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Project Summary

Indoor Air Pollutants from Household Product Sources

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A collection of GC/MS data obtained during the analysis of 1,159 household products for six common chlorocarbon solvents has been reanalyzed for the presence and concentration of 25 additional chemicals. Using computerized GC/MS software, 1,043 of the original GC/MS data files were recovered and analyzed for the presence of the additional chemicals. An efficient microcomputer-based data base system was developed and used to assemble, reduce, and view the analytical data.

Of the 25 additional chemicals, those found most frequently in the household products include acetone, 2-butanone, methylcyclohexane, toluene, ethylbenzene, *m*-xylene, and *o,p*-xylene. A total of 63.6% of the products analyzed in this study contained one or more of the 25 additional analytes at concentrations greater than or equal to 0.1% by weight. Five analytes, 1,1,2,2-tetrachloroethane, chlorobenzene, styrene, nonane, and *d*-limonene, were not found in any of the products in concentrations greater than or equal to 0.1% by weight.

The major accomplishment of this work is the completion of a large data base of semiquantitative information for 31 chemicals in the home environment. The quantitative information presented in the report is available on diskette in a spreadsheet format.

This Project Summary was developed by EPA's Environmental Monitoring Systems Laboratory, Las Vegas, NV, 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

Since most people spend a large amount of time indoors at either home or at work, in often insufficiently ventilated buildings, there is an increasing concern about the presence of toxic vapors in indoor air. To address this issue, the Office of Pesticides and Toxic Substances (OPTS) and the Office of Air and Radiation (OAR) of the U.S. Environmental Protection Agency (USEPA) have been working to define pollutants and their levels and sources in indoor air, particularly in residential settings. In addition, the Office of Solid Waste and Emergency Response (OSWER), under the authority of the Superfund Amendments and Reauthorization Act (SARA), is concerned with minimizing disposal of household products containing toxic substances.

In order to identify household products that may be sources of indoor air pollution and contribute to disposal problems, this study reviewed an analytical data base of 1,159 household products compiled by Midwest Research Institute (MRI) for a previous study to determine the presence of common solvents[a]. The objective of the original work was to quantify six chlorinated target analytes (methylene chloride, tetrachloroethylene, carbon tetrachloride, trichloroethylene, 1,1,1 trichloroethane, and 1,1,2-trichlorotrifluorethane) by purge and trap gas chromatography/mass spectrometry (GC/MS). Full mass spectra were collected at that time and archived for later

[a] Household Solvent Products: A "Shelf" Survey with Laboratory Analysis. Washington, DC: U.S. Environmental Protection Agency. EPA-OTS 560/5-87/006, 1987.

research. In the present study, computerized reduction of the archival GC/MS data was the method chosen to best estimate the concentration of 25 additional target analytes (See Table 1) in the samples. Supplementing the earlier work, this study provides data on the occurrence and estimated concentrations of those 25 additional chemicals in the household products.

Procedure

In the original study, 1,159 household products purchased from stores in six cities (Washington, DC; Denver, CO; Houston, TX; San Francisco, CA; Chicago, IL; and Miami, FL) were grouped into 65 product categories with each product given a sample code describing the sample, city of purchase, product category, product form, and sequential city/product number. The samples were analyzed by GC/MS at three laboratories: MRI, Envirodyne Engineers (St. Louis, MO), and Versar (Springfield, VA). The selection of the 25 target analytes in this study was based on the Total Exposure Assessment Methodology (TEAM) studies, analytes recommended by OPTS, and those cited in other USEPA programs. Of the 1,159 products, 922 were analyzed at MRI, 92 at Envirodyne, and 145 at Versar. Only 1,043 of the original total were available to be analyzed for this study.

