National Institute
for Public Health
and the Environment

Letter report 601782015/2009

R. van Herwijnen

Environmental risk limits for acrylonitrile

rivm

RIVM Letter report 601782015/2009

Environmental risk limits for acrylonitrile

R. van Herwijnen

Contact:
R. van Herwijnen
Expertise Centre for Substances
rene.van.herwijnen@rivm.nl

This investigation has been performed by order and for the account of Directorate-General for Environmental Protection, Directorate Environmental Safety and Risk Management, within the framework of 'International and National Environmental Quality Standards for Substances in the Netherlands' (INS).

RIVM, P.O. Box 1, 3720 BA Bilthoven, the Netherlands Tel +31 30 274 91 11 www.rivm.nl

Acknowledgements

The results of the present report have been discussed in the scientific advisory group INS (WK INS). The members of this group are acknowledged for their contribution. Marja van de Bovenkamp and Paul Janssen (both RIVM-SIR) are thanked for their assistance in the human toxicological part.

Rapport in het kort

Milieurisicogrenzen voor acrylonitril

Dit rapport geeft milieurisicogrenzen voor acrylonitril in (grond)water, bodem en lucht. Milieurisicogrenzen zijn de technisch-wetenschappelijke advieswaarden voor de uiteindelijke milieukwaliteitsnormen in Nederland. De milieurisicogrenzen voor acrylonitril zijn gebaseerd op de uitkomsten van de EU risicobeoordeling voor acrylonitril (Bestaande Stoffen Verordening 793/93). De afleiding van de milieurisicogrenzen sluit tevens aan bij de richtlijnen uit de Kaderrichtlijn Water. Omdat er geen monitoringsgegevens beschikbaar zijn kan geen verwachting worden uitgesproken of de afgeleide milieurisicogrenzen overschreden zullen worden.

Trefwoorden: milieukwaliteitsnormen; milieurisicogrenzen; acrylonitril; maximaal toelaatbaar risiconiveau; verwaarloosbaar risiconiveau

Contents

Summary

Environmental risk limits (ERLs) are derived using ecotoxicological, physico-chemical 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 acrylonitrile in water, groundwater, soil and air. 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, prepared 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. The substance has a very high vapour pressure but the high water solubility and moderate Henry coefficient make exposure though the water compartment not unrealistic.

For the derivation of the MPC and MAC_{eco} for water, the methodology used is in accordance with the Water Framework Directive. 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}, 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.

Monitoring data for acrylonitrile in the Dutch environment are not available. Therefore it cannot be judged if the derived ERLs are being exceeded.

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

ERL	unit	value			
		MPC	NC	MAC_{eco}	SRC_{eco}
water [a]	$ng.L^{-1}$	36	0.36	1.7×10^4	1.3×10^6
drinking water [b]	$ng.L^{-1}$	98			
marine	$ng.L^{-1}$	36	0.36	1.7×10^3	1.3×10^6
sediment	$\mu g.kg_{dwt}^{-1}$	n.d.			
soil [c]	$\mu g.kg_{dwt}^{-1}$	0.66	6.6×10^{-3}		1.5×10^3
groundwater	$ng.L^{-1}$	98	0.98		1.3×10^6
air	$ng.m^{-3}$	90	0.90		

[a] From the $MPC_{eco,\ water}$, $MPC_{sp,\ water}$ and $MPC_{hh,\ food,\ water}$ the lowest one is selected as the 'overall' MPC_{water}.

[b] The exact way of implementation of the $MPC_{dw,\ water}$ in the Netherlands is at present under discussion. Therefore, the $MPC_{dw,\ water}$ is presented as a separate value in this report.

[c] Expressed on the basis of Dutch standard soil.

n.d. = not derived.

rivm

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 acrylonitrile. 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 serious negative effects in an ecosystem may occur.

It should be noted that ERLs are scientifically derived values, based on (eco)toxicological, fate and physico-chemical data. 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.

1.2 Production and use of acrylonitrile

According to the Risk Assessment Report (RAR) (European Commission, 2004), acrylonitrile is produced in a closed system by catalytic ammoxidation of ammonia and propylene. Fractional distillation of the crude (85%) product following scrubbing to remove ammonia yields 99.9% pure acrylonitrile. In the RAR of 2004 is reported that the current production volume in the EU is in excess of 1,250,000 tonnes per year. Acrylonitrile is now used almost exclusively as a monomer in the production of polymeric materials, with some use as a precursor for acrylamide and adiponitrile. Acrylonitrile can therefore be regarded as an industrial intermediate. More details can be found in the RAR (European Commission, 2004).

