

EVALUATION OF (VOC) EMISSION CONTROL WITH USING SURFACE EMISSION ISOLATION FLUX CHAMBER (IFC)

Nafiseh Panahi, Siavash Derafshi, M.Mohamad Chavoshbashi

HSEQ Dept., Tabriz Petrochemical complex, National Petrochemical Company
Email:nposalu@gmail.com

Abstract

Emission rate testing of volatile and some semi-volatile compounds (VOC/SVOC) was conducted at a licensed commercial Emission rates. Measurements were made using surface isolation flux chamber. Hydrocarbon samples were collected in evacuated stainless steel canisters and analyzed off-site by gas chromatography and mass spectrometry (GC/MS). The testing protocol that was used for this program has been used in the past to establish the control strategies to VOC/SVOC emissions control from waste/hazardous waste materials. The testing protocol included the use of the EPA recommended surface emission isolation flux chamber technology and the EPA Method TO-14 canister sample collection and GC/MS analytical technique. Flux chamber, sweep air, sample collection equipment, and field documents were located on-site and at the test location. The chamber was placed on the testing surface (uncontrolled wastewater layer). The thermocouples were placed in order to monitor air temperature inside and outside of the chamber. The chamber was suspended from a portable tripod to prevent disturbance of the layer. The sweep air flow rate was initiated and the rotameter was set at 5.0 liters per minute. Constant sweep air flow rate was maintained throughout the measurement. The chamber was operated at 5.0 liters per minute sweep air flow rate, and data were recorded every residence time (6 minutes) for five residence times or 30 minutes. The samples connected to GC/MS in line and analyzed in time to overcome transferring errors. These process repeated to validate the Data and repeatability evaluation. Results showed that this method is a very reliable and accurate for sampling of VOC/SVOCs from open area sources.

Keywords: Volatile Organic Compound(VOC); EPA(Environmental Protection Agency); Isolation Flux Chamber(IFC) ; Gas Chromatography and Mass Spectrometry (GC/MS)

INTRODUCTION

This technical memorandum describes the field testing that was conducted in order to establish the VOC/SVOC emission control foams for petroleum hydrocarbon wastes. The objective of this testing was to determine the emission rates of organic compounds (VOCs/SVOCs) from uncontrolled waste and then from wastes with representative layers of foams applied to the waste for purposes of emission control. This testing was conducted by Dr. CE Schmidt on August 6, 7, and 14, 1991. The testing protocol that was used for this program has been used in the past to establish the control efficiency of other foam products developed for the same purpose, namely to control VOC/SVOC emissions from waste/hazardous waste materials. The testing protocol included the use of the EPA recommended surface emission isolation flux chamber technology and the EPA Method TO-14 canister sample collection and GC/MS analytical technique.

EPA Emission Isolation Flux Chamber

The procedure for measuring emissions from the compost pile surfaces is a modified form of the procedures found in the US Environmental Protection Agency's (EPA) Measurement of Gaseous Emission Rates from Land Surfaces Using an Emission Isolation Flux Chamber User's Guide. Under the EPA procedures, gaseous emissions from surface migration are collected from an isolated surface area with an enclosure device called an emission isolation flux chamber. Clean, dry sweep air or nitrogen is introduced to the flux chamber at a fixed, controlled rate (5.0 lit/min recommended) as a carrier where it mixes with the contaminants from the surface migration. The flux chamber encompasses a fixed surface area (1.4 ft²), and is designed to isolate the surface from phenomena that can influence the air surface interface such as wind speed, other meteorological conditions, or properties of the waste itself. The flux chamber is sunk to a depth of one inch into the surface in order to create a seal between the flux chamber and the surface. The flux chamber and sweep air system is designed such that the contents are well mixed and no internal stratification exists. A probe is located in the flux chamber to extract a gaseous sample for subsequent analysis. The probe is of such a design that the sample represents a composite of various altitudes from within the flux chamber. Sampling is conducted at a rate of lesser

than or equal to the sweep air rate. The remainder of the flux chamber contents are allowed to vent through a small opening located strategically on the flux chamber dome. For measuring flux chamber internal temperature, a

thermocouple is also located within the flux chamber. Refer to Figure 1 for specifications and exact dimensions of the flux chamber design.

