Developing ASTM Standards for Test Specimen Preparation and Measuring Emissions of Volatile and Semi-Volatile Organic Compounds (VOCs and SVOCs) from Spray Polyurethane Foam (SPF) Insulation Products

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ABSTRACT

This report will discuss the ongoing development of ASTM standard practices and test methods to measure potential chemical emissions from spray polyurethane foam (SPF) insulation designed for on-site application in buildings. The consensus standards are being developed to evaluate SPF products for their impact on indoor air quality after installation in order to establish re-occupancy times for residents and re-entry times for trade workers. ASTM D 7859-13 was developed for spraying, sampling, packaging, and test specimen preparation of SPF insulation samples for environmental chamber emissions testing. The prepared specimens are placed into micro-scale test chambers which are optimized to recover the emissions of semi-volatile organic compounds (SVOCs), e.g., flame retardant, and amine catalysts, since these compounds have been shown that they can adhere to the walls of conventional small-scale test chambers that are commonly used for product emission testing. The VOC and SVOC emissions are captured from the chambers onto stainless steel thermal desorption tubes containing the appropriate sorbents, then analyzed with thermal desorption and GC/MS. MDI is captured with a specialized micro-scale chamber to minimize sink effects. The measured values are reported as emission factors to estimate the mass emitted per unit time and surface area, which can be used to predict indoor air concentrations. The consensus standards are being developed by ASTM Committee D22 on Air Quality through Subcommittee D22.05 on Indoor Air.

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INTRODUCTION

The report will give an overview of a new ASTM standard practice and two proposed ASTM standards that can be used to measure the potential chemical emissions from spray polyurethane foam (SPF) insulation. The ACC Center for the Polyurethanes Industry (CPI) SPF Emissions Task Force is currently conducting research to support the development of ASTM standards to measure emissions of volatile organic compounds (VOCs) and semivolatile organic compounds (SVOCs) from spray polyurethane foam insulation products [1]. VOCs that could potentially be emitted from SPF insulation include organic blowing agents, solvents and aldehydes; SVOCs that could potentially be emitted from SPF insulation include amine catalysts, flame retardants and diisocyanates, usually, methylene diphenyl diisocyanate (MDI).

Building product emissions data can be used by regulators or for the qualification of voluntary label or certification programs. Emissions measurements from SPF insulation can be used by the product manufacturers to establish a safe re-entry time (the time elapsed after installation of SPF insulation in a building when it is deemed safe for applicators, helpers and other trade workers to enter the building and resume operations without the need for personal protective equipment) and re-occupancy time (the time elapsed after installation of SPF insulation in a building when it is deemed safe for building occupants or residents to resume normal building operations and activities).

Building products are routinely tested for their emissions of VOCs of concern. For insulation products such as batts and loose-fill insulation, representative samples typically are collected from their manufacturing locations and are laboratory tested for VOC emissions in small-scale environmental chambers at standardized indoor conditions following ASTM Guide D 5116 [2]. SPF insulation products are different in that they are formed in place at the building site by chemical reaction rather than produced in a factory setting. SPF insulation application procedures vary among products and the final products potentially are influenced by spray equipment parameters as well as environmental factors at the time of application. SPF insulation is usually applied on-site within the building envelop by trained technicians using specialized equipment. These characteristics present special challenges for the creation, collection, and testing of SPF insulation product samples. Furthermore, standardized procedures for measuring emissions of SVOCs in SPF insulation have not been established to address potential wall adhesion or sink effects during chamber testing.

SUMMARY

In order to ensure consistency of SPF insulation product testing, samples must be sprayed, sampled, packaged and prepared for testing in a standardized manner; therefore, ASTM Standard Practice, D 7859 was developed at ASTM Subcommittee D22.05 on Indoor Air [3]. This practice describes standardized procedures for the preparation, spraying, packaging, and shipping of fresh SPF insulation product samples to be tested for their emissions of volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs). These procedures are applicable to both closed-cell and open-cell SPF insulation products. It is beyond the scope of ASTM D7859 to address environmental chamber testing or the analytical methods that are required to measure SPF emissions; therefore, two new work items were created by the subcommittee, which resulted in the following ASTM draft standards:

WK40293, Standard Practice for Estimating Chemical Emissions from Spray Polyurethane Foam (SPF) Insulation using Micro-Scale Environmental Test Chambers [4], and

WK40292, Standard Test Method for Measuring Chemical Emissions from Spray Polyurethane Foam (SPF) Insulation Samples in Environmental Test Chambers with Thermal Desorption and Gas Chromatography / Mass Spectroscopy (TD-GC-MS) [5].

