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SUMMARY

Spray polyurethane foam (SPF) insulation is widely used to improve building energy efficiency. Efforts are underway within ASTM subcommittee D22.05 to develop a standard method to characterize vapor phase emissions from SPF using micro-chamber systems. This study aims to examine whether chemical emission rates from SPF using two different size micro-chamber systems are comparable. Chemical concentrations in the chamber exhaust air were measured six times over a one-week period. The results indicated that emission rates of 1,4 dioxane from closed cell SPF in two different size micro-chamber systems were statistically different, while the emission rates of 1,2 dichloropropane were not statistically different, under the conditions of the proposed method.

PRACTICAL IMPLICATIONS

Reported chemical emission rates from SPF using micro-chambers should describe the chamber size along with emission rates.

KEYWORDS

Spray Polyurethane Foam (SPF), Indoor air quality, Micro-chambers, Emission rate

1 INTRODUCTION

Spray polyurethane foam (SPF) insulation improves building energy efficiency by reducing both conductive and convective heat losses through the building envelope. SPF is produced at the construction site by mixing two sets of chemicals, including methylene diphenyl diisocyanate, flame retardants, catalysts, blowing agents, and polyols. Different mixtures of the chemicals result in different products for different uses, for example open versus closed cell foam. Collaborative efforts are underway within ASTM subcommittee D22.05 to develop methods to characterize vapor phase emissions from SPF using micro-chamber systems (Poppendieck et al. 2016). One question in the development of this method is whether the emission rates from different size micro-chamber systems are comparable under the proposed method.

2 MATERIALS/METHODS

Emissions from both open and closed cell SPF were tested using two micro-chamber systems of different chamber size (Table 1). To ensure the chambers were operated at the same area specific flow rate, the flow rate of each chamber in the 48 mL and 116 mL system was set to 25 mL/min and 50 mL/min, respectively. For each type of SPF, five samples were tested in the 48 mL system simultaneously, while three were tested in the 116 mL system. Air samples were collected at 2 h, 24 h, 50 h, 76 h, 121 h, and 144 h, by sampling the chamber exhaust using sorbent tubes. Temperature was set to 35 ˚C for each chamber system and monitored by inserting a NIST traceable thermocouple into an unused chamber filled with water during the experiment period. Flow rates were measured using a NIST traceable bubble flow meter.

Concentrations of tris(1-chloro-2-propyl) phosphate (TCPP), bis (2-dimethylaminoethyl) ether (BDMAEE), 1,4 dioxane, and 1,2 dichloropropane were quantified using a thermal desorption/gas chromatogram-mass spectrometer (TD/GC-MS). The average emission specific rates (air concentration times volume of sampled air/sampling time/emission area) were calculated based on the measured concentrations.

Table 1. Experimental Conditions Tested. Surface areas are the projected areas. Data after ± represent the standard deviation.

Foam Type	Chamber Size	Chamber Volume (mL)	Foam Surface Area (cm^2)	Temperature (˚C)	Flow Rate (mL/min)
Open	Small	48	16	34.5 ± 0.2	24 ± 0.7
Open	Large	116	33	31.3 ± 0.05	48 ± 1.3
Closed	Small	48	16	34.5 ± 0.2	24 ± 0.8
Closed	Large	116	33	35.4 ± 0.3	46 ± 2.6

3 RESULTS AND DISCUSSION

Data for open cell foam were not used as the large chamber did not meet the temperature requirements (35 ˚C ± 1 ˚C) of the proposed method (Table 1). TCPP data from the closed cell foam were also not used, as they did not meet quality assurance criteria. For closed cell SPF, the impact of the chamber size was chemical dependent (Figure 1). For 1,2-dichloropropane, the average emission rates were not statistically different, while the average emission rates of 1,4 dioxane were statistically different at all sampling times (MANOVA, $p<0.05$). The higher boiling point of 1,4 dioxane (117 ˚C) relative to 1,2 dichloropropane (83 ˚C) may explain the differing results. For 1,4 dioxane, the difference between the average emission rates from the two chambers was larger for the first sampling period than for the later period, which may reflect that the mass transfer coefficient over the foam surface influenced the emission rate more at the early stage of the emission period more than the later stage.

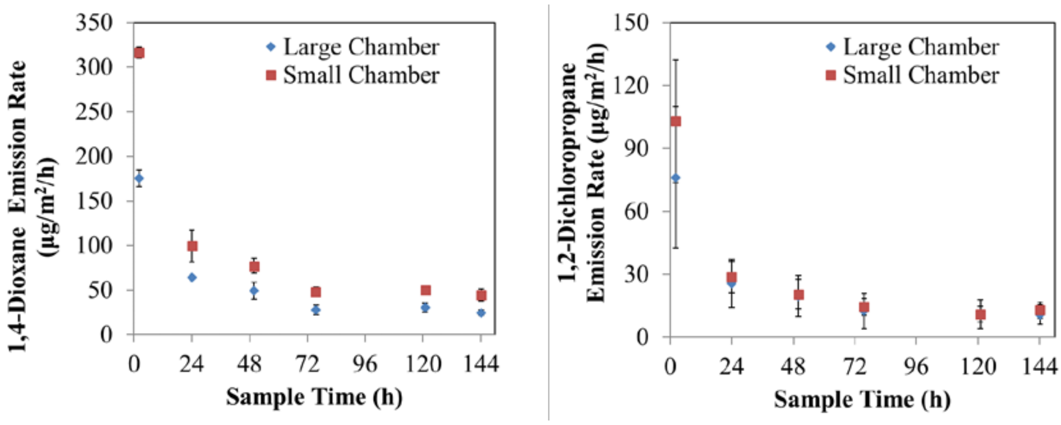

Figure 1. Emission rates from 1,4 dioxane and 1,2 dichloropropane from closed cell foam.

5 CONCLUSIONS

This study indicates that comparison of chemical emission rates from SPF using micro-chamber with different sizes should be done with caution and that the chamber size should be reported along with emission rates.

6 REFERENCES

Poppendieck, D.; M. Schlegel; A. Connor; A. Blickley. "Flame Retardant Emissions from Spray Polyurethane Foam Insulation." Accepted for publication. ASTM Selected Technical Papers. 2016.