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Rapport in het kort

Environmental risk limits for acrolein

Dit rapport geeft milieurisicogrenzen voor acroleïne in (grond)water, bodem en lucht. Milieurisicogrenzen zijn de technisch-wetenschappelijke advieswaarden voor de uiteindelijke milieukwaliteitsnormen in Nederland. De milieurisicogrenzen voor acroleïne zijn gebaseerd op de uitkomsten van de EU risicobeoordeling voor acroleïne (Bestaande Stoffen Verordening 793/93). De afleiding van de milieurisicogrenzen sluit tevens aan bij de richtlijnen uit de Kaderrichtlijn Water.

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Contents

Summary

Environmental risk limits (ERLs) are derived using ecotoxicological, physicochemical, and human toxicological data. They represent environmental concentrations of a substance offering different levels of protection to man and ecosystems. It should be noted that the ERLs are scientifically derived values. They serve as advisory values for the Dutch Steering Committee for Substances, which is appointed to set the Environmental Quality Standards (EQSs) from these ERLs. ERLs should thus be considered as preliminary values that do not have any official status.

This report contains ERLs for acrolein in various environmental compartments. The following ERLs are derived: negligible concentration (NC), maximum permissible concentration (MPC), maximum acceptable concentration for ecosystems (MAC_{eco}), and serious risk concentration for ecosystems (SRC_{eco}). The risk limits were solely based on data presented in the Risk Assessment Report (RAR) for this compound, created under the European Existing Substances Regulation (793/93/EEC). No risk limits were derived for the sediment compartment, because of the relatively low sediment-water partition coefficient.

For the derivation of the MPC and MAC_{eco} for water, the methodology used is in accordance with the Water Framework Directive (Lepper, 2005). This methodology is based on the Technical Guidance Document on risk assessment for new and existing substances and biocides (European Commission (Joint Research Centre), 2003). For the NC and the SRC_{eco} and for the ERLs for the soil and atmospheric compartment, the guidance developed for the project ‘International and National Environmental Quality Standards for Substances in the Netherlands’ was used (Van Vlaardingen and Verbruggen, 2007). An overview of the derived environmental risk limits is given in Table 1.

Table 1. Derived MPC, NC, MAC_{eco}, and SRC_{eco} values for acrolein.

ERL	unit	value			
water		MPC	NC	MAC_{eco}	SRC
$MPC_{eco, water}$	*$\mu g.l^{-1}$*	*0.1*			
$MPC_{dw, water}$	*$\mu g.l^{-1}$*	*2.0*			
$MPC_{sp, water}$	*$\mu g.l^{-1}$*	*n.d* [b]			
$MPC_{hh food, water}$	*$\mu g.l^{-1}$*	*n.d.*[b]			
water [a]	$\mu g.l^{-1}$	0.1	0.001	0.7	140
drinking water [a]	$\mu g.l^{-1}$	2.0			
marine	$\mu g.l^{-1}$	0.01		0.07 [c]	
sediment		n.d.[b]			
soil [d]	$\mu g.kg_{dw}^{-1}$	0.06	0.0006		80
groundwater	$\mu g.l^{-1}$	0.1	0.001		
air	$\mu g.m^{-3}$	0.5	0.01		

[a] The $MPC_{dw, water}$ is reported as a separate value from the other MPC_{water} values ($MPC_{eco, water}$, $MPC_{sp, water}$ or $MPC_{hh, food, water}$). From these other MPC_{water} values (thus excluding the $MPC_{dw, water}$) the lowest one is selected as the ‘overall’ MPC_{water}.

[b] n.d. = not determined.

[c] provisional value.

