Sanitation Care with less risk for human and environment

M. KLADE [1)], M. JAROS [2)], U. SEEBACHER[1)]

1) IFF/IFZ, Inter-University Research Centre for Technology, Work and Culture, Schloegelgasse 2, 8010 Graz, Austria
2) Vienna Ombuds-Office for Environmental Protection, Muthgasse 62, 1190 Vienna, Austria

Introducing challenge and project

In hospitals disinfectants are routinely used to prevent infections. As a matter of fact their application serves as a sanitary measure. However, disinfectants themselves show certain characteristics, which are dangerous to human beings and environment. The continuous contact with disinfectants may cause allergies and asthma, as shown by various studies. Moreover, disinfectants in waste water may affect the performance of sewage treatment plants or persist in the aquatic environment. Appropriate measures enabling a comparative assessment of these hazards arising from disinfectants have not been available until now. Within the scope of the project "ÖkoKauf Wien" the municipality of Vienna financed the development of an user-friendly and convenient evaluation scheme, which enables the purchasing department and/or sanitation commissioner of hospitals to select those disinfectants from the market supply, which pose less risk for hospital staff, patients and environment. The Inter-University Research Centre for Technology, Work and Culture (IFF/IFZ) in Graz developed an instrument, which can be used to assess and compare (eco)toxicological and human health characteristics of antimicrobial active substances and commercial disinfectants.

Evaluating antimicrobial active substances

The evaluation scheme is primarily designed for disinfectants applied on surfaces, instruments, laundry and dishes. It provides a preventive and comparative approach and does not aim to quantify chemical risks or substitute EU risk assessments. As a starting point data about properties and effects of antimicrobial active substances were collected. The data comprise human health and environment hazard potentials preferably by means of R (Risk) phrases. Data about toxic, mutagenic, allergenic and dermal effects, as well as effects on sewage treatment plants and surface water were considered to be the most important indicators for hazard potentials and compiled in a list of corresponding impact categories. Within these categories the severity of a hazard potential is scored by numbers ranging from 1 (no hazard) to 5 (very high hazard). The evaluation scheme provides rules how to deduce valuation numbers from R phrases or data sets and how to consider data gaps. An assessment profile consisting of six valuation numbers is generated. An example is given for glutaric aldehyde.

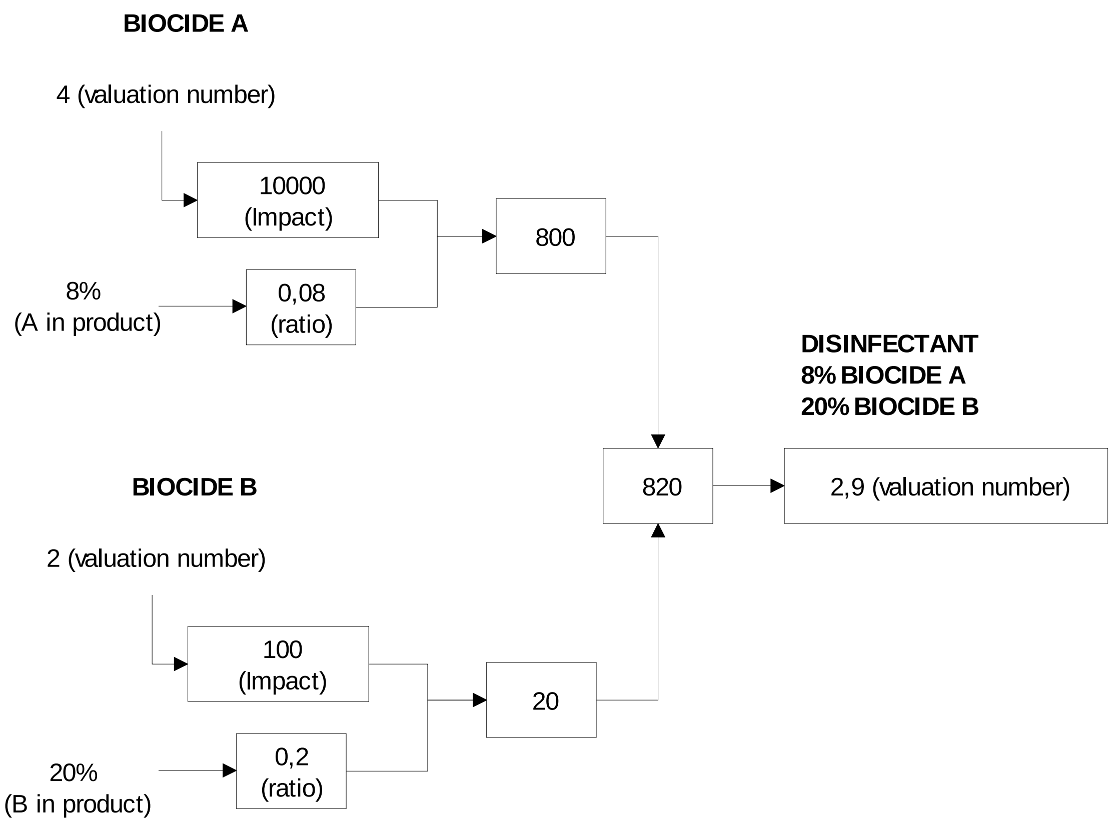
Impact category	*risk phrases and/or other available data*	*valuation number*
Acute Toxicity	R23/25	4
Dermal effects (irritation and corrositivity)	R34	4
Sensitisation	R42/43	5
CMR potential (Carcinogenicity, Mutagenicity, Reproductive toxicity)	In vivo testing results: not mutagenic, not teratogenic, not embryotoxic; unclear testing results according to carcinogenicity	2
Environmental behaviour	R50	3
Effects on sewage treatment plants	Inhibition of oxygen consumption by activated sludge: EC_{50} = 540mg/l	2