The ASTM draft standard for Work Item WK40293 describes the procedures to collect chemical emissions from SPF insulation samples using micro-scale environmental test chambers. This practice describes the use of micro-scale test chambers and operating conditions to minimize wall adhesion (sink effects) and maximize recovery of the SVOCs, which are captured onto sorbent tubes from the outlet of the micro-scale chamber. Thermal desorption tubes containing graphitized carbon and porous polymer adsorbent can be used to capture blowing agent, solvents, amine catalyst(s), flame retardant(s), etc. Sorbent tubes or cartridges containing silica gel treated with 2,4-dinitrophenylhydrazine (DNPH) can be used to capture aldehydes (e.g. formaldehyde, acetaldehyde, etc.) followed by analysis as described in ASTM D5197 [6]. MDI has been shown to adhere to the walls of the test chambers, which if unaccounted for, can significantly bias the measured emissions [7]. Therefore, a specialized micro-scale chamber with an internal glass fiber filter treated with derivitizing agent (e.g 1-(2-pyridyl)piperazine), is being developed specifically for capturing isocyanate emissions, such as MDI.

The ASTM draft standard for Work Item WK40292 describes the analytical methodology for measuring the chemical emissions of semivolatile and volatile organic compounds (SVOCs and VOCs) from spray polyurethane foam (SPF) insulation samples in environmental test chambers or alternatively, from a building to monitor indoor air concentrations. Specific compounds of interest may include blowing agents, amine catalysts, flame retardants, etc. After collecting the emissions onto the thermal desorption (TD) tubes, described above, the chemicals are thermally extracted from the TD tubes for analysis with gas chromatography / mass spectrometry (GC-MS). Reporting limits are typically in the range of 20 to 200 nanograms, depending on the compound.

Emissions samples are collected at various times during the chamber testing, usually within 4-hours to 28-days of placing the sample in the chamber. Each observed measurement is reported in mass of each compound per sorbent tube. Emission factors are used to specify the rate of emissions, usually expressed as $\mu g / m^2$ hr, which are calculated with the reported mass per tube, the sample's exposed surface area in the micro-scale chamber and the collection time on the sorbent tube. The concentration in a building at a given time after installation can be estimated using the product loading factor (amount of material applied per volume of the building) and the air exchange rate of the building, also referred to as the ventilation rate. Predicted concentrations are usually reported at a given time after installation in $\mu g/m^3$.

The re-entry time can be estimated by comparing the predicted indoor air concentrations at a given time with occupational exposure limits (OELs). The re-occupancy time can be estimated by comparing the predicted indoor air concentrations at a given time with chronic reference exposure limits (CRELs) or 1/100 OEL, if no CREL is available. If the predicted indoor air concentration of a given compound is greater than its reported odor threshold, some building occupants may notice odor associated with the compound, and the odor could be deemed objectionable by some occupants. The ventilation rate in a building can be increased to the point where the predicted indoor air concentration no longer exceeds a particular threshold (e.g. odor or exposure limit). This can then serve as the basis for a recommendation on a ventilation rate to keep airborne concentrations below a given threshold.

SPRAYING, PACKAGING AND PREPARATION OF SAMPLE SPECIMENS

Standards Development

ASTM D7859-13 was developed in order to standardize the procedures for the preparation, spraying, packaging, and shipping of fresh SPF insulation product samples to be tested for their emissions of volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs). These procedures are applicable to both closed-cell and open-cell SPF insulation products. Potential chemical emissions of interest include blowing agents, solvents, aldehydes, amine catalysts, diisocyanates, and flame retardants.

Three generic SPF insulation formulations were developed by the CPI SPF Ventilation Task Force concurrently with the emissions research. The generic formulations represent the following sample types:

- Open-cell, low density (1/2 pound) high pressure SPF,
- Closed-cell, medium density (2 pound) high pressure SPF,
- Kit formulation SPF, 2 components, low-pressure.

All three generic SPF formulations were sprayed on-site in a controlled spray booth according to CPI's specifications. These samples were used to evaluate holding times and sample preparation techniques for environmental chamber testing. The diisocyanate, blowing agent, amine catalysts, and flame retardant shown in Table 1 were used in the generic formulations to develop and evaluate the analytical and chamber test methods.

