Long Term Emission from Spray Polyurethane Foam Insulation

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Keywords: Amine Catalyst, Emission, Spray Polyurethane Foam Insulation

INTRODUCTION: The desire to build more energy efficient homes in the United States has lead to the expansion of the residential spray polyurethane foam (SPF) insulation industry. Annually, over 100,000 homes in the United States are constructed or retrofit using SPF insulation. SPF is mixed onsite from two sets of chemicals containing diisocyanates and amine catalysts. Upon application, the reacting chemicals form expanding polyurethane foam that fills cracks and gaps, effectively reducing infiltration and thermal conductivity of the building envelope. Application can be complicated because the curing reactions are impacted by spray pressure, diisocyanate-to-amine mixing ratio, nozzle temperature, and relative humidity. To date, non-isocyanate emissions from SPF have not been reported in the literature. Residential occupants re-entering SPF treated homes have complained about odor, severe asthma, and other respiratory symptoms. The severity of the health effects has in some cases caused homeowners to sell or abandon their homes (CPSC 2013). More information is needed on chemical emissions from SPS to better understand occupant exposures and their impacts on potential health effects. The causes of any health impacts are unknown and might be linked to misapplication of the product. The objective of this investigation is to identify and quantify the non-isocyanate emissions from SPF applications after curing.

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METHODS: Typically, spray foam is applied when wall temperatures are above 20 °C. Due to a lack of local spray foam installations when this project began in November of 2013, aged SPF was investigated.

This research investigated open cell, low density SPF that was applied to the National Institute of Standards and Technology (NIST) Net Zero Energy Residential Test Facility (NZERTF) in the summer of 2012. In January of 2014, three ~0.8 g samples were cored from overspray in the basement rafters of the NZERTF (Figure 1). Since the foam was in the basement, it is unlikely that the temperature of the foam ever exceeded 25 ˚C after application. The triplicate SPF samples were placed in micro-chambers at 40 ˚C with an airflow rate of 100 mL/min of ultra-high purity air humidified to 40 % at 25 ˚C. Emissions were captured on two types of sorption tubes. Tenax TA® sorption tubes were used to capture the amine catalysts, flame retardants, and other volatile organic compounds. The Tenax TA® sorption tubes collected a sample volume of 0.5 L to 1.5 L and were analysed using thermal desorption-GC/MS. Aldehydes were sampled with DNPH cartridges using 12 L to 90 L sample volumes. DNPH cartridges extracted derivatives were analysed using LC/UV.

Figure 1. Sampling of foam (left). Sample in micro chamber (right).

RESULTS: Despite aging over 1.5 years, the flame retardant tris (1-chloro-2-propyl) phosphate (TCPP) was emitted at measurable concentrations. Over a period of two weeks the average TCPP chamber concentration was 324 ± 96 µg /m^3 air (the number following the symbol ± is the numerical value of an expanded uncertainty U = k u_c, with U determined from a combination of the estimated standard deviation (u_c) and a coverage factor k = 2, with parameters assumed to be approximately normally distributed and the unknown value assumed to lie in the interval defined by U with a level of confidence of approximately 95 %). Figure 2 shows the TCPP concentrations normalized by the mass of SPF in each chamber. Due to geometry and air flow issues the measured chamber concentrations are not equivalent to expected indoor air concentrations. These results do show that when wall temperatures are elevated SPF flame retardants can be emitted into indoor air at time frames greater than 18 months after application. No amine catalysts were detected above the analytical equipment detection limits. Amines might be present below the detection limits, but at concentrations that are lower than TCPP.

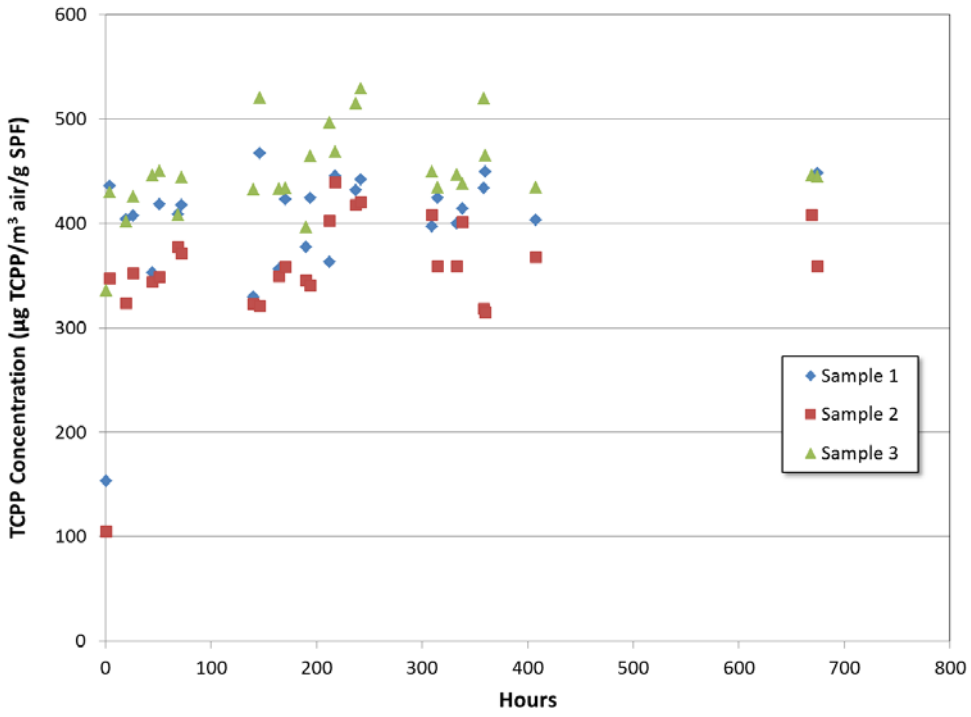

Figure 2: TCPP air concentrations in microchamber per gram of SPF sample.

A wide range of aldehydes (hexanal, heptanal, octanal, nononal) were detected from the sample. However, given that the samples were aged in a house for 1.5 years, it is impossible to determine from these measurements if the aldehydes were primary emissions or the desorption of compounds that had been emitted by other building products sorbed to the SPF. Note that air concentrations of these compounds have been measured inside the house on a monthly basis since mid-2013.

This research is still ongoing. It is expected that two more SPF samples will be tested prior Indoor Air 2014. Ideally, these samples will be tested within 24 hours of application according to ASTM D7859-13e1.

CONCLUSIONS: This paper is the first published data that examines emissions from SPF

after prolonged curing (1.5 years). TCPP was emitted at measurable levels while amine catalysts were not detected. These results suggest that occupant exposures 1.5 years after application may be associated with the flame retardant. Note that these conclusions would not necessarily apply to foam with different constituents or applied in a different manner.

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REFERENCES:

Consumer Products Safety Commission (2013). SaferProducts.Gov. Retrieved January 28, 2014, from http://www.saferproducts.gov/Search/Result.aspx?dm=0&q=Spray+foam+insulation&srt=0.

ASTM Standard D7859 (2013e1). "Standard Practice for Spraying, Sampling, Packaging, and Test Specimen Preparation of Spray Polyurethane Foam (SPF) Insulation for Testing of Emissions Using Environmental Chambers." ASTM International, West Conshohocken, PA, 2003, DOI: 10.1520/D7859-13, www.astm.org.