Semivolatile Organic Compounds (SVOCs)

Background
Semivolatile organic compounds (SVOCs) are a group of compounds that includes some pesticides, ingredients in cleaning agents and personal care products, and additives to materials such as vinyl flooring, furniture, clothing, cookware, food packaging and electronics. Reflecting their extensive use in commercial products, many SVOCs are ubiquitous contaminants of the indoor environment, and over a hundred SVOCs are among the chemicals detected in the CDC’s biomonitoring program. Exposure typically comes from direct product use, as well as from the indoor environment where people in western-style societies spend over 87% of their time. The US EPA lists more than a thousand SVOCs as high-production-volume (HPV) chemicals (produced or used at more than 1 million lbs/yr).

SVOCs are generally identified as organic molecules that can be abundant in both the gas phase and condensed phase, represented by vapor pressures between $10^{-14}$ and $10^{-4}$ atm ($10^{-9}$ to 10 Pa). Because of their slow rate of release from sources and because of their propensity to partition into sorbed states, SVOCs can persist for years indoors, akin to persistent organic pollutants in the outdoor environment (POPs).

Many SVOCs alter the activity of hormones in humans and wildlife and are therefore known as endocrine disrupting chemicals (EDCs). EDCs are suspected to contribute to the occurrence of neurodevelopmental and behavioral problems (e.g., mental retardation or attention deficit disorder), reproductive abnormalities (e.g., decreased fertility or hypospadias), metabolic disorders (e.g., obesity, diabetes), and cancer (e.g., breast, prostate, and testicular cancers).

Examples of Common SVOCs

<table>
<thead>
<tr>
<th>Chemical or Class</th>
<th>Function</th>
<th>Applications/sources</th>
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<tbody>
<tr>
<td>Phthalates</td>
<td>Plasticizer</td>
<td>PVC flooring, toys, cosmetics (fragrances), building materials</td>
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<tr>
<td>Perfluorinated surfactants</td>
<td>Stain/water repellant</td>
<td>Food packaging, cookware, clothing, textiles</td>
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<td>Brominated flame retardants</td>
<td>Fire retardant</td>
<td>Furniture, electronics</td>
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<td>Bisphenol A</td>
<td>Polymer</td>
<td>Food can/bottle linings, hard plastic bottles, thermal paper (receipts)</td>
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<tr>
<td>Triclosan</td>
<td>Antimicrobial</td>
<td>Toothpaste, hand/dish soaps</td>
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<td>Polychlorinated Biphenyls</td>
<td>Heat-transfer fluid</td>
<td>Food contamination, floor coatings (past), electronics</td>
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<td>Pentachlorophenol</td>
<td>Wood preservative</td>
<td>Building materials</td>
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<tr>
<td>Organochlorine pesticides</td>
<td>Pesticide</td>
<td>Residuals from prior indoor application</td>
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Project
As the occurrence, fate, toxicity and exposure pathways are increasingly well characterized for SVOCs, there is an opportunity to identify the drivers of hazard or exposure that could inform the
design of safer substances. Left to their own devices, environmental health scientists will tend to continue studying SVOCs without asking the following questions.

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?
- Doesn't persist for years to decades in indoor environments?
- Doesn't decay to toxic byproducts?

How can products be...
- Flexible without phthalates?
- Stain resistant without fluorinated surfactants?
- Flame retardant without halogenated compounds?
- Stable without antioxidants?
- Resistant to microbial degradation without fungicide and pesticides?
- Appealing without reactive odorants?

Working from existing literature on a class of SVOCs, students can tackle one or more of these questions from the perspective of chemical design, product formulation, regulatory drivers, or business practices. For example:

1. What are the key chemical drivers of hazard, exposure and vulnerability to one class of SVOCs?
2. How do existing metrics or assessment tools apply to SVOCs (or not)? [Note: this question could potentially be addressed through a ToxPi, as described in student project II below].
3. Can we design chemicals intended for indoor use that have a finite lifetime similar to pesticides intended for outdoor use (i.e., pesticides that are designed to decay in a finite period of time)?
4. How could additives (e.g., plasticizers, flame retardants, antioxidants) be designed to degrade to CO₂ and water whenever they migrated from their original products?
5. Which would be the highest yield to inform decision-making in a) design of new chemicals, b) selecting among alternatives, or c) requiring phase-out, elimination or substitution?
6. Is there a case for action now vs. additional study of SVOCs (or a subset thereof)?

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2 Klepeis et al. 2001.
3 USEPA 2007
4 Weschler and Nazaroff 2008