2 Methods

2.1 Data collection

The final Risk Assessment Report (RAR) of acrylonitrile (European Commission, 2004) produced in the framework of Existing Substances Regulation (793/93/EEC) was used as only source of physico-chemical and (eco)toxicity data. 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 current 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 for a chemical).

2.2.1 Drinking water abstraction

The INS-Guidance includes the MPC for surface waters intended for the abstraction of drinking water ($MPC_{dw,\ water}$) as one of the MPCs from which the lowest value should be selected as the general MPC_{water} (see INS-Guidance, Section 3.1.6 and 3.1.7). According to the proposal for the daughter directive Priority Substances, however, the derivation of the AA-EQS (= MPC) should be based on direct exposure, secondary poisoning, and human exposure due to the consumption of fish. Drinking water was not included in the proposal and is thus not guiding for the general MPC_{water} value. The exact way of implementation of the $MPC_{dw,\ water}$ in the Netherlands is at present under discussion within the framework of the “AMvB Kwaliteitseisen en Monitoring Water”. No policy decision has been taken yet, and the $MPC_{dw,\ water}$ is therefore presented as a separate value in this report.

The $MPC_{dw,\ water}$ is also used to derive the MPC_{gw}. For the derivation of the $MPC_{dw,\ water}$, a substance specific removal efficiency related to simple water treatment may be needed. Because there is no agreement as yet on how the removal fraction should be calculated, water treatment is not taken into account.

2.2.2 $MAC_{eco, marine}$

In this report, a MAC_{eco} is also derived for the marine environment. The assessment factor for the $MAC_{eco, marine}$ value is based on:

- the assessment factor for the $MAC_{eco, water}$ value, when acute toxicity data for at least two specific marine taxa are available, or
- using an additional assessment factor of 5, when acute toxicity data for only one specific marine taxon are available (analogous to the derivation of the MPC according to Van Vlaardingen and Verbruggen (2007)), or
- using an additional assessment factor of 10, when no acute toxicity data are available for specific marine taxa.

If freshwater and marine data sets are not combined the $MAC_{eco, marine}$ is based on the marine toxicity data using the same additional assessment factors as mentioned above. It has to be noted that this procedure is currently not agreed upon. Therefore, the $MAC_{eco, marine}$ value needs to be re-evaluated once an agreed procedure is available.

3 Derivation of environmental risk limits for acrylonitrile

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

3.1.1 Identity

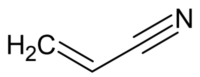

Figure 1. Structural formula of acrylonitrile.

Table 2. Identification of acrylonitrile.

Parameter	Name or number
Chemical name	2-propenenitrile
Common/trivial/other name	vinyl cyanide, cyanoethylene, acrylonitrile
CAS number	107-13-1
EC number	203-466-5
Molecular formula:	C_3H_3N

3.1.2 Physico-chemical properties

Table 3. Physico-chemical properties of acrylonitrile, for original overview and references see De Jong et al. (2007).

Parameter	Unit	Value	Remark
Molecular weight	[g.mol^{-1}]	53.06	
Water solubility	[g.L^{-1}]	73.5	20°C
log K_{OW}	[-]	0.25	shake-flask
K_{OC}	[L.kg^{-1}]	14.1	calculated from Log *K*ow 0.25
Vapour pressure	[Pa]	1.33×10^5	22.8 ºC
Melting point	[°C]	-83.6	
Boiling point	[°C]	77.3	
Henry's law constant	[Pa.m^3.mol^{-1}]	9.6	

n.a. = not applicable.

3.1.3 Behaviour in the environment

Table 4. Selected environmental properties of acrylonitrile.

