9.2 SOIL VAPOR EXTRACTION

by M.K. Carol Lee
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Process Description

This chapter covers the permitting of soil vapor extraction operations. Soil vapor extraction also known as "soil venting" or "vacuum extraction", is an in situ remedial technology that reduces concentrations of volatile constituents in petroleum products adsorbed to soils in the unsaturated (vadose) zone. In this technology, a vacuum is applied through wells near the source of contamination in the soil. Volatile constituents of the contaminant mass "evaporate" and the vapors are drawn toward the extraction wells. Extracted vapor is then treated as necessary (commonly with carbon adsorption or thermal or catalytic oxidation) before being released to the atmosphere.

Completeness Determination

The following District forms should be completed and fees provided for the soil vapor extraction operations. Use the Completeness Determination Checklist to verify completeness. Use the Data Form Guidance to ensure that the forms are completed correctly. Use the Fee Calculation Guidance to ensure that the fees are calculated accurately.

1. Form 101-B (one for facility).
2. Form G (one per source). Process code is 8999, material code is 572, and usage unit is cubic feet.
3. Form A (one per abatement device).
4. If abatement device burns fuel (i.e., thermal oxidizer), then Form C. If the abatement device is an internal combustion engine, then Form ICE.
5. Form P (one per stack).
6. If Health Risk Screening is triggered, Form HRSA (one per source).
7. Fees, calculated per Regulation 3 (Schedule G1 – Remediation Operations, Soil – Any Equipment).

Emission Calculations

Soil Vapor Extraction (Primary)

Emission calculations are based on a material balance from the proposed source with the following assumptions:

1. Standard conditions: Pressure = 1 atm; temperature = 70°F (21°C); 1 mole occupies 24.15 L
2. Influent concentrations based on estimates provided by the applicant for total organic hydrocarbons (POC), and individual toxic compounds, identified in Table 2-5-1 of Regulation 2-5):
   a. Influent Concentration (ug/L) – Use Equation 1a
   b. Influent Concentration (ppmv) – Use Equation 1b
3. Assume 100% of contaminants are stripped from the soil.
4. Influent flow rate based on operational parameters of equipment (i.e., flow rate into abatement equipment; abatement efficiency of abatement equipment (i.e., carbon system, thermal or catalytic oxidation).

Abated emission of the total organic hydrocarbons and individual toxic compounds can be calculated using the following equations:

$$E_P = Cia * Q * Coa * (1-A) \qquad \text{[Equation 1a]}$$

or

$$E_P = Cib * Q * Cob * MW *(1-A) \qquad \text{[Equation 1b]}$$

where:

E_P = Abated Emissions (lbs/day),
Cia = Influent Concentration (ug/L),
Cib = Influent Concentration (ppmv),
Q = Flow Rate (scfm),

Coa = Dimensional Constant (Conversion Factor) for Equation 1a,
Coa = 1 lb/4.536E8 ug * 28.317 L/ft3 * 1440 min/day = 8.99E-5 lb-L-min/ug-ft3-day

Cob = Dimensional Constant (Conversion Factor) for Equation 1b,
Cob = 1 mole/24.15 L * 1 lb/454 g * 28.317 L/ft3 * 1440 min/day = 3.7 lb-mole-min/g-ft3-day

MW = Molecular Weight of Pollutant (g/mole) [i.e., molecular weight for "weathered gasoline" is 100 g/mole; molecular weight for benzene is 78 g/mole], and
A = Abatement Efficiency of Abatement Device (wt%)

Annual emissions are calculated by multiplying daily emissions by the maximum number of operating hours per year (i.e., 365 days per year).

Abatement Device Emissions (Secondary)
Per Regulation 2-2-212, the aggregate sum of all increases of any given pollutant from a facility pursuant to the authority to construct or permit to operate is included in the cumulative increase. Hence, in addition to abated emissions of soil vapor extraction ("primary" emissions), emissions from the abatement device ("secondary" emissions) must also be calculated. Because the abatement device requires a permit, per Regulation 2-1-113.2.4, any "secondary" emissions from the abatement device must also be included in the cumulative increase.

Carbon Adsorption
There are no secondary emissions for the operation of a carbon adsorption system.

Thermal/Catalytic Oxidation
However, the combustion of fuel from thermal and catalytic oxidizers and internal combustion engines results in secondary criteria pollutants of combustion. These secondary pollutants must be calculated and included in the cumulative increase. Furthermore, per Regulation 2-2-112, although the abatement equipment is not be subject to BACT requirements when it is used to abate a source to meet BACT/TBACT requirements, it is subject to Reasonably Available Control Technology (RACT) for control of secondary pollutants. RACT for thermal and catalytic oxidizers has been established:

NOx = 0.2 lb/MMBTU
CO = 0.8 lb/MMBTU

Per District policy, source testing of the thermal and catalytic oxidizers are required to verify nitrogen oxide and carbon monoxide emission requirements, if the oxidizer is over 7.5 MMBTU/hr.

