

SVOCs in the Indoor Environment: Mechanistic Insights to Support Sustainable Product Design, Safe Use and Improved Public Health

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<http://epa.gov/ncct/expocast/svoc.html>

Participants Included:

Virginia Tech

Boston U

U Michigan

U Toronto

UMDNJ, Rutgers

U of Washington

UC Berkley

UC Davis

Tsinghua U

ETH, Zurich

Exxon Mobile

Harlan Laboratories

Health Canada

US CPSC

US EPA

Silent Spring Institute

SVOC Workshop Objectives

- Considering a broad range of SVOCs to demonstrate extent to which mechanisms along the source-to-dose continuum are controlled by physical/chemical properties
- Consider holistic systems-based approach that enables relevant processes to be linked across the source-to-effect continuum
- Consider evaluation of potential exposures across the product lifecycle for all chemical classes and for all use scenarios
- Propose screening-level, rapid exposure assessment approaches based on simplified forms of mechanistic exposure models

Lessons learned in exposure assessment (Christine Norman, Health Canada)

- Indirect exposures from environmental media not major driver of assessment outcomes
- Direct exposures (i.e. user of consumer products) more typically key driver
 - **Mandatory information-gathering tools inadequate to collect necessary inputs to inform exposure assessment**
- Near-field exposure tools
 - ‘worst case’ nature of exposure characterization criticized
 - For the inhalation route, available tools focus on VOCs
- Exposure to substances that are present only as a residual/by-product often drive assessment outcomes (e.g., residual monomers)
- Substance-by-substance approach inefficient for both risk assessment and management
- Priority-setting and assessment tool development needs for SVOCs
 - Common exposure triggers
 - Predictive tools for the characterizing exposure to substances in consumer products and built environments
 - Predictive tools for estimating indoor exposure (peak and long-term average),

Research Challenges for REACH (Rosemary Zaleski)

- **Focused on Model inputs** - Future considerations
- Consumer behavior (habits & practices)
 - What are important interrelationships that determine consumer behavior
- Emissions
 - Improved realism in emission estimates
 - More extensive use of traditional technologies
 - New sensor techniques
- Product characteristics
 - weight fraction in product
 - physical form
 - packaging size
 - performance – ex. link amount used to room size, emissions to estimated product lifetime
 - Can a public database of CP determinants be developed?

Workshop Highlights –

Informing green chemistry solutions (Megan Schwarzman, UC Berkeley)

As we seek to better characterize the behavior of SVOCs, ask:

- 1. What information could effectively inform the design of new, safer chemicals and products (**green chemistry**)?
- 2. What information can guide the selection of safer substitutes (**alternatives assessment**)?
- 3. How can better data on SVOCs help us approach the 10,000s of unstudied compounds (**address the data gap**)?

What would a chemical look like that...

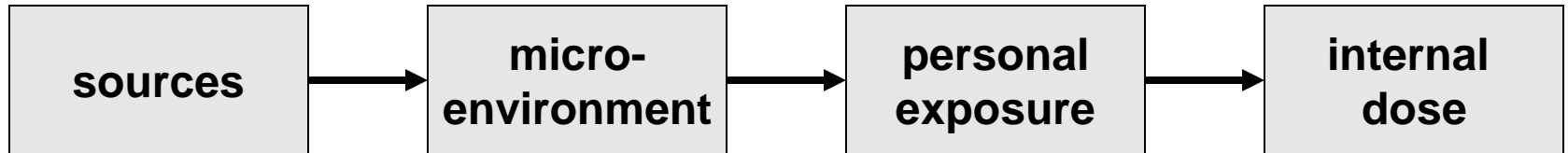
- Doesn't migrate from electronics, building materials, or packaging?
- Isn't taken up through dermal contact?
- Doesn't accumulate in food webs?

How can products be...

- Flexible without phthalates?
- Stain resistant without fluorinated surfactants?
- Flame retardant without halogenated compounds?

Sources, Emissions & Exposure—Flame Retardants & Other SVOCs(Thomas Webster, Boston U)

Presented a series of empirical studies to interrogate model and demonstrate the need for complementary use of two approaches.



• Exposure factor approach:
e.g., media concentration X exposure factor

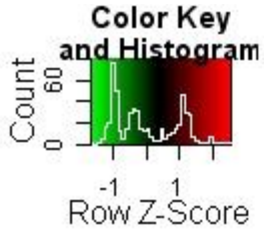
representative?
methods?

how well known?

