

UC Berkeley

UC Berkeley Previously Published Works

Title

Time-resolved measurements of phthalates in a residence by thermal desorption aerosol gas chromatography (SV-TAG)

Permalink

<https://escholarship.org/uc/item/0pc1p3rp>

ISBN

9781713826514

Authors

Lunderberg, D
Kristensen, K
Liu, Y
et al.

Publication Date

2018

Peer reviewed

Time-resolved measurements of phthalates in a residence by thermal desorption aerosol gas chromatography (SV-TAG)

David Lunderberg¹, Kasper Kristensen², Yingjun Liu², Pawel K Misztal², Yilin Tian³, Caleb Arata¹, William W Nazaroff³, and Allen H Goldstein^{2,3,*}

¹ Department of Chemistry, University of California, Berkeley, CA, USA.

² Department of Environmental Science, Policy, and Management, University of California, Berkeley, CA, USA.

³ Department of Civil and Environmental Engineering, University of California, Berkeley, CA, USA.

* *Corresponding email: ahg@berkeley.edu*

SUMMARY

Semivolatile organic compounds (SVOCs) represent a diverse and dynamic class of chemicals found indoors with poorly understood temporal behavior. Past analytical work has incorporated time-averaged sampling procedures, limiting the scope of inquiries about SVOCs in indoor air. Thermal desorption aerosol gas chromatography (SV-TAG) is an established analytical technique for measuring SVOCs in the gas- and particle-phases with hourly time resolution. In this study, SV-TAG was used to measure the indoor distribution of SVOCs in an occupied California home over a two-month period. Data reveal dynamic and persistent ranges of individual chemicals and chemical classes, including phthalates. The effects of physical parameters and occupant behavior on airborne phthalate concentrations and other SVOCs of interest were explored. Phthalate levels were roughly five times higher indoors than outdoors. Occupant behavior had no clear effect on total phthalate emissions, which were dominated by the contents of the house and strongly modulated by temperature.

KEYWORDS

Indoor SVOCs; phase partitioning; SVOC emission sources; residential environment; phthalates

1 INTRODUCTION

Semivolatile organic compounds encompass a diverse set of compounds, including plasticizers, flame retardants, pesticides, and combustion byproducts. The sources, fate, and transport of these compounds are generally not well understood. Historically, and especially in field monitoring studies, analytical challenges have prevented the characterization of SVOCs in the particle and gas-phases with high temporal resolution. Most commonly, SVOCs have been sampled onto filters and sorptive cartridges for later offline analysis. The associated temporal resolution is often on the scale of days or weeks. The approach is well suited to broad surveys of occurrence and abundance, but not for analysis of the mechanistic factors influencing concentrations.

Thermal desorption aerosol gas chromatography (SV-TAG) has previously been used in outdoor atmospheric chemistry studies to detect a wide range of organic compounds in the gas- and particle-phases with extreme sensitivity and continuous operation over months. Hourly measurements of gas- and particle-phase can be acquired from high ppq to low ppt levels, contingent upon the analyte of interest (Isaacman *et al.*, 2014). The present work discusses the application of SV-TAG towards time-resolved indoor quantification of phthalates, many of which are known or suspected endocrine disruptors and which are commonly used as plasticizers. Endocrine disrupting chemicals represent a public health concern. Because people spend 90% of their time indoors where phthalate levels are elevated, it is critical to improve knowledge about exposure and intake of phthalates in indoor environments (Rudel and Perovich, 2009).

2 METHODS

The SV-TAG developed at UC Berkeley was deployed to a residence in Contra Costa, California in tandem with a proton-transfer-reaction time-of-flight mass spectrometer (PTR-ToF-MS), an aerodynamic particle sizer (APS), a scanning mobility particle sizer (SMPS), and gas phase measurements of CO₂, O₃, and NO_x. All instrumentation was contained in an external shed with direct sample lines connecting to the home. The SV-TAG sampled air from the home's living room through a stainless-steel inlet approximately two meters in length. Indoor gas plus particle measurements were acquired hourly. Indoor particle, outdoor particle, and outdoor gas plus particle measurements were acquired sequentially every four hours. More than 50 sensors acquired metadata throughout the house, including temperature, relative humidity, motion, appliance usage, and door/window position.

3 RESULTS AND DISCUSSION

More than 2,500 chromatograms spanning two months of monitoring were acquired by SV-TAG, each encompassing hundreds to thousands of peaks that represent individual chemicals. Characterization for the present study focuses on quantifying prominent phthalates and selected SVOCs of interest.

Time-resolved measurements of dimethyl phthalate, diethyl phthalate, dibutyl phthalate, bis(2-ethylhexyl) phthalate, benzyl butyl phthalate (DMP, DEP, DBP, DEHP, and BBzP, respectively) were quantified by external standards. The observed timeline is characterized by a relatively constant background modulated by a temperature driven diurnal cycle associated with wintertime home heating. Emissions were dominated by the contents of the house, not by occupant activities. Preliminary results suggest phthalate concentrations on the order of 200 ng/m³. Previous research conducted in 120 Massachusetts homes (Rudel *et al.* 2003) discovered median phthalate concentrations > 60 ng/m³ for DEP, DBP, DEHP, and diisobutyl phthalate (DiBP).

Phthalate behavior trends were characterized by three distinct periods relating to house occupancy. During monitoring, the house was regularly occupied for three weeks, varyingly occupied for five weeks, and unoccupied for one week; trends relating to occupancy were explored. It is expected that compounds with vapor pressures sensitive to the external environment would exhibit complex, dynamic behavior. The effects of temperature, humidity, and particle concentration on the phase-distribution and concentration of multiple phthalates and other compounds of interest were explored.

4 CONCLUSIONS

At this site, phthalates are continuously present indoors with small diurnal fluctuations. Airborne phthalate concentrations were largely controlled by temperature. Long-chain phthalates exhibited much stronger temperature dependence compared to short-chain phthalates, a consequence of their lower vapor pressure. Short-chain phthalates were primarily in the gas-phase in contrast with long-chain phthalates, which were more particle associated.

ACKNOWLEDGEMENTS

This work was supported by the Alfred P. Sloan Foundation Grant and a National Science Foundation Graduate Research Fellowship to D. Lunderberg under Grant No. DGE 1752814.

5 REFERENCES

- Isaacman G, Kreisberg NM, Yee LD, Worton DR, Chan AWH, Moss JA, Hering SV, Goldstein AH. 2014. *Atmospheric Measurement Techniques*, 7:4417-4429.
- Rudel RA, Camann DE, Spengler JD, Korn LR, Brody JG. 2003. *Environmental Science and Technology*, 37(20):4543-4553
- Rudel RA, Perovich LJ. 2009. *Atmospheric Environment*, 43(1):170-181