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Project Summary

Compendium of Methods for the Determination of Air Pollutants in Indoor Air

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The objective of this project was to develop a Compendium of Methods for the Determination of Air Pollutants in Indoor Air. The Compendium has been prepared to provide regional, state and local environmental regulatory agencies with step-by-step sampling and analysis procedures for the determination of selected pollutants in indoor air. This guide assists those persons responsible for sampling and analysis of indoor pollutants.

Determination of pollutants in indoor air is a complex task, primarily because of the wide variety of compounds of interest and the lack of standardized sampling and analysis procedures. The Compendium has been prepared to provide a standardized format for such analytical procedures. A core set of ten chapters, with each chapter containing one or more methods, are presented in the current document. The current methods may be modified from time to time as advancements are made.

The Compendium covers a variety of active and passive sampling procedures, as well as several analytical techniques both on and off site. Consequently, many indoor pollutants can be sampled and analyzed by several techniques, often with different interferences and detection limitations. This allows the user flexibility in selecting procedures to complement his or her background and laboratory capability.

This Project Summary was developed by EPA's Atmospheric Research and Exposure Assessment 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

In recent years, greatly increased attention has been focused on the quality of indoor air. Most people spend a major portion of their time indoors, in living areas, offices or other workplaces, stores, restaurants, waiting rooms, public buildings, public or private transportation vehicles, etc. Obviously, then, exposure to indoor air pollutants can constitute an important fraction of a person's total exposure to air pollution.

In addition to penetration of outdoor pollutants into the indoor environment, indoor air pollutants may originate from many sources, including various indoor activities, use of many different types of appliances, tools, and substances, and outgassing of various types of construction and decoration materials. Indoor air pollutants include a wide variety of compounds and typically occur in concentrations and mixtures that generally vary greatly over time and from one area to another and are often episodic in nature. Consequently, human exposures are difficult to assess for both

individuals and groups. This difficulty is further complicated by restrictions in the sampling and measurement techniques that can be used indoors due to limitations in the physical size, noise, air flow rates, power consumption, installation, etc. of the apparatus used. Not surprisingly, there has been a lack of standardized procedures for sampling and analysis of indoor air pollutants, particularly for very low concentrations of indoor air contaminants.

To date, little guidance has been available to state and local agencies or to other organizations concerned with the determination of indoor air pollutants. As a result, state and local agencies and others responding to indoor air pollution problems have had to develop their own monitoring strategies, including selection of monitoring methods, sampling plan design, and specific procedures for sampling, analysis, logistics, calibration, and quality control. For the most part, these procedures were based on professional judgments rather than adherence to any documented uniform guidelines. Many governmental agencies and professional or research organizations have developed indoor air monitoring methods and procedures, mostly to respond to specialized needs. But these methods and procedures have generally been neither standardized nor readily available to other agencies involved with indoor air monitoring.

The objective of this project was to develop and standardize such methods and publish them in a document entitled "Compendium of Methods for the Determination of Air Pollutants in Indoor Air."

Structure of Compendium

Over the last year, the Atmospheric Research and Exposure Assessment Laboratory (AREAL), Quality Assurance Division (QAD), of the U.S. Environmental Protection Agency (USEPA) has funded Engineering-Science (ES) for research and development of the "Compendium of Methods for the Determination of Air Pollutants in Indoor Air" under Contract 68-02-4398, Work Assignment #32. This Compendium has been prepared to provide regional, state, and local environmental regulatory agencies, as well as other interested parties, with specific guidance on the determination of selected air pollutants in indoor air. The ten chapters of the Compendium cover those contaminants (as well as ventilation rate) that are considered to be of primary interest in indoor air monitoring efforts. These ten chapters address:

- Volatile organic compounds (VOCs)
- Nicotine
- Carbon monoxide (CO) and carbon dioxide (CO_2)
- Air exchange rate
- Nitrogen dioxide (NO_2)
- Formaldehyde (CH_2O)
- Benzo(a)pyrene and other polynuclear aromatic hydrocarbons
- Acid gases and aerosols (NO_x, SO_x, and NH_3)
- Particulate matter
- Pesticides

Each chapter contains one or more methods for measuring the parameter, including sampling and/or analysis techniques, calibration, quality assurance, and other pertinent topics. These methods have been compiled from the best elements of methods developed or used by various research or monitoring organizations. They are presented in a standardized format, and each has been extensively reviewed by several technical experts having expertise in the methodology used. Nearly all the procedures have some flexibility, however, and it is the user's responsibility to prepare certain standard operating procedures (SOPs) to be employed in their particular laboratory. Each procedure indicates those operations for which SOPs are required. As advancements are made in the methodology, current methods for other contaminants may be added as such methods become available. Each method has been identified with a revision date so that future modifications or updates to the methods can be identified.

