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640 High Throughput Exposure and Risks for Alternatives Assessment of Chemicals in Toys and Building Products

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Introduction: Evaluating exposure is an important component to identify viable alternatives to harmful chemicals in products. Yet, Alternatives Assessment (AA) methods lack efficient and flexible approaches to quantify exposure for the many thousand product-chemical combinations. To address this gap, we a) develop an operational matrix-based high-throughput framework efficiently coupling multi-pathway near-field (worker and consumer) with far-field (general population) exposures for use in AA, and b) apply it to case studies of chemicals in toys and in building materials. Method: We first determine the chemical mass in a product and calculated fractions transferred from toys or building product interior to other compartments and humans in a matrix. Inverting this matrix yields cumulative environmental transfer fractions and Product Intake Fractions (PiF) linking chemical mass taken in by humans to a unit mass of chemical in the product. We finally determine exposure doses expressed in mg/kgBW/d or on a product function basis. Our framework was applied to generate high-throughput exposure results for commonly used chemicals in toys and in building products. Results: For chemicals in toys, exposure is restricted for pathways such as dermal contact or dust that are associated with the use of a single toy of e.g. 0.4kg, but becomes substantial when considering a total mass of 18.3 kg_toys purchased per child and per year in developing countries and the related releases to indoor air. The PiF widely ranges from a median of 0.002 to a max of 0.04 (or 4%). Resulting exposure doses for product users can vary from a median of 4E-6 to 4.9 mg/kgBW/d, dominated by inhalation and dermal gaseous uptake. For each product application, we are able to determine the chemical-specific contributions of pathways and population groups to overall exposure and compare the relative exposure magnitude for all chemicals in a given product. Combining these exposures with toxicity data, we are able to calculate Hazard Quotients from a median of 4E-4 to 299, identifying main chemicals of concern and ranking alternatives. For building products, resulting exposure doses for product users range from a median of 1.3E-2 to 3.7 mg/kgBW/d, and Hazard Quotients from a median of 0.7 to 222. Systematic sensitivity studies enable us to identify the most important product and chemical attributes affecting the Product Intake Fraction and produce heat maps to easily determine exposure, for use in a screening AA, as will be illustrated for chemical alternatives in several product types. The more detailed mass-balanced-based framework is readily available for use by AA practitioners to screen a wide range of product-chemical combinations.

641 Flow Batteries for Renewable Energy Storage in the Grid: An Investigation into the Potential Human Health Impacts of Materials and Manufacturing

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The promotion of renewable energy in electric energy grids is motivated by the adverse effects from the use and production of conventional energy sources. To accommodate large amounts of renewable penetration, the deployment of energy storage devices is required to manage variable renewable resources such as wind and solar. As a promising energy storage device, flow battery technologies with multiple chemistry combinations have been developed in recent years. However, the manufacturing of the flow batteries is not impact free, and the associated materials could have intrinsic hazard traits. In order to minimize the adverse effects during the battery manufacturing stage and identify safer materials with less human health impact, we applied both chemical hazard assessment and life cycle impact assessment to investigate three flow battery technologies: vanadium redox, zinc bromine, and all-iron flow batteries. GreenScreen for Safer Chemicals, a chemical hazard assessment framework, has been utilized to identify toxic materials by screening relative to twenty hazard endpoints. USEtox and ReCiPe, two life cycle impact assessment tools, have been applied to investigate the disability-adjusted life years caused by human health effects and various environmental impact categories. In this study, not only the primary materials used to manufacture the battery components are considered, the associated processing materials are also assessed. The results indicate that the some of the primary materials used in the electrolyte and cell stacks are chemicals of concern. When expanded to processing materials, many of the components currently use additional chemicals of concern in the production chain. With the combined use of the chemical hazard assessment and life cycle impact assessment, the inherent hazard potential of the chemicals as well as their relative emissions and exposures are addressed and compared in highlighting the health impacts associated with different life cycle stages. The results provide insight into the effects of material selection choices on the potential health effects of these novel energy storage devices and can be applied to compare and prioritize materials and process alternatives for a safer battery system with reduced potential human health impact.

642 Exploring the Role of Decision Analysis in Chemical Alternatives Assessment

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Alternatives assessment (AA) involves the identification, assessment, and comparative evaluation of alternatives to hazardous chemicals with an aim to remove hazardous materials from consumer products. Completing an AA often requires trade-offs and value-based choices in terms of prioritizing one type of concern over another (e.g., reducing ecological impacts versus maintaining technical performance). Guidance for conducting alternatives assessment typically focuses on the data gathering and scoring of alternatives but provides less direction concerning the use of specific tools to facilitate decision making.. We report on a workshop in which a group of practitioners from US corporations, government agencies, NGOs, and consulting organizations were confronted with three AA case studies. Participants were asked to select a preferred alternative in each case using a different decision analysis method: their own current default decision-making method, an individual or group multi-criteria decision analysis (MCDA) method, and a facilitated group structured decision-making (SDM) method. For the latter two methods, participants were given a brief tutorial on the underlying decision theory as well as training on the use of specific software tools. As concerns the participants' current default decision making method, despite employing a range of apparoches, we observed that a large majority of participants selected the same alternative. After instruction in MCDA and SDM, participants reported these tools substantially increased their understanding of the trade-offs between alternatives relative to their current default decision approach. Participants were personally quite positive about using more structured decision-making methods to the context of AA but were less confident their organizations would adopt such tools. It also was clear that an appropriate facilitation approach and managing group dynamics were important factors in whether MCDA and SDM are used successfully. Overall, we find that structured decision-making methods have promise in the context of AA, but that practitioners will need more guidance to use such tools successfully. The presentation will conclude with suggestions for enhancing familiarity and understanding of decision making tools in the expanding alternatives analysis community.