Table 1- Generic SPF Compounds used for Method Development

Target Compound	Acronym	Description
HFC-245fa	-	Blowing Agent
Tris-(1-chloro-2-propyl) phosphate	TCPP	Flame Retardant
Bis (2-Dimethylaminoethyl) ether	BDMAEE	Catalyst
Tetramethyliminobispropylamine	TMIBPA	Catalyst
N,N,N-Trimethylaminoethylethanolamine	TMAEEA	Catalyst
Pentamethyldiethylene triamine	PMDTA	Catalyst
Bis (dimethylaminopropyl) methylamine	DAPA	Catalyst
Methylene diphenyl diisocyanate	MDI	Isocyanate

Spraying Parameters

The spraying of SPF insulation products to produce the samples is performed by trained individuals using professional spraying equipment under controlled conditions. SPF insulation samples are sprayed in a spray booth or at a building application site using the equipment and application parameters that are specified by the SPF insulation product manufacturer. The practice defines the spray booth or room conditions (e.g. temperature and relative humidity). Alternatively, different environmental conditions may be used to mimic a particular field condition (e.g., cold weather formulations).

Samples are sprayed onto sheets of high density polyethylene (HDPE) as the substrate. For open-cell SPF insulation, the product is sprayed to a foam thickness greater than 10 cm (typically 10-11 cm), and for closed-cell SPF insulation, the product is sprayed to a foam thickness greater than 4 cm (typically 4-5 cm). If the foam thickness cannot be achieved using one lift or pass, an additional lift may be performed. All process parameters and spraying conditions must be documented along with the applicator’s name, spray equipment, date and time sample was sprayed, number of lifts, temperature, relative humidity and whether or not the surface skin of the sample will be trimmed in the field to align the SPF surface with wall studs or other structural elements.

Packaging and Transport

After one hour, each sample is wrapped with clean aluminum foil, and then placed into a layered polyethylene terephthalate (PET) bag that is sized accordingly to minimize the headspace over the sample. If equipped, the bag is sealed with a zipper seal, folded several times and sealed with packaging tape. The sample identification can be placed on the outside of the sample bag. The samples are placed into an insulated secondary container (e.g. recreational cooler) which is sealed to be as air tight as possible. Electronic data loggers can be placed inside the shipping container to monitor pressure, temperature and relative humidity during transport. After completing a chain-of-custody form, the sample is ready for shipment to the laboratory, usually with overnight service. The names of blowing agent(s), amine catalyst(s), flame retardant(s), and solvent(s), if any, in the SPF formulation should be provided to the laboratory in advance of testing. It is important to coordinate the arrival of the sample with the laboratory since environmental chamber testing must begin within 48-hours of spraying to avoid the loss of VOCs.

Preparation of Specimens

Upon receipt in the laboratory, the samples remain sealed in their storage bags at typical office conditions. Specimens must be prepared within 20 minutes for chamber testing once the bag has been opened. Specimen preparation procedures are defined for conventional small-scale chambers (ASTM D5116); however, micro-scale chambers are preferred to minimize the potential sink effects of the SVOCs. The conventional small-scale chambers (e.g. 30-60-L) are suitable for measuring emissions of VOCs including aldehydes, but SVOCs may adhere to the chamber walls, which could significantly bias the test results. SPF specimens are cut to size to tightly fit into a stainless steel box with an open top, exposing only the top portion of the SPF specimen to measure emissions from the top surface (area specific emissions). The surface skin of the specimen is usually left intact; however, it can be trimmed to simulate field conditions if specified by the sample submitter. The sample holder containing the prepared specimen is placed inside the chamber to commence testing. Specialized procedures are described for preparing samples for micro-scale chambers, which are described in more detail in ASTM WK40293.

MICRO-SCALE ENVIRONMENTAL CHAMBER TESTING

A draft ASTM practice, WK40293, was written to describe the procedures to collect chemical emissions from specimens of SPF insulation samples using a micro-scale environmental chamber apparatus. The practice allows for estimating emissions of SPF products for vapor-phase VOCs such as blowing agents, formaldehyde and other carbonyl compounds and SVOCs such as amine catalysts, flame retardants and methylene diphenyl diisocyanate (MDI). The emissions data from this practice can be used to assess the impact on indoor air quality when the SPF material is installed in residential or commercial buildings. Such data is useful in comparing product formulations or establishing re-entry or re-occupancy times after the product has been installed.