[d] expressed on Dutch standard soil

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1 Introduction

1.1 Project framework

In this report environmental risk limits (ERLs) for surface water (freshwater and marine), groundwater, soil and air are derived for acrolein. The following ERLs are considered:

- negligible concentration (NC) – concentration at which effects to ecosystems are expected to be negligible and functional properties of ecosystems must be safeguarded fully. It defines a safety margin which should exclude combination toxicity. The NC is derived by dividing the MPC (see next bullet) by a factor of 100.
- maximum permissible concentration (MPC) – concentration in an environmental compartment at which:
  1 no effect to be rated as negative is to be expected for ecosystems;
  2a no effect to be rated as negative is to be expected for humans (for non-carcinogenic substances);
  2b for humans no more than a probability of 10^{-6} over the whole life (one additional cancer incident in 10^{6} persons taking up the substance concerned for 70 years) can be calculated (for carcinogenic substances) (Lepper, 2005).
- maximum acceptable concentration (MAC_{eco}) – concentration protecting aquatic ecosystems for effects due to short-term exposure or concentration peaks.
- serious risk concentration (SRC_{eco}) – concentration at which 50% of the species potentially present in an ecosystem may experience negative effects.

It should be noted that ERLs are scientifically (based on (eco)toxicological, fate and physico-chemical data) derived values. They serve as advisory values for the Dutch Steering Committee for Substances, which is appointed to set the Environmental Quality Standards (EQSs) from these ERLs. ERLs should thus be considered as preliminary values that do not have any official status.

2 Methods

2.1 Data collection

The final Risk Assessment Report (RAR) of acrolein produced in the framework of Existing Substances Regulation (793/93/EEC) was used as only source of physico-chemical and (eco)toxicity data (European Commission, 2001). Information given in the RARs is checked thoroughly by European Union member states (Technical Committee) and afterwards approved by the Scientific Commission on Health and Environmental Risk (SCHER). Therefore, no additional evaluation of data is performed for the ERL derivation. Only valid data combined in an aggregated data table are presented in the present report. Occasionally, key studies are discussed when relevant for the derivation of a certain ERL.

In the aggregated data table only one effect value per species is presented. When for a species several effect data are available, the geometric mean of multiple values for the same endpoint is calculated where possible. Subsequently, when several endpoints are available for one species, the lowest of these endpoints (per species) is reported in the aggregated data table.

2.2 Methodology for derivation of environmental risk limits

The methodology for data selection and ERL derivation is described in Van Vlaardingen and Verbruggen (2007) which is in accordance with Lepper (2005). For the derivation of ERLs for air, no specific guidance is available. However, as much as possible the basic principles underpinning the ERL derivation for the other compartments are followed for the atmospheric ERL derivation (if relevant).

3 Derivation of environmental risk limits for acrolein

3.1 Substance identification, physico-chemical properties, fate and human toxicology

3.1.1 Identity

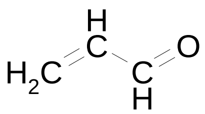

Figure 1. Structural formula of acrolein.

Table 2. Identification of acrolein.

Parameter	Name or number
Chemical name	acrolein
Common/trivial/other name	acrolein, acralaldehyd, acrylaldehyd(e), acrylic aldehyde, allylaldehyd(e), propenal
CAS number	107-02-8
EC number	203-453-4
Molecular formula:	C_3H_4O

3.1.2 Physico-chemical properties

Table 3. Physico-chemical properties of acrolein.

Parameter	Unit	Value	Remark
Molecular weight	[$g.mol^{-1}$]	56.06	
Water solubility	[$g.l^{-1}$]	206-270	at 20ºC
log K_{OW}	[-]	-1.1	Measured value
K_{OC}	[l/kg]	2.8	Calculated value
Vapour pressure	[hPa]	293	at 20ºC
Melting point	[°C]	-87	
Boiling point	[°C]	53	
Henry's law constant	[$Pa.m^3.mol^{-1}$]	6.1	at 20ºC

3.1.3 Behaviour in the environment

Table 4. Selected environmental properties of acrolein.

