A Toxicity Risk Assessment Method for Spill Incidents Involving Volatile Liquid Hydrocarbons and Aqueous Solutions in Enclosed Areas

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Abstract

A new method for the assessment of toxicity risk due to spill episodes involving volatile liquid hydrocarbons and aqueous solutions in enclosed areas is proposed. First, mass transfer models coupled with time-varying evaporation and emission rates (source models) are used to estimate the dynamic concentration profiles of potentially toxic gas/vapor pollutants following spills of volatile liquid hydrocarbons as well as aqueous solutions in an enclosed area or indoor environment. Recognizing that toxicity risk depends nonlinearly on exposure duration and concentration, while at the same time the latter varies dynamically with time at any receptor position, the use of the aforementioned models to reliably compute toxic loads in the presence of time-varying concentration profiles is pursued explicitly in the present study. In this manner, one effectively overcomes the limitations of more traditional approaches to toxicity risk assessment where toxic loads are estimated under constant (steady-state or average) concentration levels of the toxic pollutant. Furthermore, instead of resorting to complex physiologically based pharmacokinetic models and the associated formidable multi-parameter estimation problems requiring the availability of occasionally large sets of good and reliable data, the proposed method incorporates also the idea of using a simple dynamic description that provides the requisite degree of differentiation between the exposure concentration obtained through the above models and the effective concentration (often called the dose) that reaches the receptor site as determined by the uptake rate of the toxic vapor/gas. On the basis of the time-varying effective concentration or dose, an effective toxic load is then computed and integrated into a probit methodological framework where the proper quantification of a population response to toxic exposure (effective toxic load) provides the means to assess and characterize toxicity risk. Finally, the proposed method is evaluated through simulations in a case study involving a spill episode of ammonia solution in an enclosed area.