MARINER

Enhancing HNS preparedness through training and exercising

Tools for modelling impact – toxicology: establishment of criteria

Task C: HNS modelling and environmental impact

Action 2.3: Tools for modelling impact - toxicology

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1. Introduction

The general objective of MARINER is to improve regional cooperation in planning, preparedness and response to HNS spills by improving training and exercise, increasing awareness and information exchange, and by capitalization and translation of HNS relevant R & D projects' outcomes into operational products.

In order to achieve that aim, MARINER is organised around a range of coordinated technical tasks supported by two horizontal tasks, the project management and coordination (Task A) and project communication and dissemination (Task F). Among technical tasks, task C aims to:

- Improve the operational use of tools for modelling HNS transport, behaviour and biological impact;
- Define protocols and guidelines for environmental impact assessment of HNS spills.

This document is elaborated in the frame of action C2 "Tools for modelling impact", and it aims to explain the selection of ecotoxicological parameters that will be considered in the numerical models for estimating environmental hazards.

2. Tools for modelling impact – toxicology: establishment of criteria

Environmental risk assessment is a process of predicting whether there may be a risk of adverse effects on the environment caused by a chemical substance. This involves determining a predicted no-effect concentration (PNEC) and comparing it with some estimate of exposure concentration (PEC).

Environmental effect assessment of the aquatic compartment implies a base dataset that encompasses test results of three trophic levels represented by algae (primary producers), invertebrates (primary consumers) and fish (higher level consumers and predators). In acute tests, the 96 h LC50[1] is usually determined for fish and crustaceans, the 48 h EC50[2] (immobility)

[1] The concentration of a substance which produces a 50 % response in the defined endpoint.

[2] The concentration which causes 50 % mortality of the test species.

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for the commonly used freshwater crustacean *Daphnia sp*., while the 72/96 h EC50 (reproduction and/or growth) generally applies to microalgae. The lowest of the available toxicity values between and within the different trophic levels is used to define the hazard category and as the toxicological dose descriptor. The same process is used to "classify" chronic toxicity, which is a crucial component of aquatic hazard evaluation as it addresses the impact of long-term effects exposure of aquatic organisms. Chronic toxicity is represented by the NOEC (no observed effect concentration) or equivalent effective concentration, generally, EC10. Nevertheless, life-cycle studies reporting NOEC values are still scarce. In some studies, only LOEC (lowest observed effect concentration) can be obtained, in which case NOEC can be calculated as LOEC/2.

When toxicological data are missing acute-to-chronic ratio (ACR) extrapolation allows derivation of an endpoint value. ACR can be applied directly to a measured endpoint to determine the corresponding acute or chronic value. Generally accepted ACR are shown in the table below. The ACR method is used in U.S. EPA New Chemicals Program based on comparison of EC50/ChV for neutral organics and other classes (ChV equals geometric mean of NOEC and LOEC).

Class	Fish	Daphnid	Green Algae
Neutral Organics	10	10	4
Classes with Excess Toxicity	10	10	4
Polycationic Surfactants	18	14	4
Nonionic Surfactants	5	5	4
Anionic Surfactants	6.5	6.5	4

The PNECs utilized in hazard assessment are usually calculated by dividing the above defined toxicological dose descriptors by an assessment factor. The lowest value for the toxicity is divided by the relevant assessment factor. According to European Chemicals Agency (ECHA) guidance, a PNECwater for saltwater can be determined as outlined in the table below. Noteworthy, a lower/higher factor may be considered according to knowledge of the mode of action of the substance. Substances which are known to act in a non-specific manner are considered to have the same baseline toxicity and a lower assessment factor may be utilized.

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Equally a known specific mode of action (endocrine disruptors, pesticides, metals) may lead to a higher factor.

Data set	Assessment factor
Lowest short-term L(E)C50 from freshwater or saltwater representatives of three taxonomic groups (algae, crustaceans and fish) of three trophic levels	10,000 [a)]
Lowest short-term L(E)C50 from freshwater or saltwater representatives of three taxonomic groups (algae, crustaceans and fish) of three trophic levels, + two additional marine taxonomic groups (e.g. echinoderms, molluscs)	1000 [b)]
One long-term result (e.g. EC10 or NOEC) (from freshwater or saltwater crustacean reproduction or fish growth studies)	1000 [b)]
Two long-term results (e.g. EC10 or NOEC) from freshwater or saltwater species representing two trophic levels (algae and/or crustaceans and/or fish)	500 [c)]
Lowest long-term results (e.g. EC10 or NOEC) from three freshwater or saltwater species (normally algae and/or crustaceans and/or fish) representing three trophic levels	100 [d)]
Two long-term results (e.g. EC10 or NOEC) from freshwater or saltwater species representing two trophic levels (algae and/or crustaceans and/or fish) + one long-term result from an additional marine taxonomic group (e.g. echinoderms, molluscs)	50
Lowest long-term results (e.g. EC10 or NOEC) from three freshwater or saltwater species (normally algae and/or crustaceans and/or fish) representing three trophic levels + two long-term results from additional marine taxonomic groups (e.g. echinoderms, molluscs)	10

In: Environmental Chemicals Agency, 2008. ECHA guidance on information requirements and chemical safety assessment. Chapter R.10: Characterization of dose [concentration]-response for environment.

Calculation of PNECwater for intermittent releases

In several situations, chemical discharges are discontinuous in time and/or occasional, which means that environmental exposure will be temporally constrained. In such cases, it is assumed that organisms can cope with higher chemical concentrations and short-term L(E)C50 values are used to derive a PNECwater, intermittent. This is performed through application of an assessment factor of 100 to the lowest L(E)C50 of at least three short-term tests from three trophic levels. For substances with a non-specific mode of action, interspecies variation may be low and a lower assessment factor may be appropriate while for potential bioaccumulating compounds an assessment factor of 100 may not be sufficient to warrant protection. A precautionary principle should always be adopted. Furthermore, a factor lower than 10 should never be applied to a short-term L(E)C50 value.

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Ecotoxicological parameters selection criteria

The above defined toxicological criteria (LC(E)50, NOEC, PNECwater for seawater and PNECwater, intermittent) will be adopted and integrated with the developed HNS spill model, in order to foster HNS risk assessment. Specifically, LC(E)50 and NOEC data will be identified to each trophic level (algae, invertebrates and fish). PNECwater for seawater and PNECwater, intermittent will be derived from the lowest toxicological dose descriptor divided by the respective assessment factor, privileging NOEC values whenever available. In case chronic data are missing, these will be calculated through ACR extrapolation. In these cases, PNECs will be obtained through derivation of the LC50 values. Finally, the PEC PNEC ratio, also known as the Risk Characterization ratio (RCR) or Hazard quotient (HQ), will be calculated to crudely measure the scale of risk: figure of 1 to 10 is of lower concern, between 10-100 additional data are needed. Over 100 is of major concern, and action to reduce the risk to the environment should be required.

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