Evaluating commercial disinfectants

Properties of commercial disinfectants are determined by the properties and the contents of their antimicrobial active ingredients. To assess products by means of ingredients it has to be considered that they are either diluted in the disinfectant itself or may be diluted prior to use. Depending on the type of adverse effect, a dilution weakens its potency. This is the case for effects described by the categories *Acute toxicity*, *Dermal effects*, *Environmental behaviour* and *Effects on sewage treatment plants*, yet it is assumed that this is not the case for the categories *Sensitisation* and *CMR potential*. To calculate the influence of dilution, literature (Smola et al., Kalberlah & Lechtenberg-Auffarth) proposes to apply a logarithmic instead of a linear scale, so that substances with a high adverse potency adequately contribute to the overall assessment.

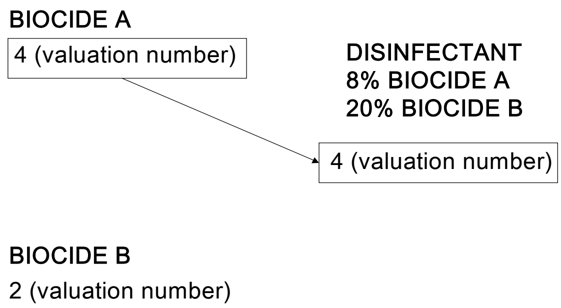
The calculation scheme is shown in figure 1. For each impact category the valuation number of an ingredient is transformed into an "impact" by means of an algorithm (impact = $10^{\text{valuation number}}$), to allow a logarithmic scaling. Subsequently the impact is multiplied with the substance - product ratio. Results for all active ingredients are summed up and the final value (i.e. 820 in figure 1) is retransformed into a linear valuation number now ranging from 0 to 5. As indicated by the calculation procedure, conversion into logarithmic scaling guarantees that ingredients with high adverse potential adequately contribute to the overall product evaluation number. This is particularly important if the content of the ingredient is rather low, but the potential adverse effect is high.

Figure 1 Calculating a product valuation number within an impact category affected by dilution



It is assumed by the authors that such a calculation should not be applied to the impacts categories *Sensitisation* and *CMR potential*. Instead, as shown by figure 2, the most "adverse" ingredient should determine the overall product valuation number within these categories. This is thought to be reasonable, since often no threshold limits for mutagenic effects can be given and thresholds for sensitising substances are not known in general. Therefore, neglecting dilution rates is consistent with the application of the precautionary principle.

Figure 2 Investigating product valuation number within categories *Sensitisation* and *CMR potential*



Depending on their vapour pressure disinfectants evaporate to a certain extent before they reach a sewage treatment plant or the aquatic environment. Therefore the vapour pressure of the ingredients is considered by a factor ranging from 1 (no evaporation) to 0,3 (high evaporation). Included in the overall calculation (not included in this paper) this factor may shift the product valuation numbers for *Acute Toxicity*, *Environmental behaviour* as well as for *Effect on sewage treatment plant* up to approximately 15%.

The hazard profile for a commercial disinfectant is generated by performing the procedures described above for all impact categories. The following table compares hazard profiles for three different dilutions of one and the same (alcoholic) disinfectant. The comparison reveals, that valuation numbers are sensitive to an even slight change in dilution (e.g. from 2% to 1%).

Impact category	*Hazard profile*		
	Concentrate (100%)	*Solution in water (2%)*	*Solution in water (1%)*
Acute Toxicity	2,4	0,8	0,6
Dermal effects	1,9	0,4	0,3
Sensitisation	2	2	2
CMR potential	2	2	2
Environmental behaviour	1,0	0,1	0,0
Effects on sewage treatment plants	2,0	0,5	0,3

How does a hazard profile express actual risk?

As mentioned before the evaluation scheme is not an absolute measure of actual risk. Yet the direction of changes in valuation number should correspond to the direction of changes in risk and therefore can indicate a trend to less risk. Comparison of hazard profiles are therefore the most promising approach for practical application. Comparison of valuation numbers of different products allows to identify those with a low sensitisation potential or good environmental performance. This has to be done within the same impact category and only combining disinfectants within the same application context (e.g. products for disinfecting hard surfaces such as floors).

Inducing practical application

The evaluation scheme was integrated into a database, together with an extensive data collection for about 60 active substances (= biocides), the formulations of about 120 commercial disinfectants and their(eco)toxicological properties and possible effects on human health. Users of the database, mainly purchasers of disinfectants, can retrieve the register of assessed products, which can be sorted according to application mode and the required anti-microbial spectra. Users can recall detailed product information as well as toxicological data collection. The possibility to compare potential risk to human health and environment of different products by a mouse click facilitates the consideration of associated risks in purchasing decisions. The work done has been supported and reviewed by various experts in the field of hygiene, occupational medicine and ecology as well as by representatives of the biocidal industry. The integration of other biocidal products into the database is intended as a next step.

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