Apparatus

The purge and trap methodology used in the original study complies with EPA Method 624, "Purgeables." Although no actual samples were analyzed by GC/MS in this study, the same methodology was used for the analysis of calibration standards for the 25 additional target analytes. MRI's MAT CH4-B, one of the GC/MS systems used in the original study, was optimized to replicate the chromatographic behavior observed for the original analyses, and was used to produce calibration curves for the 25 additional analytes. Reference standards of target analytes were obtained from Aldrich Chemical Co. Calibration standard solutions were prepared by accurate dilutions of the reference standards with high purity methanol.

System Calibration for Target Analytes

In order to obtain response factor information for the target analytes, two quantitation curves were generated according to EPA Method 624. Two quantitation ions were chosen for each analyte based upon its mass spectrum. For the low level calibration curve, the base peak was selected to provide sensitivity to the 0.1% w/w level. For the high level curve, an ion of lesser abundance was chosen so that saturation of the ion signal was not a factor at the highest concentration level. The estimated analyte concentrations were determined by comparing the electronically integrated analyte ion abundances of the quantitation ions with the internal standard integrated ion abundances, using response factors determined from the analysis of the calibration standards.

GC/MS Data Processing

A Finnigan/INCOS data system was used for data acquisition and handling for both the analysis of the standards for the 25 new target analytes as well as reprocessing of the original GC/MS data files. Analysts used Finnigan's Target Compound Analysis (TCA) software to identify the target analytes based upon relative retention times and to compare the observed mass spectrum with an authentic spectrum obtained by the analysis of a standard solution. Each identification made by the TCA software was verified manually and edited, if necessary, to produce a completed quantitation report for each household product. Completed quantitation reports were transferred as ASCII text to a Macintosh II computer and archived on floppy disks. The ASCII quantitation reports were imported into a 4th Dimension custom designed data base, where they were reviewed, listed, modified, searched, and sorted using the software. After the concentrations of each of the 25 analytes were computed, that information was merged with the original data base containing the analytical information for the original six analytes.

Results and Discussion

Calibration System

The precision of the response factors for both the low and high level calibration curves for the 25 target analytes was less than 35%, which meets the EPA Method 624 calibration criterion. As the calibration was used to *estimate* the analyte concentrations obtained from several different instruments and laboratories, this limit was deemed acceptable. It was assumed that the relative responses of the target analytes obtained during the calibration were representative of the responses obtained during the original analyses.

Accuracy

For GC/MS analyses, accuracy is normally determined by the analysis of performance audit or calibration check samples which have been fortified with the known levels of the target analyte. However, no calibration standards were analyzed for the 25 analytes at the time of the original GC/MS analyses. Further, 28.5% of the samples were analyzed on instruments other than MRI's CH-4B, and the GC/MS data were acquired more than 2 years before the calibration curves for the new target analytes were generated. As a result, no direct measure of the accuracy of the concentration values for the new target analytes is available. To estimate the accuracy of the data for the additional analytes, the response factors for the original six chlorocarbons across the five GC/MS systems were compared. Based on that comparison, it is estimated that, in the worst case, a reported concentration value for one of the 25 additional analytes may be in error by a factor in the range of 0.2 to 5.

In estimating the accuracy of the results for the additional analytes, three factors were considered. First, the method readily distinguishes the presence of an analyte at relatively high concentrations from an analyte present at trace levels. However, concentrations near the lower reporting limit of 0.1% could have been omitted incorrectly from the data base. Second, since over 70% of the samples were originally analyzed on MRI's CH-4B, which was used to obtain the calibration data for the 25 additional analytes, the reported concentrations are probably more accurate than the estimate based upon the variation of calibration between instruments. Third, the relative differences between concentrations reported for each set of data from a single instrument are approximately correct. Thus, even if there were a five-fold error in a subset of data, samples could be ranked from highest to lowest concentration.

Precision

Precision was determined by the repeated analysis of one of the standard solutions by the purge and trap method. Twenty-one of the target analytes met the 25% range percent criterion recommended in EPA Method 624[b].