Parameter	Unit	Value	Remark
hydrolysis half-life	DT_{50} [d]	-	RAR: *"Acrolein does not contain any hydrolysable groups, but it does react with water in a reversible hydration reaction to 3-hydroxypropanal (HPA). The half-life for this reaction was found to be 15 hours in sewage water, 45 hours in drinking water and up to 11 days in deionised water. Besides this reaction step HPA reacts in a secondary reaction with acrolein to 3,3'-oxydipropoionaldehyde, which further reacts to other secondary products. In field studies (irrigation canals) half-life values for the elimination of acrolein between 3 and 7 hours were calculated. Apparently, processes other than hydration, e.g volatilisation, also contribute to acrolein dissipation in the aquatic environment."*
photolysis half-life	DT_{50} [h]	-	*RAR: "Photolysis competes with photo-oxidation (a.o. reaction with OH radicals; see below), but plays a lesser role in the degradation of acrolein in the troposphere. Irridiation of acrolein in synthetic air with UV-light results mainly in the formation of carbon monoxide and ethene. Other organic products, e.g. formaldehyde, carbon dioxide and small amounts of hydrogen and methane, were detected as well. Photolysis is low at normal atmospheric pressure, but increases at lower atmospheric pressure. The half-life of photolysis of acrolein is 10 days in the lower troposphere and less than 5 days in the upper troposphere. Photolysis in water is low." "The calculated half-life of acrolein for the reaction with the OH-radical in the troposphere (*OH-concentration $5*10^5$ molecules/cm3 and 24 hours) is less than one day. The calculated half-life is in correspondence with the half-life values derived from experiments".*
degradability	readily biodegradable		

The RAR gives some general considerations on the environmental distribution of acrolein:

"According to the TGD (1996) a Henry's Law constant of 6.1 Pa.m^3/mol at 20°C can be calculated. A measured Henry's Law constant of 3.1 Pa.m^3/mol at 20°C was found (BUA, 1994; 33). This indicates that volatilization of acrolein from surface waters and moisty soil is expected to be high (Lyman, 1982).
Using the measured log K_{ow} of -1.10 (Baker, 1991), a K_{oc} of 2.8 l/kg can be estimated according to the TGD (1996). Experimentally determined K_{oc}-values (dimensionless) were in the range of 51-270 for two different soils, but further details of this study are lacking (BUA, 1994). Based on the calculated and experimental K_{oc} values, acrolein is expected to be moderately to highly mobile in soil. However, there are indications that the adsorption of acrolein to soil (bound fraction) is irreversible (BUA, 1994). In a simulation test, assuming the absence of water evaporation, acrolein was found to evaporate for 79% from sandy soil and 47% from loam soil during one year (BUA, 1994). When the water evaporated simultaneously, 85% of acrolein evaporated for both types of soil. In another experimental study acrolein showed a limited (30% of 0.1% solution) sorption to activated carbon (Giusti et al., 1974). These experimental results further support the conclusion that acrolein has a low sorption to soil and therefore that leaching may occur. However, volatilisation and degradation processes are expected to attenuate movement through soil towards groundwater (ATSDR, 1990).
As important details are lacking for the experimentally derived K_{oc}-values, the calculated K_{oc} of 2.8 l/kg will be used throughout the further exposure assessment of acrolein. K_p-values for soil, sediment and suspended matter can subsequently be calculated by multiplying the K_{oc} with the corresponding f_{oc}-values, resulting in K_p's of 0.06 l/kg (soil), 0.14 l/kg (sediment) and 0.28 l/kg (suspended matter). It should be borne in mind, however, that the derivation of a K_p from low log K_{ow}-values is less reliable (estimation outside domain).
Whilst physical removal from the atmosphere by precipitation and dissolution in clouds can occur, the short atmospheric residence time suggests that wet deposition is of limited importance."

3.1.4 Bioaccumulation and biomagnification

Table 5. Overview of bioaccumulation data for acrolein.

Parameter	Unit	Value	Remark
BCF (fish)	[l.kg^{-1}]	n.r.	
BCF (mussel)	[l.kg^{-1}]	n.r.	
BMF	[kg.kg^{-1}]	n.r.	

The RAR concluded the following on bioaccumulation: "*On the basis of the high water solubility and chemical reactivity of acrolein and its low experimentally determined log K_{ow} of -1.10 (Baker, 1991), no bioaccumulation would be expected. Following the exposure of Bluegill sunfish to ^{14}C-labelled acrolein (0.013 mg/l water) for 28 days, the half-time for removal of radiolabel taken up by the fish was more than 7 days (WHO, 1992). The study does not represent bioaccumulation (BCF was 344) of acrolein per se, but rather incorporation of the radioactive carbon into tissues following the reaction of*

acrolein with protein sulfhydryl groups or metabolism of absorbed acrolein and incorporation of label into intermediary metabolites (WHO, 1992).
The calculation of a BCF for fish and worm according to the TGD QSARs and the subsequent risk assessment for secondary poisoning is considered not to be relevant for this compound."

