Chemical alternatives assessment of different flame retardants - A case study including multi-walled carbon nanotubes as synergist.

Abstract:
Flame retardants (FRs) are a diverse group of chemicals used as additives in a wide range of products to inhibit, suppress, or delay ignition and to prevent the spread of fire. Halogenated FRs (HFRs) are widely used because of their low impact on other material properties and the low loading levels necessary to meet the required flame retardancy. Health and environmental hazards associated with some halogenated FRs have driven research for identifying safer alternatives. A variety of halogen-free FRs are available on the market, including organic (phosphorus and nitrogen based chemicals) and inorganic (metals) materials. Multi-walled carbon nanotubes (MWCNT) have been demonstrated to act as an effective/synergistic co-additive in some FR applications and could thereby contribute to reducing the loading of FRs in products and improving their performance. As part of the FP7 project DEROCA we carried out a chemical alternatives assessment (CAA). This is a methodology for identifying, comparing and selecting safer alternatives to chemicals of concern based on criteria for categorising human and environmental toxicity as well as environmental fate. In the project we assessed the hazard data of different halogen-free FRs to be applied in 5 industrial and consumer products and here we present the results for MWCNT, aluminium diethylphosphinate, aluminium trihydroxide, N-alkoxy hindered amines and red phosphorus compared to the HFR decabromodiphenylether. We consulted the REACH guidance, the criteria of the U.S.-EPA Design for Environment (DfE) and the GreenScreen® Assessment to assess and compare intrinsic properties affecting the hazard potential. A comparison/ranking of exposure reference values such as Derived No Effect Levels (DNELs) showed that FRs of concern are not identified by a low DNEL. A comparison based on hazard designations according to the U.S.-EPA DfE and GreenScreen® for human health endpoints, aquatic toxicity and environmental fate showed that the major differences between FRs of concern and their proposed alternatives are the potential for bioaccumulation and CMR (carcinogenic, mutagenic or reprotoxic) effects. As most alternatives are inorganic chemicals, persistence (alone) is not a suitable criterion. From our experiences in carrying out a CAA we conclude: i) REACH registration dossiers provide a comprehensive source of hazard information for an alternative assessment. It is important to consider that the presented data is subject to changes and its quality is variable. ii) Correct identification of the chemicals is crucial to retrieve the right data. This can be challenging for mixtures, reaction products or nanomaterials or when only trade names are available.
The quality of the data and the practice on how to fill data gaps can have a huge impact on the results and conclusions. Current assessment criteria have mainly been developed for organic chemicals and create challenges when applied to inorganic solids, including nanomaterials. It is therefore crucial to analyse and report uncertainties for each decision making step.

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