• **Empirical studies linking boxes:**
e.g., association of dust concentrations
& body burden

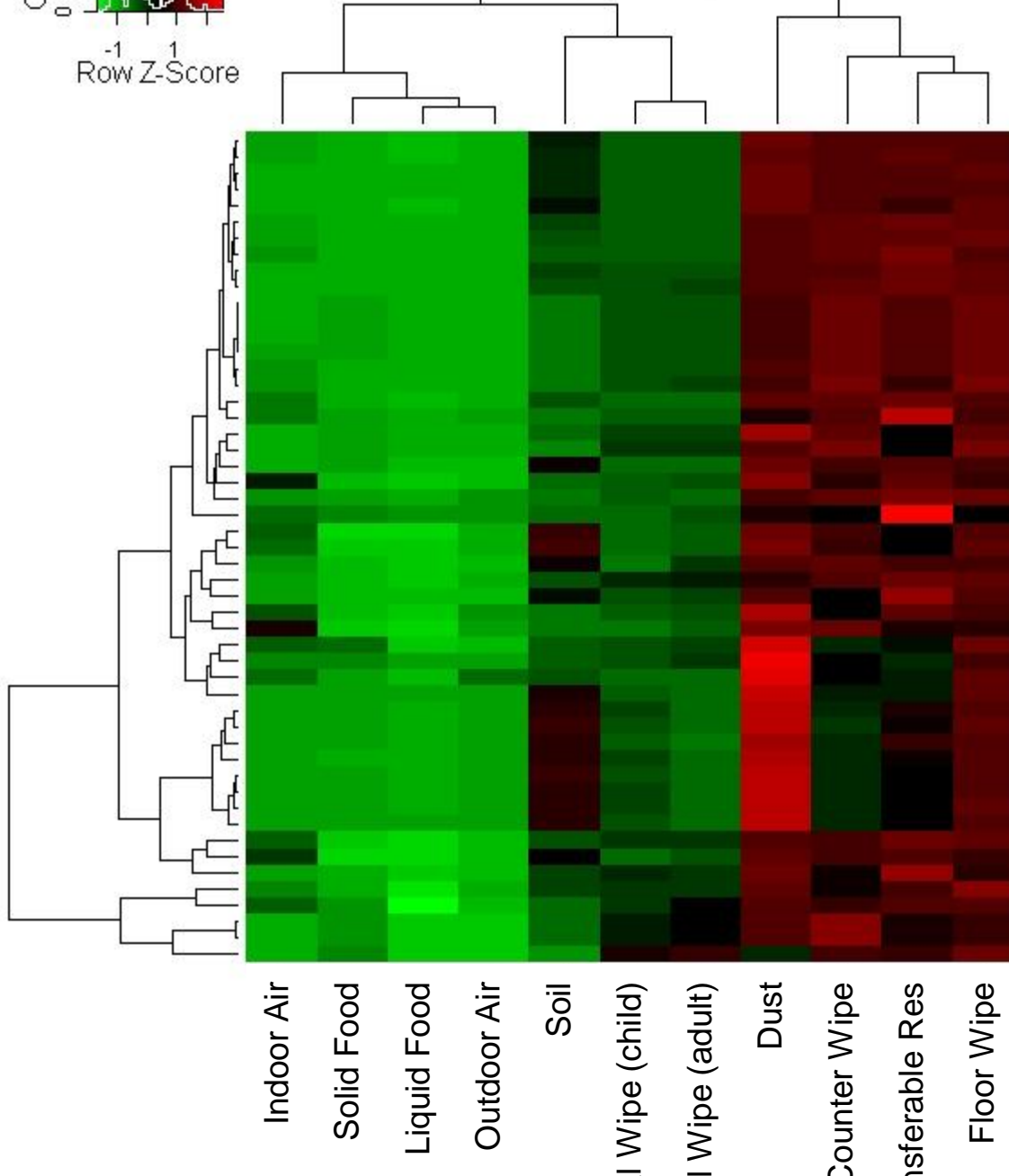
Workshop Highlights –

- **Key factors for transfer into food (Natalie von Götzt, ETH, Zurich)**
- Persistence → DT50 in different media
- Transport → complex of properties
- Partitioning → solubility, vapor pressure, K_{OC} , K_{OW}
- Uptake by organism → molecular weight / size, K_{OW}
- Use pattern → amount of use, region of use
- Product matrix → e.g. additive or covalently bound/monomer
- Use in food contact materials