3.1.5 Human toxicological threshold limits and carcinogenicity

Classification and labelling according to the 28th ATP of Directive 67/548/EEC:

R-phrases:

F; R11

T+; R26

T; R24/25

C; R34

N; R50

S-phrases: S23-S26-S28-S36/37/39-S45-S61

There is evidence from the RAR that acrolein is not an oral carcinogen. The available data do not allow a conclusion with regard to possible carcinogenicity upon exposure by inhalation. No dermal carcinogenicity studies were available.

US-EPA (2003) gives an RfD (=TDI) of 0.5 µg/kg bw/day for acrolein. In the Netherlands an MPC air of 0.5 $\mu g/m^3$ is available. For comparison: the RAR gives an oral NOAEL of 0.05 mg/kg bw/day for acrolein from a two year rat study, and a LOAEL of 0.5 mg/m^3 (lowest value from animal studies) is used in the risk assessment.

3.2 Trigger values

This section reports on the trigger values for MPC_{water} derivation (following WFD methodology).

Table 6. Acrolein: collected properties for comparison to MPC triggers for water ERL-derivation. n.a. = not available, n.r. = not relevant.

Parameter	Value	Unit	Method/Source
log $K_{P,susp\text{-}water}$	- 0.55	[-]	$K_{OC} \times f_{OC,susp}$ [1]
BCF	n.r.	[$l.kg^{-1}$]	
BMF	n.r.	[-]	
log K_{OW}	- 1.1	[-]	
R-phrases	R24, R25, R26, R34, R50	[-]	
A1 value	n.a.	[$\mu g.l^{-1}$]	
DW standard	n.a.	[$\mu g.l^{-1}$]	

[1] $f_{OC,susp} = 0.1\ kg_{OC}.kg_{solid}^{-1}$ ((European Commission (Joint Research Centre), 2003)).
K_{OC} = 2.8 l/kg.

- acrolein has a log $K_{P,\ susp\text{-}water}$ << 3; derivation of $MPC_{sediment}$ is not triggered.
- acrolein has a log $K_{P,\ susp\text{-}water}$ << 3; expression of the MPC_{water} as $MPC_{susp,\ water}$ is not required.

- acrolein is not suspected to bioaccumulate on basis of its low K_{ow}; assessment of secondary poisoning is not triggered.
- acrolein has an R24/25 classification, but BCF values are not available (not relevant). Therefore, MPC_{water} for human health via food (fish) consumption ($MPC_{hh\ food,\ water}$) does not need to be derived.

3.3 Toxicity data and derivation of ERLs for water

3.3.1 $MPC_{eco,\ water}$ and $MPC_{eco,\ marine}$

Note: from the RAR only studies with reliability index scores of 1 and 2 are taken into account for current ERL derivation. Freshwater acute toxicity data for acrolein reported in the RAR are listed in Table 7.

Table 7. Acrolein: selected acute freshwater data for ERL derivation.

Taxonomic group	L(E)C_{50} (μg.l^{-1})
Algae	
Anabaena sp.	690
Cladophora glomerata	1000
Enteromorpha intestinalis	1800
Scenedesmus subspicatus	61
Invertebrates	
Daphnia magna	51
Daphnia magna	90
Aplexa hypnorum	>150
Dreissena polymorpha	15,200
Tanytarsus dissimilis	> 150
Pisces	
Catastomus commersoni	14
Lepomis macrochirus	33
Oncorhynchus mykiss	16
Pimephales promelas	14
Amphibia	
Xenopus laevis	7

In addition to the acute freshwater toxicity data, also marine acute toxicity data were available for acrolein (Table 8).

Table 8. Acrolein: selected acute marine data for ERL derivation.

Taxonomic group	L(E)C_{50} (µg.l^{-1})
Invertebrates	
Crangon crangon	340
Pisces	
Pleuronectes platessa	between 100 and 320

Freshwater chronic toxicity values from the RAR are reported in Table 9. No marine chronic toxicity data are available from the RAR.