A micro-scale test chamber is an environmental test chamber ranging in volume from a few milliliters to about 150 mL and designed to operate at moderately elevated temperatures that is used to measure vapor-phase organic emissions from small specimens of solid materials and products. The micro-scale chamber is normally operated at ambient temperature, but can be operated at a moderately elevated temperature up to 60 °C to simulate warm temperatures in attics or wall cavities. Due to large loading factor (the ratio of the exposed test specimen area to the chamber volume), and air exchange rate, micro-scale chambers are better suited to measure emissions from SVOCs to minimize losses from wall adhesion. A specialized micro-scale chamber with an internal sampling device is also described for collecting emissions of MDI.

This draft practice can be used in conjunction with ASTM D7859-13 (spraying, preparation and packaging); however, SPF insulation samples collected from buildings can also be tested with this procedure (e.g. to evaluate odor issues). SPF insulation samples are cut with a stainless steel coring tool so that the specimen fits tightly into the chamber body. The sample thickness fills almost the entire chamber body with only a few millimeters between the sample and the micro-scale chamber lid. Spacers and/or shim rings may be used to tightly fit the sample into the chamber body. Clean nitrogen or air is supplied to a micro-scale chamber and passes over the exposed surface of the test specimen before reaching the exhaust point. The gas flow rate and temperature within the micro-scale chamber are controlled. As the gas passes over the test specimen, emitted compounds are swept away from the surface.

After the test specimen has equilibrated in the micro-scale chamber, a sampling device is connected to the outlet for collection of vapor-phase compounds exiting the chamber. Emission samples can be collected sequentially or with duplicate samples loaded into separate micro-scale chambers. Sampling should be repeated periodically during the duration of the test to monitor emissions versus time (e.g. 4-hrs, 12-hrs, 24-hrs, 48-hrs, 72-hrs, 7-days, 14-days, 21-days, 28-days).

GAS COLLECTION AND ANALYTICAL MEASURMENTS

Blowing Agents, Amine Catalysts, Flame Retardants and Solvents

Procedures to collect gas samples for the analysis of SPF target compounds are described in ASTM Draft Test Method WK40292 for analysis of VOCs and SVOCs using thermal desorption and gas chromatography / mass spectrometry (TD-GC/MS). TD-GC/MS is widely used to measure volatile organic compounds (VOCs) in environmental test chambers (e.g. California Specification 01350) and for monitoring ambient air (e.g. EPA TO-17) [10, 11]. However, TD-GC/MS is a novel approach to measure the potential SVOC emissions from SPF insulation. In addition to capturing VOCs, such as the blowing agent and solvents, the TD-GC/MS procedure has been optimized to capture emissions of amine catalysts and flame retardant. Thermal desorption tubes are typically collected from the micro-scale chamber at 50-mL/min for 20 to 100 minutes (1 to 5-L).

This test method will be used in conjunction with Standard Practice D7859-13 for Spraying, Sampling, Packaging, and Test Specimen Preparation of Spray Polyurethane Foam (SPF) Insulation Samples for Environmental Chamber Emissions Testing. The method is primarily intended for measuring chemical emissions from specimens in environmental test chambers or micro-scale chambers; however, it could also be used for field measurements – i.e. for monitoring emissions from SPF that has been applied in residential or commercial buildings. When used in conjunction with ASTM WK40293 using micro-scale test chambers, this test method will provide a standardized means of determining the levels of VOCs and SVOCs that are emitted from SPF, which can be used to determine the specific area emission rate for the material.

With this method, VOCs and SVOCs are actively sampled onto thermal desorption tubes packed with a specific combination of sorbents containing glass wool, graphitized carbon and porous polymer adsorbent. This involves direct sampling from the exhaust of micro-scale test chambers or pumped sampling from emission test chambers. Samples can be stored in sealed containers prior to analysis. GC-compatible organic compounds which are retained by the sorbent tube during vapor collection are released during a two-stage thermal desorption process and are identified and quantified by gas chromatography/mass spectrometry.

Selective ion monitoring, ion extraction or spectral de-convolution shall be used to quantify specific volatile organic compounds. Individual components of interest are quantified using authentic standards of that particular compound. Other compounds can be tentatively identified with the NIST Mass Spectral library; estimated concentrations can be determined using toluene as the surrogate standard reference material. Results are reported in nanograms (ng) per sample with reporting limits ranging from 20 to 200 ng. The estimated quantitation limits for compounds in th e generic SPF formulations are shown in Table 2, and the precision and recovery data are shown in Table 3 [7].

