usually be detected during respiration tests. If the bacteria that degrades the contaminant in question is not typically found in the native soils, laboratory tests may be warranted to ascertain the feasibility of bioventing technology.

Guidelines regarding standard practices for the design and implementation of in situ respiration tests are presented below. Adherence to these guidelines should improve the overall quality of data obtained during respiration tests, although deviations may be warranted depending on site specific conditions.

2.0 IN SITU RESPIRATION TEST DESIGN RECOMMENDATIONS

Air Injection Wells/Probes: Monitoring probes are the preferred type of air injection points and are typically installed in highly contaminated soils. However, an existing monitoring well can be used if a significant portion of the screened interval is above the water table. The following standards apply:

- The injection well/probe must be located near the center of the most contaminated zone or 'hot spot' in order to ensure that oxygen levels are depleted. As a general guideline, oxygen concentrations should be less than 2%.
- The injection well/probe should not be placed in the vicinity of man-made air flow conduits, such as sewer or utility lines.
- Only wells with known construction details should be used. Older wells should be avoided.
- Well construction should insure that short-circuiting of air flow is unlikely to occur across the seal and surface grout. If the screened interval is near the land surface, short circuiting is likely to occur.

3.0 STANDARD IN SITU RESPIRATION TEST PROCEDURES

- Generally, air should be injected into the test well(s)/probe(s) over a 24 hour period at rates ranging from 1.0 cubic feet per minute (cfm) to 1.7 cfm (60 cubic feet per hour to 100 cfh). Sufficient air should be injected in order to avoid boundary effects from interfering with test results.

- If helium is used as a tracer it must be 99% pure. When used, the flow rate of helium should be generally adjusted from 0.6 cfh to 1.0 cfh in order to obtain 1%-2% helium in the final air mixture injected.
- If a well is used for injection and the screened interval is greater than 10 ft, the required air injection rate may be too high to allow for helium injection.

4.0 IN SITU RESPIRATION TEST MONITORING REQUIREMENTS

- Prior to beginning the test, sample injection well(s) and probe(s) for O₂, CO₂, CH₄ and VOC's.
- Prior to beginning the test, sample background well and probe located in uncontaminated soil for O₂ and CO₂.
- Measure pressure and flow rate during air injection.
- After air injection and helium injection (when used) is complete (i.e., 24 hours following start of injection), begin periodic monitoring of O₂, CO₂, and helium. Typically measurement of the soil gas should be conducted at ½, 2, 4, 6, and 8 hours and then every 4 to 12 hours, depending on the rate at which the oxygen is utilized. If oxygen uptake is rapid, more frequent monitoring is required. The actual frequency should be selected in the field so that the data collected shows a definite trend in O₂ and CO₂ concentrations to compensate for the scatter caused by measuring errors.
- There is a risk of pulling in atmospheric air during the process of purging and sampling at shallow monitoring points. When sampling shallow points, care should be taken to minimize the volume of air extraction. Low extraction rates should be maintained (i.e., 5 - 10 liters/minute).
- Monitoring should be terminated when the oxygen level is near background conditions or after 5 days of sampling.

5.0 REPORTING IN SITU RESPIRATION TEST RESULTS

- A site map drawn to scale indicating location(s) of air injection well(s)/probe(s).
- Descriptions of field equipment and procedures used during testing.
- Sampling methods and procedures.
- Boring logs and construction diagrams for air injection well(s) and probe(s) and background well/probe in uncontaminated zone.
- O₂ and CO₂ concentrations measured in background well.
- O₂, CO₂, CH₄ and VOC's measured in injection well(s) and probe(s) prior to injection.
- Table of injection flow rate and pressure including the time of each reading.
- Table of O₂ and CO₂ concentrations including time elapsed.
- Plot of % O₂, % CO₂