Table 9. Acrolein: selected freshwater chronic data for ERL derivation.

Taxonomic group	NOEC (µg.l^{-1})
Bacteria	
Pseudomonas putida	210
Protozoa	
Chilomonas paramecium	1700
Entosiphon sulcatum	850
Uronema parduczi	440
Algae	
Scenedesmus subspicatus	10
Microcystis aeruginosa	40
Invertebrates	
Daphnia magna	16.9
Dreissena polymorpha	1800
Pisces	
Pimephales promelas	11.4

Treatment of fresh- and saltwater toxicity data

No marine PNEC was derived in the RAR. In the current report freshwater and marine data were pooled for the ERL derivations (similar sensitivity).

Derivation of $MPC_{eco, water}$ and $MPC_{eco, marine}$

The RAR concludes the following on the $PNEC_{aquatic}$ derivation: *"The lowest long-term test result for acrolein covering four trophic levels is the Scenedesmus NOEC of 10 µg/l. This NOEC would normally be used for the derivation of the PNEC in water using an assessment factor of 10. However, the available long-term tests do not cover the most sensitive species from the short-term tests, i.e. the LC_{50} for Xenopus laevis of 7 µg/l. Therefore the latter result will be used for the derivation of the PNEC. As there are long-term data available for several trophic levels, an assessment factor of 100 (rather than 1000) is considered to be appropriate. It is further known that the acute/chronic toxicity ratio for fish* *and daphnids is relatively low (ratio between 1.2 and 5.5). However, the entire aquatic data set for acrolein is considered too small to justify a further lowering of the extrapolation factor. The extrapolation with the factor 100 results in a PNEC for aquatic organisms of 0.1 μg/l (rounded off value)."* The $MPC_{eco,\ water}$ is equal to the $PNEC_{aquatic}$, thus 0.1 $\mu g.l^{-1}$.

Data on micro-organism were not taken into account in the RAR when deriving the PNEC water. They were only used for deriving a separate PNEC for the sewage treatment plant. (Note: if data on micro-organisms would have been used, a similar PNEC would have been derived).
In the RAR no effect assessment for the marine environment is carried out. When following the TGD and using the pooled dataset for freshwater and marine organisms an assessment factor of 1000 should be applied to the lowest LC50 value of 7 μg/l. -> $MPC_{eco,\ marine}$ = 0.01 $\mu g.l^{-1}$.

3.3.2 $MPC_{sp,\ water}$ and $MPC_{sp,\ marine}$

Acrolein has a BCF<100. Thus, assessment of secondary poisoning is not triggered (Table 6).

3.3.3 $MPC_{hh\ food,\ water}$

Derivation of $MPC_{hh\ food,\ water}$ for acrolein is not triggered (Table 6).

3.3.4 $MPC_{dw,\ water}$

No A1 value and DW standard are available. The TDI (TL_{hh}) for acrolein amounts to 0.5 μg/ kg bw/day is used. The $MPC_{dw,\ water,\ provisional} = (0.1*TL_{hh} * BW)/uptake = (0.1 * 0.5 * 70)/2 = 1.75\ \mu g.l^{-1}$. According to Zwolsman et al. (2004) the fraction not removable by simple surface water treatment amounts to 0.87 for toluene (evaporation is the main removal step). The $MPC_{dw,\ water,}$ then becomes 1.75/0.87 = 2 $\mu g.l^{-1}$.

3.3.5 Selection of the MPC_{water} and MPC_{marine}

In the Fraunhofer document (Lepper, 2005) it is prescribed that the lowest MPC value should be selected as the general MPC. In the proposal for the daughter directive Priority Substances, a standard based on drinking water was not included. Provisionally, in the Netherlands the $MPC_{dw,\ water}$ will always be noted as a separate value from the other MPC_{water} values ($MPC_{eco,\ water}$., $MPC_{sp,\ water}$ or $MPC_{hh,\ food,\ water}$). From these other MPC's$_{water}$ (thus excluding the $MPC_{dw,\ water}$) the lowest one is taken forward as the 'overall' MPC_{water}. Subsequently, the NC_{water} is always based on this overall MPC_{water} value (1/100th). This irrespective if this value is lower than the $MPC_{dw,\ water}$ or not.
The $MPC_{dw,\ water}$ = 2 $\mu g.l^{-1}$.
The MPC_{water} is the $MPC_{water,\ eco}$ (lowest value of the other values) of 0.1 $\mu g.l^{-1}$.
The only marine MPC of 0.01 $\mu g.l^{-1}$ is set as MPC_{marine}. MPC_{marine} = 0.01 $\mu g.l^{-1}$.