Table 1 lists the procedures contained in the Compendium, and Table 2 presents a partial listing of indoor pollutants which can be determined using those procedures. Many of the procedures may be used to determine other toxic organics not indicated in Table 2. The user must be cautioned to evaluate the applicability of the method for that specific toxic organic analyte before use.

Table 1. List of Methods in the Compendium

Method Number	Description	Types of Compounds Determined
IP-1A IP-1B	Stainless Steel Canister Solid Adsorbent Tubes	Volatile organic compounds (VOCs) (e.g., aromatic hydrocarbons, chlorinated hydrocarbons) having boiling points in the range of 80° to 200°C
IP-2A	XAD-4 Sorbent Tube	Nicotine (gaseous and particulate)
IP-2B	Treated Filter Cassette	
IP-3A IP-3B IP-3C	Nondispersive Infrared (NDIR) Gas Filter Correlation (GFC) Electrochemical Oxidation	Carbon monoxide and/or carbon dioxide
IP-4A IP-4B	Perfluorocarbon Tracer (PTF) Tracer Gas	Air exchange rate
IP-5A IP-5B IP-5C	Continuous Luminox Monitor Palmes Diffusion Tube Passive Sampling Device	Nitrogen oxides
IP-6A IP-6B IP-6C	Solid Adsorbent Cartridge Continuous Colorimetric Analyzer Passive Sampling Device	Formaldehyde (CH_2O) and other aldehydes/ketones
IP-7	Medium Volume PUF/XAD-2 Sampler	Polynuclear aromatic hydrocarbons
IP-8	Low Volume PUF Sampler followed by GC/ECD Detection	Pesticides (e.g., Organochlorine, Organophosphorus, Urea, Pyrethrin, Carbamate, and Triazine)
IP-9	Annular Denuder System	Acid Gases/Aerosols/Particles (e.g., nitrates, sulfates, and ammonia)
IP-10A IP-10B	Size-Specific Impaction Continuous Particulate Monitor	Particulate Matter

Table 2. List of Compounds of Primary Interest

Volatile Organic Compounds – Methods IP-1A, IP-1B

Freon 12 (Dichlorodifluoromethane)
Methyl chloride (Chloromethane)
Freon 114 (1, 2 - Dichloro-1,1,2,2- tetrafluoroethane)
Vinyl Chloride (Chloroethylene)
Methyl bromide (Bromomethane)
Ethyl chloride (Chloroethane)
Freon 11 (Trichlorofluoromethane)
Vinylidene chloride (1,2-Dichloroethane)
Dichloromethane (Methylene chloride)
Freon 113 (1,1,2-Trichloro-1,2 2-trifluoroethane)
Tribromomethane
cis-1,2-Dichloroethylene
Chloroform (Trichloromethane)
1,2-Dichloroethane (Ethylene dichloride)
Methyl chloroform (1,1,1-Trichloroethane)
Benzene (Cyclohexatriene)
Carbon tetrachloride (Tetrachloromethane)
1,2-Dichloropropane (Propylene dichloride)
Trichloroethylene (Trichloroethane)
cis-1,3-Dichloropropene
1,2 -Dichloropropane
1,3-Dichloropropane
1,2,3-Trichloropropane
1-Bromo-3-chloropropane
3-Chloro-1-propene
1,2-Dibromopropane
2-Chlorobutane
1,3-Dichlorobutane
1,4- Dichlorobutane
Dichloropropylene
1,1,2-Trichloroethane (Vinyl trichloride)
1,1,2-Trichloroethane
Trichloroethene
2-Chloroethoxyethene
1,1,1,2-tetrachloroethane
1,1,2,2-tetrachloroethane
Toluene (Methyl benzene)
1,2-Dibromomethane (Ethylene dibromide)
Tetrachloroethylene (perchloroethylene)
Chlorobenzene (Phenyl chloride)
Ethylbenzene
m-Xylene (1,3-Dimethlbenzene)
p-Xylene (1,4-Dimethylbenzene)
Styrene (Vinyl benzene)
1,1,2,2-Tetrachloroethane
0-Xylene (1,2-Dimethylbenzene)
4-Ethyltoluene
1,3,5-Trimethylbenzene (Mesitylene)
1,2,4-Trimethylbenzene (Pseudocumene)
m-Dichlorobenzene (1,3-Dichlorobenzene)
Benzyl chloride (-Chlorotoluene)
o-Dichlorobenzene (1,2- Dichlorobenzene)
p-Dichlorobenzene(1,4- Dichlorobenzene)
1,2,4-Trichlorobenzene
Hexachlorobutadiene (1,1,2,3,4,4-Hexachloro-1,3-butadiene)
(1-Methylethyl) Benzene
Butylbenzene
1-Methyl-4-(1-Methylethyl) Benzene
Bromobenzene
1-Ethyl-4-chlorobenzene
Bromochloromethane
Bromotrichloromethane
1-Chloropropane
2-Chloropropane
2,3-Dichlorobutane
1,4-Dichloro-2-Butane (cis)
3,4-Dichloro-1-Butane
Tetrahydrofuran
1,4- Dioxane
1-Chloro-2,3-Epoxypropane
Benzaldehyde
Benzonitrile
Pentachloroethane
Bromoethane
1-Phenylethanone
1,1-Dichloroethane (Ethylidene dichloride)