Parameter	Unit	Value	Remark
Hydrolysis half-life	DT50 [d]	n.a.	
Photolysis half-life	DT50 [d]	5	based on oxidation with OH^-
Degradability			not readily biodegradable

Quote from the RAR:
"Acrylonitrile monomer released to the environment as a consequence of production or further processing will distribute primarily to the atmosphere and to the aqueous environment. Redistribution to other environmental compartments is anticipated to be negligible. There is rapid photodegradation of acrylonitrile, while in the aquatic environment acrylonitrile, while not readily biodegradable based on available information, appears to degrade rapidly in wastewater treatment plants following acclimation, and also degrades in surface water. Up to 99% biodegradation has been reported in simulation tests."

3.1.4 Bioconcentration and biomagnification

An overview of the bioaccumulation data for acrylonitrile is given in Table 5.

Table 5. Overview of bioaccumulation data for acrylonitrile.

Parameter	Unit	Value	Remark
BCF (fish)	[$L.kg^{-1}$]	**48**	experimental value based on ^{14}C uptake, according to RAR probably too high because the value is attributable to binding of acrylonitrile to tissue macromolecules rather than to true bioaccumulation (see RAR)
BCF (fish)	[$L.kg^{-1}$]	1.41	calculated in the RAR with EUSES
BMF	[$kg.kg^{-1}$]	1	default value since the BCF <2000 $L.kg^{-1}$.

In the RAR no final BCF is selected. The QSARs in EUSES are not reliable to calculate BCF values for compounds with low K_{ow} values as acrylonitrile. Therefore, in this report is the experimental value of 48 $L.kg^{-1}$ selected as worst case scenario.

3.1.5 Human toxicology: classification and limit values

The following classification and labelling was reported in the RAR according to the 25th ATP of Directive 67/548/EEC:
Carc. Cat.2; R45 May cause cancer
T; R23/24/25 Also toxic by inhalation, in contact with skin and if swallowed
Xi; R37/38-41 Irritating to respiratory system and skin. Risks of serious damages to eyes
R43 May cause sensitisation by skin contact
N; R51-53 Dangerous for the environment, toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment

Toxicological limit values for oral and inhalation exposure to acrylonitrile have been derived by RIVM/SIR. The EU-RAR concluded that based on the available evidence acrylonitrile should be regarded as a possible genotoxic carcinogen. For such compounds a non-threshold quantitative cancer risk assessment (QCRA) is applied in toxicological limit value derivation. For acrylonitrile an oral limit value was derived on the basis of the lower confidence limit (LCL) of an oral TD05-value obtained via dose-response modelling using the increased incidences of nervous system tumours as found in an oral carcinogenicity study in rats (Biodynamics 1980). The LCL-TD05 of 1.4 $mg.kg_{bw-z}^{-1}.day^{-1}$ (female rats) was recalculated to a lifetime cancer risk of 10^{-6}, which is the risk level used within the present scope (Van Vlaardingen and Verbruggen 2007). The result was an oral limit value of 0.028 $\mu g.kg_{bw}^{-1}.day^{-1}$. For inhalation QCRA, the lower confidence limit of the inhalation TD05-value as derived from a rat inhalation study reported by Quast et al. (1980) was used as point of departure for extrapolation to the lifetime cancer risk of 10^{-6}. Thus, based on an LCL-TD05 of 4.5 $mg.m^{-3}$, obtained via dose-response modelling based on increased incidences of nervous system tumours in female rats, a lifetime cancer risk of 10^{-6} at 0.09 $\mu g.m^{-3}$ was calculated.

3.2 Trigger values

This section reports on the trigger values for ERL_{water} derivation (as demanded in WFD framework).

Table 6. Acrylonitrile: collected properties for comparison to MPC triggers.

Parameter	Value	Unit	Method/Source
Log $K_{p,susp-water}$	0.045	[-]	$K_{OC} \times f_{OC,susp}$ [1]
BCF	48	[$L.kg^{-1}$]	experimental
BMF	1	[$kg.kg^{-1}$]	
Log K_{OW}	0.25	[-]	
R-phrases	R23/24/25, 37/38-41, 43, 45, 51-53	[-]	
A1 value	-	[$\mu g.L^{-1}$]	
DW standard	-	[$\mu g.L^{-1}$]	

1 $f_{OC,susp} = 0.1\ kg_{OC}.kg_{solid}^{-1}$ (European Commission (Joint Research Centre), 2003).

