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Diffusion-controlled reference material for volatile organic compound emissions testing: Pilot inter-laboratory study

Cynthia Howard-Reed [a,*], Zhe Liu [b], Jennifer Benning [c], Steven Cox [b], Daniel Samarov [a], Dennis Leber [a], Alfred T. Hodgson [d], Stephany Mason [e], Doyun Won [f], John C. Little [b]

[a] National Institute of Standards and Technology, 100 Bureau Dr., Gaithersburg, MD 20899, USA
[b] Virginia Tech, 405 Durham Hall, Blacksburg, VA 24061, USA
[c] South Dakota School of Mines and Technology, 501 E Saint Joseph St., Rapid City, SD 57701, USA
[d] Berkeley Analytical Associates, LLC, 815 Harbour Way, Richmond, CA 94804, USA
[e] Air Quality Sciences, Inc., 2211 New Market Parkway, Marietta, GA 30067, USA
[f] National Research Council Canada, 1200 Montreal Rd., Ottawa, Ontario K1A 0R6, Canada

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ABSTRACT

To improve the reliability and accuracy of tests used to measure emissions of volatile organic compounds (VOCs) from samples of interior building products, the National Institute of Standards and Technology (NIST) and Virginia Tech (VT) have created a program to develop reference materials with independently predictable emission rates. A diffusive reference material and associated mechanistic model have been developed and are undergoing extensive evaluation. As part of this process, a pilot inter-laboratory study (ILS) was conducted with four laboratories using a polymer material loaded with toluene as the reference source. Results showed the prototype material to be a relatively stable, homogeneous source with consistent emissions both within and between production batches. A comparison of toluene emission rates determined by the laboratories showed relative standard deviations as low as 9%, which are significantly lower than inter-laboratory variations for most previous ILS exercises with VOC sources. At a sample time of 48 h, the mean measured toluene emission rate for all four laboratories was within 1% of the model predicted value. The success of this pilot ILS is a key step toward being able to provide a VOC reference material for independent validation of VOC emission tests conducted in small chambers.

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1. Introduction

The market for interior building products with low emission rates of volatile organic compounds (VOCs) continues to grow with an increased demand for products that are compliant with a range of acceptance criteria. The most common procedure used to determine compliance is to test representative product samples in environmental chambers according to standard methods. A typical chamber test involves placing a prepared specimen in an inert chamber operated at standard conditions of airflow rate, temperature and humidity that are selected to be representative of typical indoor conditions (e.g., an air change rate of 1.0 h^{-1}, temperature = 23 °C, relative humidity = 50%). Concentrations of VOCs of interest are measured in chamber exhaust air at specified times. Using a mass balance on the air within the chamber, and assuming quasi-steady state conditions, the specimen's emission rate in units of mass per area per time is then calculated. The measured emission rate is dependent on multiple factors affecting chamber operation, air sampling and analysis that vary among laboratories. To date, it has not been possible to independently verify the performance of these environmental chamber measurements. The primary method available to assess laboratory performance is via an inter-laboratory study. Such studies can be expensive, time-consuming, and lead to inconclusive results, especially because there is no way to identify which laboratory's results are correct.

The first extensive inter-laboratory studies for product emissions testing were conducted in the 1990s [1,2]. These early studies showed significant variation among laboratories with relative standard deviations of individual VOC emission rates often around

* Corresponding author. National Institute of Standards and Technology, MS 8633, Gaithersburg, MD 20899-8633, USA. Tel.: +1 301 975 8423; fax: +1 301 975 4409.
E-mail addresses: chreed@nist.gov (C. Howard-Reed), liuzhe@vt.edu (Z. Liu), jennifer.benning@gmail.com (J. Benning), stcox2@vt.edu (S. Cox), daniel.samarov@nist.gov (D. Samarov), dennis.leber@nist.gov (D. Leber), ahodgson@berkeleyanaltyical.com (A.T. Hodgson), smason@aqs.com (S. Mason), doyun.won@nrc-cnrc.gc.ca (D. Won), jcl@vt.edu (J.C. Little).

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