Inorganics – Methods IP-3A, IP-3B, IP-3C, IP-5A, IP-5B, IP-5C, IP-9, IP-10A, IP-10B

Ammonia (Ammonium)
Nitrogen dioxide
Nitric acid
Nitrous acid
Sulfuric acid
Sulfite
Sulfur dioxide
Carbon monoxide
Carbon dioxide
Particulate matter

Polynuclear Aromatic Hydrocarbons (PAHs) – Method IP-7

Acenaphthene
Acenaphthylene
Anthracene
Benzo(a)anthracene
Benzo(a)pyrene
Benzo(b)fluoranthene
Benzo(e)pyrene
Benzo(g,h,i)perylene
Benzo(k)fluoranthene
Chrysene
Dibenzo(a,h)anthracene
Fluoranthene
Fluorene
Indeno(1,2,3-cd)pyrene
Naphthalene
Phenanthrene
Pyrene

Table 2. List of Compounds of Primary Interest (Continued)

Pesticides – Method IP-8

Organochlorine

Aldrin
p,p,-DDT
p,p,-DDE
Dieldrin
Dicofol
2,4,5-Trichlorophenol
Pentachlorophenol
BHC (α- and β - Hexachlorocyclohexanes)
Captan
Chlordane, technical
Chlorothalonil
2,4,-D esters

Organophosphorus

Chlorpyrifos
Diazinon
Dichlorvos (DDVP)
Ethyl parathion
Malathion
Methyl parathion
Ronnel

Carbamates

Propoxur
Carbofuran
Bendicarb
Mexacarbate
Carbaryl

Triazine

Simazine
Atrazine
Propazine

Organochlorine

Methoxychlor
Mirex
trans-Nonachlor
Oxychlordane
Pentachlorobenzene
Folpet
Heptachlor
Heptachlor epoxide
Hexachlorobenzene
Lindane (γ-BHC)

Ureas

Monuron
Diuron
Liuron
Terbuthiuro
Fluometuron
Chlortoluron

Pyrethrin

Pyrethrin I
Pyrethrin II
Allethrin
d-trans-Allethrin
Dicocrotophos
Resmethrin
Fenvalerate

Other

o- phenylphenol

Environmental Tobacco Smoke (ETS) – Methods IP-2A, IP-2B

Nicotine (particle and gaseous)

Aldehydes and Ketones – Methods IP-6A, IP-6B, IP-6C

Formaldehyde
Acrolein
Propionaldehyde
Butyraldehyde
Isovaleraldehyde
o-Tolualdehyde
p-Tolualdehyde
2,5-Dimethylbenzaldehyde

Acetaldehyde
Acetone
Crotonaldehyde
Benzaldehyde
Valeraldehyde
m-Tolualdehyde
Hexanaldehyde

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The complete report, entitled "Compendium of Methods for the Determination of Air Pollutants in Indoor Air," (Order No. PB90-200 288/AS; Cost: $74.00, subject to change) will be available only from:

National Technical Information Service
5285 Port Royal Road
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Telephone: 703-487-4650

The EPA Project Officers can be contacted at:

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