Average concentration measurements (by media)

Exposure Pathways



2,3,3',4',6-pentachlorobiphenyl
2,2',4,5,5'-pentachlorobiphenyl
2,3',4,4',5-pentachlorobiphenyl
2,2',4,4',5,5'-hexachlorobiphenyl
2,2',3,4,4',5'-hexachlorobiphenyl
2,2',3,5',6-pentachlorobiphenyl
2,3',4',5-tetrachlorobiphenyl
2,2',3,5'-tetrachlorobiphenyl
2,3,3',4,4'-pentachlorobiphenyl
2,2',3,4,4',5,5'-heptachlorobiphenyl
3,3',4,4',5,5'-hexachlorobiphenyl
3,3',4,4',5-pentachlorobiphenyl
3,3',4,4'-tetrachlorobiphenyl
4,4'-dichlorobiphenyl
2,4,4'-trichlorobiphenyl
pentachloronitrobenzene
2,2',5,5'-tetrachlorobiphenyl
2,6-dichlorobiphenyl
dicamba
2,4,5-T (2,4,5-trichlorophenoxyacetic acid)
p,p'-DDE
aldrin
endrin
lindane
gamma-chlordane
alpha-chlordane
dieldrin
nonylphenol
p,p'-DDT
pentachlorophenol
heptachlor
3,5,6-TCP (3,5,6-trichloro-2-pyridinol)
2,4-D (2,4-dichlorophenoxyacetic acid)
IMP (2-isopropyl-6-methyl-4-pyrimidinol)
dibenzo[a,h]anthracene
chrysene
benzo[a]pyrene
benz[a]anthracene
benzo[b]fluoranthene
indeno[1,2,3-c,d]pyrene
benzo[g,h,i]perylene
benzo[e]pyrene
benzo[k]fluoranthene
chlorpyrifos
diazinon
cyfluthrin
benzylbutylphthalate
di-n-butylphthalate
cis-permethrin
trans-permethrin
bisphenol-A

Workshop Highlights

Uptake to production ratio -UPR (Bill Nazaroff, UC Berkeley)

- Result of SVOC 1
- UPR defined as the rate of chemical uptake in a human population divided by the rate at which the chemical is produced (used) in the population's economy.
- Economy-wide assessment of exposure potential
- Mechanism-free evaluation
- Simple in principle (but data availability a major issue)
- UPR is a *magnitude estimate* that characterizes the level of exposure intimacy between a chemical and a population.
- Provided examples calculations for 5 compounds.

Brainstorming – Exposure Indices

- Source Classification
 - Chemical: functional classes
 - Product: form
 - Product: use, application (Look to Consexpo for bins/categories)
- Pathways
 - Kow, Kaw (to predict media)
 - Indoor IF (intake fraction)
 - Multiple
- Scale
 - Indoor persistence

Brainstorming – Exposure Indices

- Use
 - Intimacy factor – use categories
 - Approximate concentration/mass of chemical in product/house (magnitude)
 - Exposure “persistence” – timing of exposure/use – pattern of exposure
 - Multiple uses/products per compound
- Target –
 - Potential for child and fetal exposure
- Production:Dose
 - UPR – uptake:production ratio

Top Research Priorities

- **Who's high and why?**
 - Using NHANES or other, see what the drivers are for high exposure
 - Studies of the relationship between biomarkers and sources indoors
 - Subset when biomonitoring is conducted, adding in detailed consumer behavior
 - Occupational exposures
- **How are people exposed to SVOCs in the indoor environment and how does it depend on the properties of the SVOCs: intersection between experiment and theory**
 - Intensive characterizations of real indoor environments to determine sources, emission rates, different exposure routes for different (all) types of sources; also consider different ages of population

High Research Priorities

- What SVOCs are actually in indoor environments
- What chemicals are in products now, understanding the sources
- **Models to estimate SVOCs in air surfaces, and dust using phys-chem properties and validated with empirical data across a range of properties**
- Extend the uptake production ratio; pick a set of compounds that are applied to body, versus in house/furniture. Consider imports/exports.
- **Better approaches for quantifying exposure related to consumer use**
- Harmonized data sets for the description of consumer behavior for modeling
- Better understand of relationship between particle and vapor phase
- Role of dust on fate, transport and exposure, (esp for very high Kow)
- **Standard method for characterizing persistence in indoor environment of new and existing chemicals**