

# Measuring the emissivity of semi-volatile organic compounds from articles of commerce

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## Background

The National Academies of Sciences has called for better characterization of potential human exposure to thousands of chemicals from proximate sources such as consumer products and articles of commerce.<sup>1</sup> Existing public databases of chemicals in the indoor environment are limited primarily to consumer products for which material safety data sheets of declared chemicals are available.<sup>2</sup> New, non-targeted analytical chemistry methods are gradually identifying chemicals in articles such as flooring and upholstery.<sup>3</sup> However, the presence of a chemical in an object does not equate with exposure. The emissivity of a chemical from a specific formulation is needed to predict human exposure via multiple routes, including inhalation and dermal. New data and models are needed to characterize the ability of a chemical to emit from its source. The EPA has selected a pilot set of 14 environmental compounds (i.e., flame retardants, plasticizers, and perfluorinated chemicals) to undergo emission rate from solvent extraction of polyurethane foam (PUF) and XAD-2 with gas chromatography and liquid chromatography analysis for 19 articles of commerce (i.e., carpet, clothing), using short-term (30 min) and long-term (10 hr) chamber studies at 37-43° C. The short-term studies yielded a combination of emission rates for 4 compounds in 11 articles while the long-term studies yielded a combination of emissions rates for 11 compounds in 17 articles. Perfluorooctanoic acid (PFOA), which has been eliminated in U.S. products since 2015<sup>4</sup>, was detected in 7 articles overall. These proof of concept quantitative data on chemical emissions from articles of commerce, allow both more comprehensive exposure assessments for the specific chemicals and articles under study as well as provide the basis for developing new mathematical models for predicting chemical emissivity from formulations. ***This abstract does not necessarily reflect U.S. EPA policy.***

## Objectives

- Determine a short list of compounds to undergo a pilot study that both tests for and measures their emission rates from various near-field articles of commerce
- Select a set of representative near-field articles of commerce to undergo both short- and long-term emission studies
- Measure the emission rates of multiple chemical:article pairs, thus providing proof-of concept data that enhances the ability both measure and model chemical article emissions.

## Methods

- Pilot Chemicals - Selection set was based on several considerations but were not limited to:
  - if they were chemicals of interest based on previous surveys.<sup>5,6</sup>
  - if they were readily available in stock (had at least 20mg available).
  - if analytical methods were available to measure the compounds.
- Article Selections - Representative fabrics were selected and then actual articles were purchased at random with no particular consideration for colors, brands, or marketplace.
- Measurement Methods - Studies were carried out with special considerations for volatile and semi-volatile organic compounds, for which there are existing and newly developed methods.

## Results & Discussion

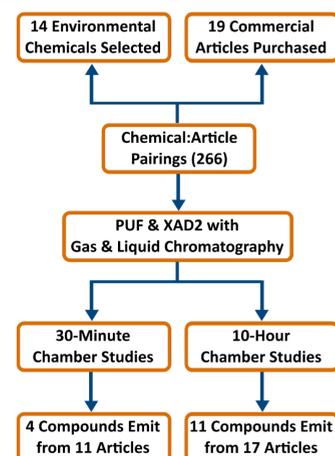


Figure 1. Process map for article emissions.