Table 2- Estimated Quantitation Limits with TD-GC/MS

Peak Number	Compound Name	MS Quantitation Ion	Estimated Quantitation Limit, ng
1	HFC-245fa	51	20
2	TMAEEA	58	200
3	BDMAEE	58	20
4	PMDTA	72	50
5	DAPA	58	100
6	TMIBPA	58	200
7	TCPP	99	50

Table 3- Precision and Recovery using TD-GC/MS

Compound	True Value, ng	Mean (n=4), ng	Recovery, %	RSD, %
HFC-245fa	706	634	89.7	10.9
TMAEEA	2179	1559	71.5	24.6
BDMAEE	1034	977	94.5	4.10
PMDTA	1114	1035	92.9	3.52
DAPA	1072	1031	96.2	3.38
TMIBPA	2397	1631	68.1	13.3
TCPP	996	922	92.6	2.94

MDI Emissions

Potential MDI emissions can be measured with a method similar to OSHA Method 47 or US EPA CTM-036, except a 58mm internal filter is used to capture emissions in the micro-scale chamber [8, 9]. Samples are collected by drawing a known volume of air through a glass fiber filter coated with 1-(2-pyridyl)piperazine (1-2PP) which is housed inside a specialized micro-scale chamber body. After collecting gas samples, the chamber walls can be wiped with a glass fiber filter coated with 1-2 PP moistened with acetone to account for potential wall adhesion. The filter samples are extracted with 90/10 (v/v) acetonitrile/dimethyl sulfoxide (ACN/DMSO) and analyzed by high performance liquid chromatography (HPLC) using an ultraviolet (UV) or fluorescence detector. Mass spectrometry (MS) or tandem mass spectrometry (MS/MS) detection can also be used for greater sensitivity. Samples can be collected from the chambers for several hours in order to achieve adequate detection limits. Results are typically reported as micrograms (µg) per sample.

Aldehyde Emissions

Formaldehyde and other carbonyl compounds are tested as described in ASTM Test Method D5197. This test method involves drawing air through a cartridge or sorbent tube containing silica gel coated with 2,4-dinitrophenylhydrazine (DNPH) reagent. Carbonyl compounds readily form stable derivatives with the DNPH reagent, which are analyzed for parent aldehydes and ketones utilizing high performance liquid chromatography (HPLC). Samples can be collected from the chambers for several hours in order to achieve adequate detection limits. Results are typically reported as µg per sample.

EVALUATION OF EMISSIONS DATA

Model to Estimate Building Concentrations

Emission factors are used to specify the rate of emissions and are usually expressed as $\mu g / m^2$ hr. The emission factors are calculated with the reported mass per tube, the sample's exposed surface area in the micro-scale chamber and the collection time on the sorbent tube. The concentration in a building at a given time after installation can be estimated using the product loading factor (amount of material applied per volume of the building) and the air exchange rate of the building, also referred to as the ventilation rate. Predicted concentrations are usually reported at a given time after installation in $\mu g/m^3$. The indoor concentration for each VOC or SVOC is calculated using a well-mixed, single zone mass balance model. Building sink effects are not accounted for, therefore, the model is assumed to be a predictor of worst case scenario of airborne concentrations in a building. It is recommended to compare the predicted concentrations against field data as validation of the model.

Establishing Re-entry Times, Re-occupancy Times and Ventilation Rates

The re-entry time is defined in the current draft of WK40293 as the time elapsed after installation of SPF insulation in a building when it is deemed safe for applicators, helpers and other trade workers to enter the building and resume operations without the need for personal protective equipment. The re-occupancy time is defined as the time elapsed after installation of SPF insulation in a building when it is deemed safe for building occupants or residents to resume normal building operations and activities. The re-entry time can be estimated by comparing the predicted indoor air concentrations at a given time with occupational exposure limits (OELs).

The recommended re-entry time is defined in the current draft of WK40293 as the point in time at which no compound exceeds its OEL, or more conservatively, 1/10 OEL. The re-occupancy time can be estimated by comparing the predicted indoor air concentrations at a given time with chronic reference exposure limits (CRELs), and the re-occupancy time should be the point in time at which no compound exceeds its CREL or 1/100 OEL, if no CREL is available [12]. CRELs for several substances are published by California Office of Environmental Health Hazard Assessment (CA OEHHA) [13].

