United States
Environmental Protection
Agency

Environmental Monitoring Systems
Laboratory
Research Triangle Park NC 27711

Research and Development

EPA/600/S4-85/079 Jan. 1986

EPA

Project Summary

Development of a Sampler for Particulate-Associated and Low Volatility Organic Pollutants in Residential Air

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Little information is currently available on the effects indoor air quality may have on public health. Since most of the population spends the majority of each day indoors, indoor air quality may be a more important component of the risk to which the public is subjected than is outdoor air quality. A recent trend towards energy-efficient building construction typically results in significant reductions in the indoor-outdoor air exchange rate. This trend, coupled with the increasing use of alternative heating sources in homes, results in a potential for concentrations of incomplete combustion products to achieve undesirable levels.

Current analytical techniques for these organic compounds require sampling of large volumes of air with a filter/sorbent combination. The use of available ambient, high-volume air samplers in occupied residences is not practicable due to the noise they emit and their very high flow rates. There is a need, therefore, to develop an air sampler suitable for in-house usage so that the quality of indoor air can be adequately assessed.

The full report describes the development of a sampler for particulate-associated and low-volatility organic pollutants in residential air. The performance of the sampler inlet, which is compatible with the proposed PM-10 regulations for particulate sampling, is documented under a variety of conditions of interest. The details of construction of the sampler and the resulting acoustic performance of the unit are described. While the unit described in the full report can perform the task it has been designed for, several design enhancements are recommended which would result in an improved residential sampler.

This Project Summary was developed by EPA's Environmental Monitoring Systems 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

Until recently, research and monitoring efforts have generally focused on assessing and improving the quality of air in the ambient (outdoor) environment. However, concern about the effects of indoor air quality on the public welfare has recently become more pronounced. Some reasons for this concern are the variety of pollutants that may arise from commercial products used indoors, the increase in woodburning as a heating source, and the energy conservation measure of reducing the air exchange rate in buildings. Some recent studies have shown that indoor pollutant levels contribute far more to total exposure than outdoor pollutant levels.

For many organic compounds of interest, methodology is not available to determine airborne pollutant levels in indoor environments. Because some of

these compounds pose a health risk at very low concentrations, there is the need to sample air at the highest practicable rate in order to collect sufficient material for analysis. This need has not yet been met satisfactorily. The sampling rate of existing systems does not provide adequate sample mass for detection at levels prevalent in indoor air, appropriate equipment is not available, or existing samplers (usually ambient types) are not suitable for indoor applications because of size, noise, etc.

Thus, in this project, an air sampler was developed for indoor use that can collect quantities of particulate-bound and vapor-phase organic compounds sufficient for detailed organic analysis and biological screening. The particulate and vapor phase samples of the semi-volatile compounds are collected by the sampler in a manner that minimizes artifact formation and background interferences that would be detrimental to subsequent analyses and bioassays. The inlet provided for the system is designed with a nominal 10 μm cut point consistent with proposed requirements for PM-10 ambient particulate samplers. The resulting sampler is quite transportable and relatively unobtrusive. Its low maintenance requirements and high reliability also render it suitable for air sampling in residential environments.

Procedure

Design requirements for the sampler were determined. These requirements include the ability to collect sufficient material for both chemical analyses and bioassays, the ability to collect both vapor and particulate phase organic compounds, flow rate sufficiently low to perturb the indoor environment only minimally, high collection efficiency and minimal background interferences, noise level low enough to be acceptable in the home, ease of transport, high reliability, and low maintenance.

To meet these requirements, the following criteria were set. An 8 cfm flow rate was chosen as most appropriate. This flow rate gives two-hour time resolution for most compounds of interest and provides sufficient sample for bioassay in eight hours. ANSI 51.2 noise standards (or a noise criterion of 35) were chosen. These standards allow sampler noise approximately equivalent to that in a quiet conference room or bedroom. A filter/sorbent sampling module employing a quartz fiber filter and a sorbent bed of polyurethane foam (PUF) and/or XAD-2 resin were incorporated. Additionally, a removable PM-10 inlet was incorporated.

The starting point for the sampler development was the existing EPA PUF sampler currently manufactured by General Metal Works. This sampler was then modified to meet the criteria above. A PM-10 inlet was separately designed and tested.

Results

Results obtained during building and testing the prototype air sampler can be summarized as follows:

- PM-10 Inlet—The inlet for aerosol particles achieves a cut point of 10 μm aerodynamic diameter and is reasonably insensitive to small variations in the sampling flow rate. Carryover of large particles and particle bounce have been essentially eliminated in the inlet.
- Sorbent Bed—The sampler is capable of collecting adequate samples on the sorbent bed for limited time resolution of the species of interest at the design flow rate.
- Acoustics—A noise criterion (NC) of NC = 45 was achieved versus the stringent design goal of NC = 35. A few minor design changes to eliminate a spurious whistle and increase the baffling in the motor cooling chamber should permit reaching NC = 37.
- Motor Cooling—The motor cooling air must be carefully separated from the hot vacuum exhaust air in order to prevent air recirculation and subsequent overheating of the motor.

An air sampling system suitable for use in residential environments has been developed and evaluated. The flow rate achievable with this device is adequate for at least eight hour time resolution of typical concentrations of most semi-volatile organics of interest in either the particulate or the vapor phase. The system is quiet, transportable, and relatively unobtrusive.

Overall, the prototype has proven the basic design to be effective. The design goals can be met with minor redesign, and limited additional testing would be required to confirm the effectiveness of the modifications.

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The complete report, entitled "Development of a Sampler for Particulate-Associated and Low Volatility Organic Pollutants in Residential Air," (Order No. PB 86-131 950/AS; Cost: $9.95, subject to change) will be available only from:
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EPA/600/S4-85/079