Emission factors from AP-42, Table 1.4-2 (Natural Gas Combustion) may be used for particulate (PM10), sulfur dioxide (SO_2), and POC emissions, unless vendor data for the abatement device is available:

PM10 = 7.6 lb/MM scf *(scf/1020 BTU) = 0.075 lb/MMBTU
SO_2 = 0.6 lb/MM scf *(scf/1020 BTU) = 0.0006 lb/MMBTU
POC = 5.5 lb/MM scf *(scf/1020 BTU) = 0.0054 lb/MMBTU

With these emission factors, the annual emissions from the thermal/catalytic oxidizer can be calculated using the following equation:

$E_S = F \times B \times H$

where:

E_S = Annual Emissions of Abatement Device (lbs/yr)
F = Emission Factor of Criteria Pollutant (lb/MMBTU)
B = Maximum Firing Rate of Burner in Abatement Device (MMBTU/hr)
H = Maximum Number of Hours The Oxidizer Will Operate
(i.e., 24 hr/day x 365 day/yr = 8760 hrs/yr)

Internal Combustion (IC) Engines
The use of IC engines for abatement of the soil vapor extraction operations is infrequent. When IC engines are used, the supplementary fuel is usually natural gas or propane. RACT for IC engines is Regulation 9-8 standards:

NOx (Rich Burn) = 56 ppmv @ 15 ppmv O_2 = 0.2 lb/MMBTU
NOx (Lean Burn) = 140 ppmv @ 15 ppmv O_2 = 0.5 lb/MMBTU
CO = 2000 ppmv @ 15 ppmv O_2 = 4.3 lb/MMBTU

Initial startup source testing should be required to ensure that the IC engine ($\geq$ 250 HP) will meet the emission standards for nitrogen oxides and carbon monoxide, per Regulation 9-8 requirements.

Emission factors from AP-42, Table 3.2-1 (Uncontrolled Emission Factors from 2-Stroke Lean Burn Engines) may be used for particulate (PM10), sulfur dioxide (SO_2), and POC emissions, unless vendor data for the abatement device is available:

PM10 = 3.84 E-2 lb/MMBTU
SO_2 =5.88 E-4 lb/MMBTU
POC = 1.2E-1 lb/MMBTU

With these emission factors, the annual emissions from the IC engine can be calculated using the following equation:

$E_S = F \times B \times H$

where:

E_S = Annual Emissions of Abatement Device (lbs/yr)
F = Emission Factor of Criteria Pollutant (lb/MMBTU)
B = Maximum Firing Rate of Burner in Abatement Device (MMBTU/hr)
H = Maximum Number of Hours The IC Engine Will Operate
(i.e., 24 hr/day x 365 day/yr = 8760 hrs/yr)

Applicable Requirements
District Rules and Regulations
Soil vapor extraction operations are subject to Regulation 8-47 (Air Stripping and Soil Vapor Extraction Operations) ; which requires at least 90% control of emissions unless the applicant meets the exemptions of Sections 109 through 113 of that regulation.

Any IC engines over 250 HP used for abatement of the soil vapor extraction operation would also be subject to Regulation 9-8 (Nitrogen Oxide and Carbon Monoxide Emissions From Stationary Internal Combustion Engines). Initial startup source testing should be required to ensure that the IC engine ($\geq$ 250 HP) will meet the emission standards for nitrogen oxides and carbon monoxide.

Best Available Control Technology (BACT)
The following are applicable BACT requirements for:

Soil Vapor Extraction

Inform the BACT Coordinator of updates to the BACT/TBACT Workbook.

California Environmental Quality Act (CEQA)
Permit applications which are reviewed following the specific procedures, fixed standards and objective measurements set forth in this chapter (9.2) are classified as ministerial and will accordingly be exempt from CEQA review per Regulation 2-1-311.

In addition to the above-mentioned source-specific applicable requirements, other requirements may also be applicable depending on the facility, its application emissions, and its source location:

- ❑ Offsets
- ❑ Prevention of Significant Deterioration
- ❑ School Notification
- ❑ Health Risk Screening Analysis

Permit Conditions
Standardized conditions for soil vapor extraction operations (including that for RACT requirements for thermal oxidizers and IC engines) are available from the Permit Condition Guidance. Refer to the Evaluation Report Template Guidance to obtain the Microsoft Word formatted permit conditions for this source category.