United States
Environmental Protection
Agency

Air and Energy Engineering
Research Laboratory
Research Triangle Park, NC 27711

Research and Development

EPA/600/S8-88/069 July 1988

EPA

Project Summary

Construction and Operation of a 10 CFM Sampling System with a 10:1 Dilution Ratio for Measuring Condensable Emissions

William J. Steele, Ashley D. Williamson, and Joseph D. McCain

This report describes a transportable sampling apparatus designed to sample incineration sources at municipal and hazardous waste disposal facilities,and to provide non-contaminated samples of condensable materials. The sample gas, at a flowrate of 10 cfm (283 lpm), passes through a modified Source Assessment Sampling System (SASS) cyclone and is then diluted with clean air at 100 cfm (2830 lpm) by a novel, perforated cone assembly. Rapid uniform dilution takes place through the vigorous mixing of the sample and clean air streams in the dilution chamber. The resultant gas, cooled to approximately atmospheric conditions, is passed through a mixing section that provides a residence time of approximately 3 sec. The resulting aerosol particles are collected on a Teflon-coated glass-fiber filter. These solids, along with those collected in the cyclone, are subsequently provided for chemical and biological assay analysis.

This Project Summary was developed by EPA's Air and Energy Engineering Research Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

The primary design objective of this apparatus was to provide (for bioassay) non-contaminated samples of condensable materials from stack discharges at municipal incinerators and hazardous waste disposal facilities. Two opposing design constraints were: (1) to provide sufficient quantities of particulate matter within a reasonable sampling time (i.e., < 1 day), and (2) to provide a portable instrument that could be operated at various sites. For microbial mutagenicity (Ames) assays, sufficient particulate to obtain 10-100 mg of extractable organic material is desirable. This resulted in the design of a 10 cfm (283 lpm) sampling system with a 10:1 dilution ratio.

System Description

The main flow paths within the dilution system are: 1) dilution air, 2) sample gas, 3) diluted gas, and 4) outlet gas. The dilution air is extracted from the ambient atmosphere and conditioned with a condenser system, High Efficiency Particulate Air (HEPA) filter, and a charcoal bed. A heater raises the dilution air temperature to 70°F (21°C) when necessary. An in-line orifice is used to measure the dilution air flowrate (nominally 100 cfm or 2830 lpm).

The sample gas is extracted from the stack through a 3/4-in. (1.9 cm) ID glass-lined probe. The probe introduces

the stack gas to a modified Source Assessment Sampling System (SASS) cyclone which has a D_{50} of 1.8 μm for a 10 cfm flowrate at about room temperature (75°F or 24°C). The probe and cyclone are heated to maintain the sample gas at the existing flue gas temperature.

The sample gas is diluted by the dilution air at a 10:1 ratio in the dilution cone. The sample gas is introduced at the throat of the cone, and the dilution air is forced through the perforations on the outer surface of the cone. The combined gas (called diluted gas) enters a dwell chamber where a residence time of approximately 3 sec allows for the formation of condensable emissions. The resulting particulate materials are then collected on a Teflon-coated glass-fiber filter.

An outlet transform below the filter directs the filtered gas to the exhaust pump. The flow of the outlet gas is measured by an orifice upstream of the pump.

The support assembly for the dilution system provides a cradle for supporting the dilution manifold and the associated probe. The cradle can be adjusted vertically to position the probe at the selected sampling port. The critical temperatures and pressures of the dilution system are regulated by the control and monitoring assembly.

System Assembly

The first step in assembling the system is to construct the dilution manifold inside the support structure. Three wooden cradles support the assembled dilution manifold; heavy-duty elastic cords hold the transform on the cradles. Once the manifold is supported, the outlet transform may be removed and the filter placed in the recessed surface of the filter flange. The cyclone may then be attached to the face of the diluter. The rear of the cyclone is supported with a clamp attached to a front rail of the support structure. A second clamp supports one end of the probe; this clamp is attached to a side rail for horizontal probe access or to a rail directly under the cyclone for vertical probe access.

The HEPA filter and charcoal bed used to condition the dilution air should be replaced prior to each test. During a run, the probe and cyclone should be kept as near to stack temperature as feasible. The cyclone should not be heated above 375°F (191°C) to avoid damaging the internal finish. Care should be used during leak tests and sampling to apply and release pressures and/or vacuums gradually to avoid rupturing the sample filter. At the completion of a run, the sample filter should be handled carefully (surgical gloves are suggested) and sealed in a glass or Teflon container to prevent external contamination

William J. Steele, Ashley D. Williamson, and Joseph D. McCain are with Southern Research Institute, Birmingham, AL 35255-5305.
***Sharon L. Nolen** is the EPA Project Officer (see below).*
The complete report, entitled "Construction and Operation of a 10 CFM Sampling System With a 10:1 Dilution Ratio for Measuring Condensable Emissions," (Order No. PB 88-198 551/AS; Cost: $12.95, subject to change) will be available only from:
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703-487-4650
The EPA Project Officer can be contacted at:
Air and Energy Engineering Research Laboratory
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

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EPA/600/S8-88/069