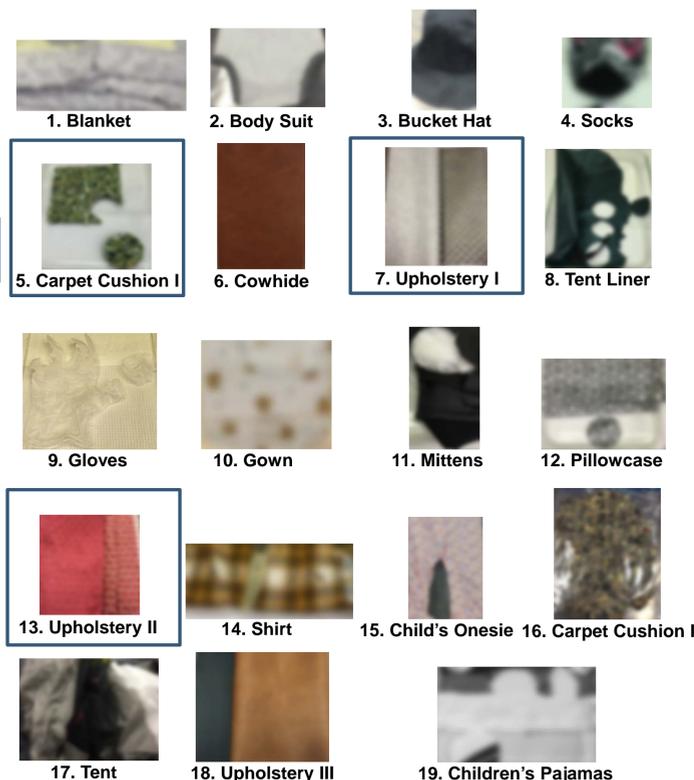


Figure 2. Images of 19 articles that were selected for emissions testing. Blue boxes indicate item was screened for chemical content.<sup>3</sup>

Table 1. Summary of compounds that were found in each article of commerce.

Product	Chemicals Emitting (30 min)	Chemicals Emitting (10 hr)
1	N/A	PCP, PFOA, TCEP, TDCPP, TDP
2	N/A	TCEP, BBP, TDP
3	TDP	TCEP, TDP
4	TDP	PCP, PFOA, TCEP, TDP
5	TCIPP	BPA, PCP, TCEP, TCIPP, TDCPP, TPP, TDP
6	BPA, TDP	N/A
7	BPA, TCIPP	BPA, DINP, PFOA, TCEP, TPP, TDP
8	N/A	TDP
9	PCP, TDP	PCP, TCEP, TDP
10	N/A	BPA, DINP, TCEP, TDCPP, DBP, TDP
11	BPA, TDP	BPA, PFOA, TCEP, TPP, TDP
12	PCP	BPA, PCP, TCEP, DBP, TDP
13	N/A	BPA, TCEP, TCIPP, TDCPP, TDP
14	BPA	PFOA, TCEP, TCIPP, TDCPP, TDP
15	N/A	BPA, DINP, TCEP, TDCPP, DBP, TDP
16	N/A	TCEP, TCIPP, TDCPP, TPP, TDP
17	N/A	PFOA, TCEP, TPP, TDP
18	BPA	PFOA, TCIPP, TDCPP, DBP, PP, TDP
19	TDP	TCEP, TDP

Blue boxes indicate article was screened for tentative identification of compounds in a previous pilot study.<sup>3</sup>

Table 2. List of the 14 selected environmental chemicals and their abbreviations.

Chemical Name	Abbreviation	Chemical Name	Abbreviation
Bisphenol-A	BPA	2-phenyl phenol	PP
Dibutyl phthalate	DBP	tris (2-chloroethyl) phosphate	TCEP
Diisononyl phthalate	DINP	tris (2-chloroisopropyl) phosphate	TCIPP
4-nonyl phenol	NP	tris (1,3-dichloro-2-propyl) phosphate	TDCPP
Pentachlorophenol	PCP	4-(1,1,3,3-tetramethylbutyl) phenol	TMBP
Perfluorobutanesulfonic acid	PFBSA	2,2,4-trimethyl-1,3-pentanediol- diisobutyrate	TPD
Pentafluorooctanoic acid	PFOA	Triphenyl phosphate	TPP

Blue font indicates chemical was confirmed as tentatively present in materials in a previous pilot study.<sup>3</sup>

## Conclusion and Future Direction

There were a total of three articles that were previously tested via suspect screening to determine whether a number of compounds were present.<sup>3</sup> In that previous study, there were a total 10 chemicals that were tentatively identified in commercial articles.<sup>3</sup> This serves as further proof of concept that emissions testing is necessary for ground truthing both analytical and QSAR-derived data that point to the presence or absence of a compound in articles of commerce. Emissions testing is also necessary to confirm whether chemicals that are no longer in commerce continue to emit from current commercial articles. PFOA is an example of one such compound that is no longer in commerce, and yet was found to emit from 7 articles in this study<sup>4</sup>. Comprehensive chemical emissions testing of commercial articles is needed to support high-throughput risk prioritizations for which the presence of compound is insufficient for predicting exposures.

## References

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