Occurrence of Target Analytes

The chemicals found most frequently in the household products were acetone (315 products), 2-butanone (200 products), methylcyclohexane (150 products), toluene (488 products), ethylbenzene (157 products), *m*-xylene (101 products), and *o,p*-xylene (93 products). A total of 63.6% of the household products analyzed contained one or more of the analytes at concentrations of at least 0.1% by weight. Five analytes, 1,1,2,2-tetrachloroethane,

[b] Guidelines establishing test procedures for the analysis of pollutants: Method 624-Purgeables (40 CFR 136, Appendix A, pp. 432-446), 1988.

chlorobenzene, styrene, nonane, and *d*-limonene, were not found in any of the products at or greater than 0.1% by weight.

The complete analytical results for the determination of the concentrations of the 25 target analytes in the household products are presented in the appendices to the full report. Appendix A lists the household products, including the manufacturer or distributor; the physical form (i.e., liquid, aerosol, paste, etc.); the package type, size, and lot number if available. Appendix B includes the estimated concentration (weight percent) of each analyte in each product. Tables for each analyte showing products containing that analyte at levels greater than approximately 0.1% are in Appendix C, along with a table listing those 377 household products in which none of the analytes were observed above 0.1%.

Conclusions and Recommendations

An archived collection of GC/MS data was reanalyzed for the presence of 25 common volatile chemicals in over 1,000 household products. The reanalysis provided the concentration and frequency of occurrence for each chemical in each of 65 product categories. The newly generated information was integrated into a computerized data base and configured for ready access by researchers.

The major accomplishment of this work is the compilation of analytical information for 25 common chemicals found in over 1,000 household products and integration of that information with the analytical information for the original six analytes. The data base described in this report is available from USEPA on diskette in a spreadsheet format.

The data base will be useful in future research efforts to assess exposure to these chemicals in the home environment. It should allow exposure assessment researchers to: conduct studies on the determination of household sources of specific chemicals; assess the potential of specific products to generate harmful vapors; and, character of the major chemical components of the household product. Further, based on the success of this study, it is feasible that the archived GC/MS data can be revisited to characterize the remainder of the volatile chemicals present in the household products.

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Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

Table 1. *Indoor Air Pollutant Chemicals Used in the Household Product Survey*

Analyte	Formula	CAS registry number
Acetone	C_3H_6O	67-64-1
Benzene	C_6H_6	71-43-2
2-Butanone	C_4H_8O	78-93-3
Chlorobenzene	C_6H_5Cl	108-90-7
Chloroform	$CHCl_3$	67-66-3
Cyclohexane	C_6H_{12}	110-82-7
1,2-Dichloroethane	$C_2H_4Cl_2$	107-06-2
1,4-Dioxane	$C_4H_8O_2$	123-91-1
Ethylbenzene	C_8H_{10}	100-41-4
n-Hexane	C_6H_{14}	110-54-3
Limonene	$C_{10}H_{16}O$	5989-27-5
Methylcyclohexane	C_7H_{14}	108-87-2
Methylcyclopentane	C_6H_{12}	96-37-7
Methyl isobutyl ketone	$C_6H_{12}O$	108-10-1
n-Nonane	C_9H_{20}	111-84-2
n-Octane	C_8H_{18}	111-65-9
a-Pinene	$C_{10}H_{16}$	7785-70-8
Propylene oxide	C_2H_4O	75-56-9
Styrene	C_8H_8	100-42-5
1,1,2,2-Tetrachloroethane	$C_2H_2Cl_4$	79-34-5
Tetrahydrofuran	C_4H_8O	109-99-9
Toluene	C_7H_8	108-88-3
m-Xylene	C_8H_{10}	108-38-3
o-Xylene[1]	C_8H_{10}	95-47-6
p-Xylene[1]	C_8H_{10}	106-42-3

[1] *o*- and *p*-Xylene coelute under the analytical conditions originally used and are treated as one analyte.

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The complete report, entitled " Indoor Air Pollutants From Household Product Sources," (Order No. PB92-136837/AS; Cost: $26.00, subject to change) will be available only from:
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