3.3.6 $MAC_{eco,\ water}$

The EC_{50}-value of 7 $\mu g.l^{-1}$ for *Xenopus laevis* is the lowest reported acute toxicity value in the RAR. The base set is complete and acrolein has no potential to bioaccumulate. Furthermore the most sensitive species is assumed to be included in the data set. Therefore, an assessment factor of 10 is applied. The MAC_{eco} for fresh water is 7 $\mu g.l^{-1}$/10 = 0.7 $\mu g.l^{-1}$.

$MAC_{eco,\ marine}$ amounts to 0.7/10 = 0.07 $\mu g.l^{-1}$. It has to be noted that this procedure for $MAC_{eco,\ marine}$ is currently not agreed upon. Therefore, the $MAC_{eco,marine}$ value needs to be re-evaluated once an agreed procedure is available.

3.3.7 NC_{water}

The NC_{water} is set to a factor of 100 below the MPC_{water}. NC_{water} is 0.1/100 = 0.001 µg/l.

3.3.8 $SRC_{eco,\ water}$

More than three NOECs are available for acrolein (see Table 9). Therefore the $SRC_{eco,\ water}$ is based on the geometric mean of these NOEC data without an additional assessment factor (see Table 27 of Van Vlaardingen and Verbruggen, 2007). The $SRC_{eco,\ water}$ for acrolein amounts to 138 $\mu g.l^{-1}$.

3.4 Toxicity data and derivation of ERLs for sediment

The log $K_{p,\ susp\text{-}water}$ of acrolein is below the trigger value of 3, therefore, ERLs are not derived for sediment.

3.5 Toxicity data and derivation of ERLs for soil

No valid experimental data on the toxicity of acrolein to soil organisms are reported in the RAR.

3.5.1 $MPC_{eco,\ soil}$

In the RAR, the equilibrium partitioning method is applied according to the TGD. EUSES is reported to have generated a $PNEC_{terrestrial}$ of 0.02 $\mu g.kg_{dwt}^{-1}$. After conversion to Dutch standard soil the value for the $MPC_{eco,\ soil}$ becomes 0.02* 5.88/2 = 0.06 $\mu g.kg_{dwt}^{-1}$. It should be noted that the use of the equilibrium partitioning method is questionable for chemicals with a very low hydrophobicity (log K_{ow} of -1.1).

3.5.2 $MPC_{human,\ soil}$

The $MPC_{human,\ soil}$ is based on the US-EPA TDI of 0.5 µg/kg bw (see paragraph 3.2). Specific human intake routes are allowed to contribute 10% of the human toxicological threshold limit. Four different routes contributing to human exposure have been incorporated: consumption of leafy crops, root crops, milk and meat. The critical route for acrolein was calculated to be consumption of root crops. The $MPC_{human,\ soil}$ was determined to be 5.6 $\mu g.kg_{dwt}^{-1}$ Dutch standard soil.

3.5.3 Selection of the MPC_{soil}

The lowest MPC_{soil} is the MPC $_{eco,\ soil}$ of 0.06 $\mu g.kg_{dwt}^{-1}$ Dutch standard soil.

3.5.4 NC_{soil}

The NC_{soil} is set a factor 100 lower than the MPC_{soil}. NC_{soil} = 0.0006 $\mu g.kg_{\ dwt}^{-1}$ Dutch standard soil.

3.5.5 $SRC_{eco,\ soil}$

No terrestrial data are presented in the RAR for acrolein. The SRC-value can be based on equilibrium partitioning but it is again emphasized that the validity of the partitioning coefficients is questionable (low K_{ow}). From the $SRC_{eco,\ water}$ of 138 µg/l an $SRC_{eco,\ soil}$ of 0.03*5.88/2 = 0.08 $mg.kg_{dwt}^{-1}$ is derived for Dutch standard soil.

