Towards a Life Cycle Based Chemical Alternative Assessment (LCAA)

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Published in:
SETAC Europe 27th Annual Meeting Abstract Book

Publication date:
2017

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

Citation (APA):
Increasingly, various stakeholders require information on eco-toxicity aspects of products beyond regulatory requirements for chemicals, e.g., in the framework of Life Cycle Assessment ("LCA"). The method developed (here referred to as "ProScale") aims at a life-cycle-based, transparently applicable methodology for a toxicological assessment of products. It is a development of initial ideas of an approach for merging applicable information from REACH with LCA. The ProScale method has been developed in an industrial consortium with expertise both from the Life cycle assessment and Risk assessment and prerequisites for the method have been to: (i) assess the relevant direct exposure potential along the whole life cycle; (ii) use existing data, e.g. REACH based; (iii) allow comparison in relation to technical performance; and (iv) be relevant for business-to-business and business-to-customer communication. The ProScale method estimates a score for a specific instance of exposure for each substance for a given process and exposure route as expressed in an Exposure Factor (EF). The EF is modelled based on the ECETOC Targeted Risk Assessment Tier 1 approach for both worker and consumer exposure. This is combined with its corresponding hazard for the substance considered expressed in a ProScale Hazard Factor (HF). The HF reflects the health hazard severity and potency based on Hazard statement Code(s) (H-phrases) and Occupational Exposure Limits (OEL). This relates the amount of the compound over the specific times of the defined unit process at hand. Subsequently, the method accounts for the amount of each unit process necessary for the fulfillment of the functional unit as defined by the product system/flow chart. This is done for all included exposure instances, so that eventually a large number of ProScale scores for all included exposure instances are making up the ProScale toxicity impact potential for the overall product system of the studied product (PSP = ProScale of Product). A product can in this context also mean a service provided by the system. The smethod structure allows for comparisons based on the same function as for other LC indicators. Currently the basic structure is in place, and case studies are carried out and used way to demonstrate the applicability of the method.

557 Learnings from LCA-based methods: should chemicals in food packaging be a priority focus to protect human health? A. Ernstoff, Quantis / Quantitative Sustainability Assessment; K. Stylianou, University of Michigan - School of Public Health / Environmental Health Sciences; P. Fantke, Technical University of Denmark / Quantitative Sustainability Assessment Division; A. Dauriat, Quantis; A. Kounina, Quantis / EPEL; O. Jolliet, University of Michigan

558 Towards a Life Cycle Based Chemical Alternative Assessment (LCAA) O. Jøllyet, University of Michigan; L. Huang, University of Michigan / Dept of Environmental Health Sciences; M. Overcash, Wichita State University / Industrial, Systems, and Manufacturing Engineering Department; P. Fantke, Technical University of Denmark / Quantitative Sustainability Assessment Division

559 Modeling indoor occupational air emissions of nanomaterials for life-cycle assessment M. Tsang, US EPA / ASPH Fellow / ISM CyVi; D. Li, K. Garner, University of California, Santa Barbara / Bren School of Environmental Science and Management; A. Keller, University of California, Santa Barbara / Bren School of Environmental Science and Management; S. Suh, University of California, Santa Barbara / Bren School of Environmental Science and Management; G. Sonnemann, University of Bordeaux / ISM CyVi

Engineered nanomaterials (ENM) provide industrial and commercial benefits across many sectors but they also raise concerns over their potential environmental and human health hazards. While the technologies that utilize ENM can be evaluated by life-cycle assessment (LCA) to determine their environmental resource efficiencies, existing methodologies do not allow for the evaluation of the environmental and human health hazards posed by the emission of individual ENM. Across the life-cycle of nanotechnologies, occupational settings present scenarios where production of pristine particles with small size distributions and thus exposure may occur. Nanomaterial Emission Scenarios were developed to improve the transparency and efficiency of comparative assessment of ENM emissions in a LCA may result in burden shifting from the environment to workers. Currently existing life-cycle impact assessment methods take advantage of several assumptions that conveniently describe the fate and transport of small organic molecules and metals quite well, but these methods are not appropriate for ENM. In this paper, a two-zone, dynamic fate and transport model is presented for use with indoor, occupational ENM airborne emissions. The fate and transport model is linked to a physiologically-based pharmacokinetic (PBPK) inhalation exposure model that considers the deposition, removal and retention of particles in the lung over time. During emission events, the fate and transport of titanium dioxide nanoparticles resulted in a distinct near-field concentration that was generally twice as high as far-field concentrations. Inhalation exposure and final retention of particles in the lung was significantly influenced by the magnitude of the airborne concentration. As airborne concentrations rose significantly, phagocytosing cells in the air-exchange and interstitial regions became saturated. The results of the fate and exposure model were compared with a number of emission scenarios ranging from low to medium to high emission events. A notable finding was that the retained-intake fraction was inversely related to the emission magnitudes, which is counter-intuitive to conventional thinking in LCA.

560 Environmental risk assessment of biocides: regulatory requirements, challenges and consequences