If the predicted indoor air concentration of a given compound is greater than its reported odor threshold, some building occupants may notice odor associated with the compound, and the odor could be deemed objectionable by some occupants. The ventilation rate in a building can be increased to the point where the predicted indoor air concentration no longer exceeds a particular threshold (e.g. odor or exposure limit). This can then serve as the basis for a recommendation on a ventilation rate at that particular point in time to keep airborne concentrations below a given threshold.

STATUS OF ASTM WORK ITEMS

ASTM Standard Practice D7859-13

Standard Practice ASTM D7859-13 for Spraying, Sampling, Packaging, and Test Specimen Preparation of Spray Polyurethane Foam (SPF) Insulation for Testing of Emissions Using Environmental Chambers was successfully balloted and approved at ASTM. Minor editorial revisions were made after the main committee ballot; therefore the standard designation was published as D7859-13e1. This standard practice is available at http://www.astm.org/Standards/D7859.htm and in ASTM Annual Book of Standards Volume 11.07 on Air Quality. Two new work items, which are described below, will complement the new standard practice.

ASTM Work Item WK40293

ASTM Work Item WK40293, Draft Standard Practice for Estimating Chemical Emissions from Spray Polyurethane Foam (SPF) Insulation using Micro-Scale Environmental Test Chambers, was created in January 2013. A collaboration website is available for task group members to review the draft standard practice, which was posted for task group review in May 2013. The draft standard practice will be revised if necessary, and then balloted at Subcommittee D22.05 on Indoor Air in August 2013. The results of the ballot will be discussed during the subcommittee's semi-annual meeting in October. In the interim, the CPI SPF Emissions Task Force will continue to evaluate the practice and conduct research to further support the development of the standard. For example, research is underway to evaluate the carrier gas (dry air or nitrogen vs. humid air) and to evaluate prototype micro-scale chambers designed specifically for MDI emissions.

ASTM WK40292

ASTM Work Item WK40292, Draft Standard Test Method for Measuring Chemical Emissions from Spray Polyurethane Foam (SPF) Insulation Samples in Environmental Test Chambers with Thermal Desorption and Gas Chromatography / Mass Spectroscopy (TD-GC-MS), was created in January 2013. A collaboration website is available for task group members to review the draft standard practice, which was posted for task group review following the last D22.05 meeting in April 2013. The draft standard method will be revised if necessary, and then balloted at Subcommittee D22.05 on Indoor Air in August 2013. The results of the ballot will be discussed during the subcommittee's semi-annual meeting in October. In the interim, the CPI SPF Emissions Task Force will continue to evaluate the method and conduct research to further the development of the standard. For example research is currently underway to determine maximum sample volumes to optimize detection limits, evaluate internal standardization and to evaluate de-convolution software to optimize the analysis of chromatograms and mass spectra.

CONCLUSION

Standardized methods are urgently needed for spraying, packaging, specimen preparation, environmental chamber testing and analytical methods to evaluate SPF insulation products for their potential emissions of VOCs and SVOCs. The emissions data can be used to establish re-entry and re-occupancy times, to optimize ventilation rates to meet exposure or odor thresholds, and to evaluate new product formulations. A new standard practice, D7859-13 was developed at ASTM Subcommittee D22.05 on Indoor Air. This practice standardizes the spraying, sampling, packaging, and test specimen preparation of SPF insulation for testing of emissions using environmental chambers. The chamber testing and analytical determinations are being addressed with ASTM Work Items WK40292 (TD-GC/MS) and WK40293 (Micro-Scale Chambers). The proposed standards and D7859-13 will provide standardized procedures and methods for evaluating SPF insulation for emissions.

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BIOGRAPHY

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John is a Senior Scientist in the Environmental Analytics laboratory for Bayer MaterialScience LLC, located in Pittsburgh, PA. John is a graduate of West Liberty University with a Bachelor's degree in chemistry, and he is a graduate of Duquense University where he received his Master's degree in Environmental Science and Management. John is currently the chair of the Spray Polyurethane Foam Emissions Task Force at the Center for Polyurethanes Industry of the American Chemistry Council. He is also the chair of the Spray Polyurethane Foam Emissions Task Group at ASTM Subcommittee D22.05 on Indoor Air Quality.