Consistently Integrating Life-Cycle Impact Metrics into Chemical Alternatives Assessment

Fantke, Peter; Jolliet, O.; McKone, T.E.

Published in:
Abstract book

Publication date:
2015

Document Version
Publisher's PDF, also known as Version of record

Citation (APA):
Fantke, P., Jolliet, O., & McKone, T. E. (2015). Consistently Integrating Life-Cycle Impact Metrics into Chemical Alternatives Assessment. In Abstract book: Buzzing with science (pp. 132-132). SETAC.

SETAC SALT LAKE CITY

ABSTRACT BOOK

BUZZING WITH SCIENCE

Cross-Pollination for Environmental Progress

Society of Environmental Toxicology and Chemistry
North America 36th Annual Meeting

Salt Lake City, Utah | 1–5 November 2015 and the mechanism is associated with lung overload of poorly water-soluble particles. All three chemicals are relatively inert by other routes of exposure due to their poor water solubility and limited bioavailability. In addition, particle size may play an important role in the carcinogenicity. For example, titanium dioxide nanoparticles have been shown to be carcinogenic, while pigment grade particles are not. To characterize their hazards more accurately, we "stratified" the GreenScreen® assessment of these chemicals by the route of exposure, and obtained different Benchmark scores for different routes. The Benchmark scores for pigment grade titanium dioxide are 2 (inhalation) and 4 (oral and dermal), and for carbon black and crystalline silica are 1 (inhalation) and 2 (oral and dermal). These form-specific/route-specific Benchmark scores can be used by suppliers and alternatives assessors to support the safety of these individual chemicals, if it can be demonstrated that only the specific low hazard forms or routes are relevant throughout the life cycle of the chemicals. This research underlines the importance of exposure route and physical form in GreenScreen® assessment.

485 Performance and hazard assessment of alternative fluorinated and non-fluorinated DWR (Durable Water Repellent) technologies

H. Andersson, IVL Swedish Environmental Research Inst Ltd / Dept of Chemical and Biological Engineering; S. Schellenberger, Dept of Applied Environmental Science ITM; I. van der Veen, VU Univ Amsterdam / Inst for Environmental Studies; P. Gillgard, Swerea IVF AB Gothenburg; G.M. Peters, Chalmers Univ of Technology / Dept of Chemical and Biochemical Engineering; P.E. Leonards, VU Univ Amsterdam / Inst for Environmental Studies; I. Cousins, Stockholm Univ / Dept of Environmental Science and Analytical Chemistry ACES

Due to the ongoing phase-out of long-chain per- and polyfluoroalkyl substances (PFASs), the textile industry has had to find alternative chemistries for durable water repellence (DWR) in fabrics. This ongoing phase-out of long-chain PFASs has resulted in a market where both fluorinated and non-fluorinated DWRs are available, dividable into three broad groups: fluorocarbon-based, silicon-based and hydrocarbon-based polymers. During our research in the SUPFES (Substitution in practice of prioritised fluorinated compounds for textile applications) project, the alternative DWRs were assessed with regards to: (i) their structural properties and connected performance, (ii) loss and degradation processes resulting in diffuse environmental emissions, and (iii) hazard profile for the emitted substances. We worked with DWR-chemistry and outdoor clothing manufacturers to appropriately treat various fabrics with the DWR alternative chemistries (fluorinated and non-fluorinated) using conventional solvent phase chemistry and gas phase chemistry (plasma). We compared the performance of the treated fabrics developed in the project by testing the following properties in the laboratory: general properties (i.e., washability, compatibility with dyestuffs), mechanical properties (i.e., resistance to abrasion and tearing), physical and DWR properties (water vapor resistance, water and oil repellency, stain and soil repellency, soil and stain release, durability and overall comfort). We demonstrated that there are large differences in performance between the alternative DWRs, most importantly the lack of oil repellence of non-fluorinated alternatives. We further showed that for all alternatives, impurities and/or degradation products of the polymeric DWR are emitted to the environment. Our hazard ranking suggested that hydrocarbon-based polymers are the most environmentally benign, followed by silicone- and fluorocarbon-based polymers. Hazards connected to the silicone-based substances (largely through release of low levels of residual cyclic siloxanes; D4: octamethylcyclotetrasiloxane and D5: decamethylcyclopentasiloxane and degradation of silicones to silanols) may be reduced by fate processes efficiently removing the substances from sensitive environmental compartments and lowering the actual risks. Future work will include risk and life cycle assessments (LCA) to estimate long-term advantages and disadvantages of the different DWR-technologies.