3.6 Derivation of ERLs for groundwater

3.6.1 $MPC_{eco, gw}$

Since groundwater-specific ecotoxicological information is absent, the derived ERLs for surface water based on ecotoxicological data are taken as substitute. Thus, $MPC_{eco, gw} = MPC_{eco, water} = 0.1$ μg.l^{-1}.

3.6.2 $MPC_{human, gw}$

The $MPC_{human, gw}$ is set equal to the $MPC_{dw, water}$. Thus, $MPC_{human, gw} = MPC_{dw, water} = 2$ μg.l^{-1}.

3.6.3 Selection of MPC_{gw}

The lowest available MPC is the $MPC_{eco, gw}$ of 0.1 μg.l^{-1}. Thus, the final $MPC_{gw} = 0.1$ μg.l^{-1}.

3.6.4 NC_{gw}

The NC_{gw} is set a factor 100 lower than the MPC_{gw}. Thus, $NC_{gw} = 0.1/100 = 0.001$ μg.l^{-1}.

3.7 Derivation of ERLs for air

Although it is clear from the RAR that acrolein is a phytotoxic compound, the set of data for the atmospheric compartment was considered insufficient to derive a meaningful PNEC for this compartment. However, in the RAR a prudent attempt is made to estimate an <u>indicative</u> PNEC for acrolein in the atmosphere (plants). This indicative PNEC for plants is derived from the LOEC (9 hours) of 200 μg/m^3 for alfalfa. Taking into account that it concerns a <u>L</u>OEC and short-term data only, and that very few plant species were tested, an extrapolation factor of 100 is in this case considered to be appropriate. This results in an indicative PNEC for plants of 2 μg/m^3. However, based on this indicative value, no $MPC_{eco, air}$ can be derived.
An MPC $_{human,air}$ of 0.5 μg/m^3 (annual average) for man is available. This value is selected as overall MPC_{air} (thereby pragmatically assuming that it will be protective to plants as well). The NC_{air} in the Netherlands amounts to 0.01 μg/m^3 (annual average).

4 Conclusions

In this report, the environmental risk limits negligible concentration (NC), maximum permissible concentration (MPC), maximum acceptable concentration for aquatic ecosystems (MAC_{eco}), and serious risk concentration for ecosystems (SRC_{eco}) are derived for acrolein in water, groundwater, soil and air. No risk limits were derived for the sediment compartment because exposure of sediment is considered negligible. The ERLs that were obtained are summarised in Table 10 below.

Table 10. Derived MPC, NC, MAC_{eco}, and SRC values for acrolein.

ERL	**unit**	**value**			
water		MPC	NC	MAC_{eco}	SRC
$MPC_{eco, water}$	*$\mu g.l^{-1}$*	*0.1*			
$MPC_{dw, water}$	*$\mu g.l^{-1}$*	*2.0*			
$MPC_{sp, water}$	*$\mu g.l^{-1}$*	*n.d* [b]			
$MPC_{hh\ food, water}$	*$\mu g.l^{-1}$*	*n.d.* [b]			
water [a]	$\mu g.l^{-1}$	0.1	0.001	0.7	140
drinking water [a]	$\mu g.l^{-1}$	2.0			
marine	$\mu g.l^{-1}$	0.01		0.07 [c]	
sediment		n.d. [b]			
soil [d]	$\mu g.kg_{dw}^{-1}$	0.06	0.0006		80
groundwater	$\mu g.l^{-1}$	0.1	0.001		
air	$\mu g.m^{-3}$	0.5	0.01		

[a] The $MPC_{dw, water}$ is reported as a separate value from the other MPC_{water} values ($MPC_{eco, water}$, $MPC_{sp, water}$ or $MPC_{hh, food, water}$). From these other MPC_{water} values (thus excluding the $MPC_{dw, water}$) the lowest one is selected as the 'overall' MPC_{water}.

[b] n.d. = not determined.

[c] provisional value.

[d] expressed on Dutch standard soil

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