Modifications to the Flux Chamber Method

The Flux Chamber procedure is intended primarily for surface migration from landfills, hazardous waste treatment facilities, and hazardous spill remediation covered under the RCRA and CERCLA acts. The procedure assumes that gaseous emissions from the surface within the chamber area are much less than that of the sweep air rate. Under this assumption, mass emissions of a given contaminant is a product of the measured sample concentration and sweep air rate and reported per unit of surface area. Upon field evaluation of the flux chamber, it was discovered that the surface flux migration rate was more appreciable in the composting operation and could not be ignored as compared to the sweep air rate. The calculation of mass emissions of a given contaminant thus becomes a product of the measured sample concentration, sweep air rate, and surface migration rate. Furthermore this migration rate could not be directly measured due to the discovery that any attempt to employ a measuring device resulted in an impedance of the surface migration.

As an amendment to the EPA procedure, the surface migration rate must be determined. A procedure for calculating surface migration employs a material balance and concentrations taken from the sample analysis of an inert known component initially mixed into the sweep gas (refer to material balance section). For this reason, the sweep gas is composed of 10% helium (balance ultra-pure grade air) as a component to perform the analysis and material balance. Alternatively surface migration can be determined by allowing the compost emissions to fill a very thin plastic bag and recording elapsed time.

The bags can later be pumped through a calibrated volumetric meter to determine volume.

For the purposes of this test, the flux chamber's shell and sample path was constructed entirely of non reactive materials. Since sulfur compounds were measured, this also meant that metals of any kind could not be used in its construction to avoid catalytic decomposition. The following sampling specifications were used during testing:

Sweep Air Type: 10% Helium, 90% Air (99.999 % purity)

Sweep Air Rate: 5.0 lit/min

Each sampling run was integrated over several points to insure representativeness. In order to account for general spatial variability, the flux chamber samples were drawn and integrated over several points

TEST METHODOLOGY

Testing was conducted using the EPA recommended Surface Isolation Flux Chamber (flux chamber) as the emission assessment tool to collect emissions data. The primary reference for this section is the document entitled "Measurement of Gaseous Emission Rates From Land Surfaces Using an Emission Isolation Flux Chamber, Users Guide.

The operation of the flux chamber is given below:

- 1) Flux chamber, sweep air, sample collection equipment, and field documents were located on-site and at the test location.
- 2) The site information, location information, equipment information, name of sampler, date, and proposed time of testing were documented on the Emissions Measurement Field Data Sheet.
- 3) The exact test location was selected and the chamber was placed on the testing surface.
The thermocouples were placed in order to monitor air temperature inside and outside of the chamber. The chamber was suspended from a portable tripod when used on foam layers to prevent disturbance of the foam layer.
- 4) The sweep air flow rate was initiated and the rotometer was set at 5.0 liters per minute. Constant sweep air flow rate was maintained throughout the measurement.
- 5) The chamber was operated at 5.0 liters per minute sweep air flow rate, and data were recorded every residence time (6 minutes) for five residence times or 30 minutes. The sample line was continually purged by withdrawing exhaust gas and monitoring with an Organic Vapor Analyzer.
- 6) At steady-state (5 residence times or more), gas samples were collected. Sample collection rate of 2.5 liters per minute was not exceeded at any time. This prevented unwanted entraining of ambient air.
- 7) After sample collection, all samples were labeled and documented on the data sheet.
- 8) After labeling, all samples were properly stored in shipping boxes.
- 9) Sample collection was documented on the chain-of-custody sheet.
- 10) After sampling, the flux measurement was discontinued by shutting off the sweep air, removing the chamber, and securing the equipment.
- 11) Where contact was made with the surface, the chamber was decontaminated using appropriate cleaning supplies.