486 Incorporating Life Cycle Thinking into Alternatives Analysis

L. Burns, J. Chamberlain, K. Magnuson, C. Meier, Y. Yu, R. Geyer, A.A. Keller, Univ of California Santa Barbara / Bren School of Environmental Science and Management

The California Safer Consumer Products Regulations went into effect in 2013, requiring a two-stage alternatives analysis as a way to identify and assess potential alternatives to products containing chemicals of concern. The first stage is a screening-level analysis that leads to a thorough investigation of alternatives in the second stage. In both stages, the alternatives analysis must incorporate life cycle considerations. To aid future practitioners, a framework was developed to quickly incorporate life cycle thinking into a screening-level analysis. This framework consists of six primary steps: (1) determining the function of the product and chemical of concern; (2) identifying potential alternatives; (3) defining a functional unit; (4) brainstorming questions to consider regarding potential impacts in different life cycle stages; (5) conducting focused qualitative and quantitative research to address the questions that stem from step 4; and (6) evaluating impacts using standard evaluation criteria. A case study of methylene chloride-based paint stripper and three alternatives was used to inform and test this framework. Several tools and databases were explored (e.g., UseTox; GaBi), and data gaps were identified. The findings of the case study were used to develop an approach for visually communicating results to aid in decision-making. This framework focuses on human and environmental impacts, but it is malleable and can be adjusted to include other considerations, such as social or economic impacts. While this framework is only one potential way for incorporating life cycle considerations into an alternatives analysis, it will provide guidance for practitioners unsure of how to conduct such an assessment to be in compliance with the Safer Consumer Products Regulations.

487 Consistently Integrating Life-Cycle Impact Metrics into Chemical Alternatives Assessment

P. Fantke, Technical Univ of Denmark / Quantitative Sustainability Assessment Division; O. Jolliet, Univ of Michigan / Environmental Health Sciences; T.E. McKone, Univ of California / School of Public Health

To address hazardous chemicals in consumer products, alternatives assessment (AA) is an emerging approach combining hazard and exposure assessment with technical and economic feasibility. However, life cycle aspects are typically not considered in AA, but are relevant to avoid decisions that involve burden shifting or that result in only incremental improvement. As the life cycles of chemical and non-chemical alternatives may have widely differing types of impacts on humans and the environment, there is a need to incorporate life-cycle metrics into the AA process including all relevant impacts and consistently comparing all near-field and far-field exposures. We propose and evaluate a framework that includes different tiers and iterative assessment loops to systematically account for life cycle inventories and impacts. We build on seven questions: 1. What is the function of a chemical for a given application of a specific product? This defines the product-based assessment boundaries; 2. What are potential functionally equivalent alternatives? This identifies alternatives to the target chemical including non-chemical solutions; 3. Are the alternatives less hazardous? A hazard assessment screens out alternatives with certain toxicity profiles; 4. Are the alternatives safe enough in a given application? Comparative near-field and far-field exposure over product life cycles combined with hazard profiles leads to full risk characterization; 5. Which alternatives provide optimal environmental and social performance? Life cycle environmental and sustainability impacts complement human health focused risk characterization; 6. Are the alternatives technically feasible to implement? This step accounts for stakeholder-specific technical limitations; 7. What are the most economically feasible alternatives? Cost-benefit analysis helps to rank alternatives according to stakeholder-specific economic valuations and market constraints. In an example, we will show that systematically answering these questions helps (a) to align assumptions used in different assessment methods in a manner that can avoid contradictory results, (b) to consistently consider and compare all relevant impacts, thereby avoiding burden shifting that could result from disregarding chemical and product life cycles, and (c) to prioritize the most relevant impacts across all life cycle stages – setting the scene for a "life cycle alternatives assessment."