

Hydro Priority Pollutants (HPP) - a chemical ranking and scoring system for effective risk management.

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Introduction

With involvements in industries as oil and gas, fertilizers, petrochemicals and light metals, a great number of chemicals are used and produced in Norsk Hydro ASA. In order to evaluate the chemicals with respect to their potential effects on human health and environment in a systematic and cost-effective way, a ranking and scoring method called Hydro Priority Pollutants (HPP) has been developed at Norsk Hydro Research Centre Porsgrunn. This is a tool for hazard assessment for identification and prioritization of chemicals hazardous to human health and/or the environment. Risk assessment is not included in the method.

The HPP method has been applied in a case study for the Petrochemical Division in Norsk Hydro. For this study a database prototype, called the Petro Priority Pollutants (Peppo) database, has been developed. In this database, data on toxicity and amounts of substances detected in effluents and wastes from a selection of plants are collected. Based on the ranking of the substances, individual substances and group of substances will be selected for risk assessment and monitoring programs.

Materials and methods

The principles of the HPP method are based on the criteria defined in the EU Directive 67/548/EEC with amendments, on the classification, packaging and labelling of dangerous substances /1/. Both acute and chronic effects to the compartments human health, aquatic and terrestrial ecosystems and the atmosphere, are assessed in the HPP method. The effect categories are listed in Table 1. For each of the categories, a discrete score value is given depending on the degree of seriousness and reversibility of the effect type. The score values are given in Table 1. As the EU Directive 67/548/EEC does not state any classification criteria for substances discharged to soil, the score criteria for terrestrial environment are based on range-finding test concentrations in the OECD guidelines /2/ and guidelines proposed by Torstensson *et al.* /3/.

The assignment of scores is based on the risk phrases in Directive 67/548/EEC Annex I. If a substance is not classified, the statement of scores shall be based, if available, on test data directly. The data shall then be derived from studies following standardised guidelines or methods for testing of chemicals. Secondary data sources (databases, reviews etc.), where applied test methods are not stated, can be used if they are approved by The Nordic Council of Ministers for environmental hazard classification /4/. While classification is

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Table 1: The Hydro Priority Pollutants ranking and scoring system. Depending on the application area, the weighting between the compartments will be varied. The relative scaling within one compartment is set.

Compartment	Effect Category	Score
Human health	No/very low effects	0
	Acute toxicity (harmful/toxic/very toxic)	1/2/3
	Irritant/corrosive	1/2
	Sensitizing	2
	Chronic effects - chronic toxicity - classified CMR effects* - indicated CMR effects*	3 3 1
Aquatic eco-systems (water)	No/very low effects	0
	Acute toxicity (harmful/toxic/very toxic)	1/2/3
	Chronic effects - chronic toxicity - bioaccumulation/biomagnification - biodegradation	3 2/3 1
Terrestrial eco-systems (soil)	No/very low effects	0
	Acute toxicity - flora - micro-organisms (bacteria) - soil organisms (earth-worms) - insects (bees) - fauna (birds)	3 3 3 3 3
	Chronic effects - chronic toxicity - bioaccumulation/biomagnification - biodegradation	15 10/15 5
Atmosphere (air)	No effects	0
	Ozone depletion	3
	Global warming potential	3
	Ground level ozone/smog	3

* If a substance is classified as carcinogenic, mutagenic or reproductive toxic (CMR), it is given score 3. If it is not classified as CMR, but a study indicates such effects, it is given score 1.

often based on a general impression of several test results, scores are given based on one test result only. If there exist several data for one specific category, e.g. toxicity data on both sexes, various species etc., the scores are given based on the worst case data.

Missing data present a main obstacle to ranking and scoring systems. In the present version of the HPP method, this is handled by giving maximum score for an effect category if data is missing. This score is called "score unknown" to distinguish it from the scores assigned due to known toxicity; "score known". In this way it is possible to rank the substances both according to score known, to identify potential hazardous substances, and to score unknown, to identify substances with lack of information.

Depending on the application, the substances can be ranked according to one specific compartment (human health, water, soil or atmosphere), the combination of several compartments or the total score for all compartments. While the relative scaling within one compartment is set, the weighting between the compartments can be varied depending on the purpose for the ranking.

Examples of applications are;

- hazard identification,
- screening of chemicals for further risk assessment and risk management,
- identification of datagaps and chemical testing needs,
- identification of candidates for phase out/reduction,
- evaluation of raw-materials and auxiliary chemicals.

Results and discussion

The HPP method has been applied in a case study for the Petrochemical Division in Norsk Hydro to identify priority pollutants in effluents and waste from the Chlorine and VCM plants in Sweden and Norway. Results from chemical analysis of samples from effluents to air and sea, and wastes, are recorded in a Lotus Approach database. For each of the identified substances, data on potential effects on human health and aquatic ecosystems are entered in the database, called the Petro Priority Pollutants (Peppo) database. Each substance is given scores according to the HPP method. The results from the ranking are now being used to select substances for further risk assessment.

The Peppo database also includes substances which appear on official lists of hazardous substances. This to highlight substances in the effluents and wastes that are in focus nationally and/or internationally. Official lists included in the present version of the database are lists from the Norwegian State Pollution Control Authority and European Union, the UK Red list, the US EPA Priority Pollutants list and North Sea Conference lists. In total, more than 550 different substances are registered in the database.

The principles of the HPP method have shown to be consistent with other reported chemical ranking and scoring systems /5/6/7/. Experiences from the case study Peppo and other chemical ranking and scoring systems will be considered and evaluated in a further development and improvement of the HPP method. However, the main challenge is the lack of toxicity data.

References

1. EU Directive 67/548/EEC, Annex I, V and VI.
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4. Pedersen, F., Tyle, H., Niemelä, Guttman, B., Lander, L. and Wedebrand, A, Environmental Hazard Classification-data collection and interpretation guide, 2nd edition, TemaNord 1995:581, Nordic Council of Ministers, **1995**, ISBN 92-9120-711-X.
5. Swanson, M.B. and Socha, A.C. (Ed.), *Chemical Ranking and Scoring: Guidelines for Relative Assessments of Chemicals*, Setac Press, **1997**; ISBN 1-880611-12-0.
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