12) Sample equipment was then relocated to the next test location and steps 1 through 12 were repeated.

Gas samples were collected from the exhaust of the flux chamber in evacuated stainless steel canisters and analyzed by GC/MS following EPA Method TO-14.

EXECUTIVE SUMMARY

Emission rate measurements were made using the EPA recommended surface isolation flux chamber. Hydrocarbon samples were collected in evacuated stainless steel canisters and analyzed off-site by gas chromatography and mass spectrometry (GC/MS) following EPA Method TO-14.

EPA Method TO-14 provides for the speciation of a listed 39 air toxic compounds, some of which were routinely identified in these samples. However, most of the sample compounds were aliphatic hydrocarbons and were accounted for by the summation of total non-methane hydrocarbon compounds (TNMHCs). In addition, the analysis included the listing of up to the ten highest tentatively identified compounds found in each sample. As such, improvements in this sample collection and analytical technique, as compared to historical testing, have provided additional test data for this evaluation.

Testing included uncontrolled emission rate testing, application of foam products, and retesting of fugitive TNMHC emissions. VOC/SVOC emission control data were calculated by dividing controlled TNMHC emission rate data by pad specific uncontrolled TNMHC emission rate data, subtracting this quotient from one, and multiplying this result by 100 (percent control). Test data were not corrected for foam baseline emissions. These control efficiencies were also calculated by dividing controlled emission rate data by the average of all uncontrolled emission rate data. This normalized uncontrolled emission rate accounts for waste heterogeneity.

These data, along with other compound data, are useful for evaluating other aspects of VOC/SVOC control efficiency.

QUALITY CONTROL

Quality control procedures are described below. The application and frequency of these procedures were developed to meet the program objectives and the data quality objectives.

- Field Notebook -- A field notebook with data forms was maintained for the testing program.

- *Laboratory Blank* -- A total of five laboratory blank samples were analyzed for the program. No compounds were detected in any of these samples at or above 1.0 ppbv per species or 0.10 ppmv TNMHC. These data indicate acceptable laboratory blank performance.
- *Blank Sample* -- Blank samples were obtained by placing the clean chamber on a clean surface (away from areas of known contamination on the test site). The chamber was operated as described and blank samples were collected prior to and after testing. Blank sample testing frequency was about 5 percent. The blank sample concentrations of compounds were acceptable. Only one compound, 1,2,4-trimethylbenzene at 2.6 ppbv, was detected. Method detection limit for this method was 1.0 ppbv per species and 0.13 ppmv for TNMHC. This results in a system blank test emission estimate of $<21 \mu\text{g}/\text{m}^2, \text{min}^{-1}$.
- *Replicate Analysis* -- Two canisters were analyzed in replicate (about 10 percent). Six-to-eight compounds were identified per sample and the relative percent difference (RPD) for these replicate analyses ranged from 4.8 to 15 (average of 9.8) for one and 0.0 to 8.9 (average of 3.7) for the other. These data represent acceptable precision as compared to a criteria of 30 percent RPD.
- *Replicate Sample* -- A replicate canister was collected immediately after collection of an initial canister sample during a measurement at one location. Replicate frequency was about 5 percent. The relative percent difference of the duplicate emission test per one location ranged from 14 to 23 for all six compounds detected (average of 19). These data indicate acceptable sampling and analytical precision as compared to acceptance criteria of 50 percent.
- *Chain-of-Custody* -- Sample labels and sample custody forms were completed and samples were executed as follows: canisters - avoid heat and light, package for shipping, ship priority mail, analysis within 30 days.
- *Laboratory Quality Control Data* -- Laboratory quality control data for canister samples are available upon request. Laboratory surrogate recovery data and matrix sample recovery data are included with sample results. Three matrix samples were analyzed and average recoveries for the TO-14 compounds were 85, 97, and 105 percent for an overall average recovery of 96 percent. These data indicate acceptable performance as compared to recovery criteria 80 to 120 percent.