- acrylonitrile has a log $K_{p,\ susp-water} <\ 3$; derivation of $MPC_{sediment}$ is not triggered.
- acrylonitrile has a log $K_{p,\ susp-water} <\ 3$; expression of the MPC_{water} as $MPC_{susp,\ water}$ is not required.
- acrylonitrile has a BCF < 100 $L.kg^{-1}$; assessment of secondary poisoning is not triggered.
- acrylonitrile has an R23/24/25, 37/38-41, 43, 45 classification. Therefore, an MPC_{water} for human health via food (fish) consumption ($MPC_{hh\ food,\ water}$) should be derived.

3.3 Toxicity data and derivation of ERLs for water

Acrylonitrile has been assessed before by De Jong et al. (2007). Only those ERLs that were not derived in that report are derived here. An overview of the selected freshwater toxicity data for acrylonitrile as reported in the RAR and De Jong et al. (2007) is given in Table 7. Marine toxicity data are shown in Table 8.

Table 7. Acrylonitrile: selected freshwater toxicity data for ERL derivation.

Chronic		Acute	
Taxonomic group	**NOEC/EC_{10} ($mg.L^{-1}$)**	**Taxonomic group**	**$L(E)C_{50}$ ($mg.L^{-1}$)**
Crustacea		**Algae**	
Daphnia magna	0.78	*Scenedesmus subspicatus*	3.1
Pisces		**Mollusca**	
Lepomis macrochirus	10.0	*Radix pliculata*	17.94[e]
Pimephales promelas	**0.17**[f]	**Annelida**	
		Limnodrilus hoffmeisteri	16.9
		Crustacea	
		Daphnia magna	11.3[a]
		Insecta	
		Chironomus sp.	14.21
		Pisces	
		Danio rerio	15.0
		Carrasius sp.	40.0
		Cyprinus carpio	21.7[b]
		Lebistes reticulatus	33.5
		Lepomis macrochirus	10.9[c]
		Leucaspius delineatus	22.7
		Leuciscus idus	21.2
		Oncorhynchus mykiss	13.0[d]
		Phoxinus phoxinus	17.6
		Pimephales promelas	10.1[e]
		Rhodeus sericeus	25.7

Notes:
a: geometric mean of 8.7, 7.6 and 22
b: geometric mean of 19.64 and 24
c: geometric mean of 10 and 11.8
d: geometric mean of 7 and 24
e: lowest value for this species
f: is LOEC/2

Table 8. Acrylonitrile: selected marine toxicity data for ERL derivation.

Chronic		Acute	
Taxonomic group	**NOEC/EC_{10} ($mg.l^{-1}$)**	**Taxonomic group**	**$L(E)C_{50}$ ($mg.l^{-1}$)**
Algae		**Bacteria**	
Skeletonema costatum	0.41[b]	*Vibrio fischeri*	254
Pisces		**Algae**	
Cyprinodon variegatus	5.6	*Skeletonema costatum*	1.63
		Annelida	
		Ophryotrocha diadema	18.2
		Crustacea	
		Artemia salina	14.34
		Crangon crangon	10.4[a]
		Pisces	
		Cyprinodon variegatus	8.6
		Gobius minutes	14.0
		Lagadon rhomboides	24.5

Notes:
a: geometric mean of 18.2 and 6 $\mu g.L^{-1}$.
b: lowest value, parameter biomass.

3.3.1 Treatment of fresh- and saltwater toxicity data

Marine data do not indicate a difference in sensitivity between freshwater and marine species. Therefore data for freshwater and marine species are pooled.

3.3.2 Mesocosm studies

No mesocosm studies are presented in the RAR.

3.3.3 Derivation of MPC_{water} and MPC_{marine}

3.3.3.1 $MPC_{eco,\ water}$ and $MPC_{eco,\ marine}$

De Jong et al. (2007) derived an $MPC_{eco,\ water}$ of 17 µg.L^{-1} and an $MPC_{eco,\ marine}$ of 1.7 µg.L^{-1}. The lower value of 0.08 mg.L^{-1} for *Radix peregra* was not used in the derivation because this value was not considered valid in the RAR and only given as supporting information.

3.3.3.2 $MPC_{sp,\ water}$ and $MPC_{sp,\ marine}$

Acrylonitrile has a BCF < 100 L.kg^{-1}, thus assessment of secondary poisoning is not triggered.