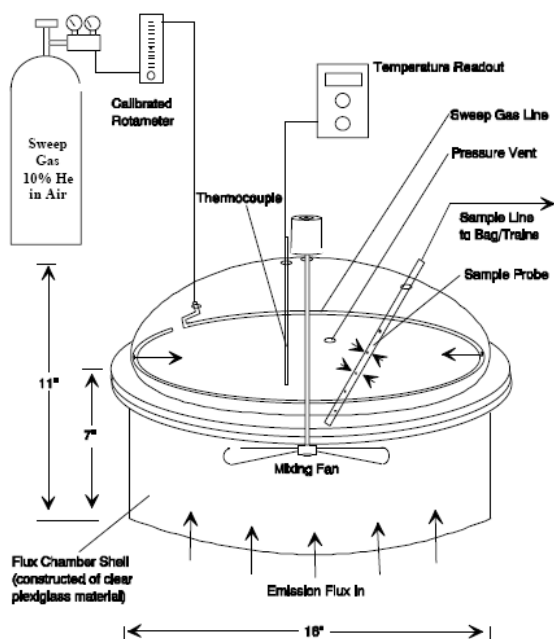


Figure 1 Emission Isolation Flux Chamber

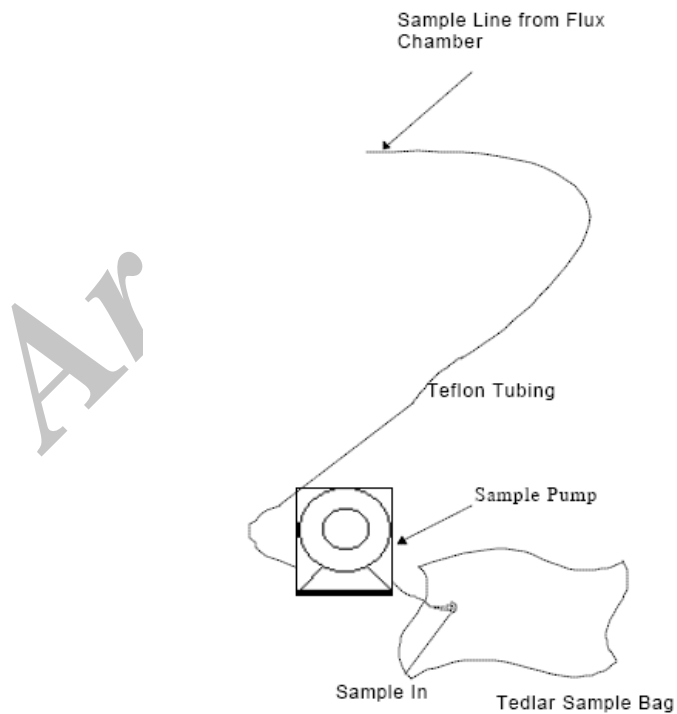


Figure 2 Integrated Gas Sampling Apparatus

RESULTS AND DISCUSSION

Emission rate data for TNMHC are summarized in Table 1 as well as percent control data. In addition to TNMHC, four species were selected and used to calculate percent control efficiency including benzene, toluene, xylenes, and ethylbenzene. Other species emission rate data were not summarized or used in this data presentation but are available upon request.

Emission rate data were calculated using measured data. Emission rate data are calculated by multiplying chamber concentration ($\mu\text{g}/\text{m}^3$) by sweep air flow rate (5.0 l/min), dividing by chamber surface area (0.13 m^2), and converting these data to the appropriate units resulting in emission rate data in $\mu\text{g}/\text{m}^2, \text{min}^{-1}$.

The standard test for foam evaluation, namely TNMHC emission measurement from soils contaminated with hydrocarbons, immediate application of the foam to the soil/waste, and controlled TNMHC emission rate measurement on the foam.

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