3.3.3.3 $MPC_{hh\ food,\ water}$

Derivation of $MPC_{hh\ food,\ water}$ for acrylonitrile is triggered (Table 6). This derivation is based on the oral limit value of 0.028 µg.kg_{bw}^{-1}.day^{-1}. $MPC_{hh,\ food}$ = 0.1 * 0.028*70/0.115 = 1.7 µg.kg_{feed}^{-1}. The resulting $MPC_{hh\ food,\ water}$ is then: 1.7 / (48*1) = 0.036 µg.L^{-1}.

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

The lowest value is the $MPC_{hh\ food,water}$ of 0.036 µg.L^{-1}. This sets the final MPC_{water} to the MPC of human health: 0.036 µg.L^{-1}. Similarly is the final MPC_{marine}: 0.036 µg.L^{-1}.

3.3.4 $MPC_{dw,\ water}$

No A1 value and DW standard are available for acrylonitrile. With the oral limit value of 0.028 µg.kg_{bw}^{-1}.d^{-1} an $MPC_{dw,\ water,\ provisional}$ can be calculated with the following formula: $MPC_{dw,\ water,\ provisional}$ = 0.1.TL_{hh}.BW / $Uptake_{dw}$ where TL_{hh} is the oral limit value, BW is a body weight of 70 kg, and $uptake_{dw}$ is a daily uptake of 2 L. As described in section 2.2 water treatment is currently not taken into account. Therefore the $MPC_{dw,\ water}$ = The $MPC_{dw,water,\ provisional}$ and becomes: 0.1 * 0.028 * 70 / 2 = 0.098 µg.L^{-1}.

3.3.5 Derivation of MAC_{eco}

The MAC_{eco} is based on the lowest L(E)C50. This is the algae *Skeletonema costatum* with an L(E)C50 of 1.63 mg.L^{-1} (see Table 8). An assessment factor of 100 is applied since acryloniltrile has no potential to bioaccumulate. This sets the $MAC_{eco,\ water}$ initially to 16.3 µg.L^{-1}. This value is not deemed realistic since this would imply that one expects acute toxic effects at concentrations below the ERL that protects from chronic exposure (van Vlaardingen and Verbruggen 2007). Therefore is the $MAC_{eco,\ water}$ set equal to the $MPC_{eco,\ water}$: 17 µg.L^{-1}.

The $MAC_{eco,\ marine}$ is set a factor 10 lower than the initial $MAC_{eco,\ water}$ since there are no data for additional marine taxa. The fish, *Cypridon variegates,* and annelinda, *Ophryotrocha diadema,* in Table 8 do not account as additional marine taxonomic groups since they have the same life form and feeding strategy as freshwater species. Therefore is the $MAC_{eco,\ marine}$ is initiall set to 1.63 µg.L^{-1}. This value is lower than the $MPC_{eco,\ marine}$ of 1.7 µg.L^{-1}. Therefore is the $MAC_{eco,\ marine}$ set equal to the

$MPC_{eco, marine}$: 1.7 µg.L^{-1}.It has to be noted that this procedure for the $MAC_{eco, marine}$ is currently not agreed upon. Therefore, the $MAC_{eco, marine}$ needs to be re-evaluated once an agreed procedure is available.

3.3.6 Derivation of NC

Negligible concentrations are derived by dividing the MPCs by a factor 100. This gives an NC_{water} of 0.36 ng.L^{-1} and an NC_{marine} of 0.36 ng.L^{-1}

3.3.7 Derivation of $SRC_{eco, aquatic}$

De Jong et al. (2007) derived an $SRC_{eco, aquatic}$ of 1.25 mg.L^{-1}. The $SRC_{eco, aquatic}$ is valid for the marine and the freshwater environment.

3.4 Toxicity data and derivation of ERLs for sediment

The log $K_{p, susp\text{-}water}$ of acrylonitrile 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 data for soil organisms has been presented in the EU-RAR.

3.5.1 Derivation of the MPC_{soil}

3.5.1.1 $MPC_{eco, soil}$

De Jong et al. (2007) derived an MPC_{soil} of 0.021 mg.kg_{dwt}^{-1} for Dutch standard soil.

3.5.1.2 $MPC_{human, soil}$

For the derivation of the $MPC_{human, soil}$, the oral limit value of 0.028 µg.kg_{bw}^{-1}.day^{-1} can be used as TL_{hh} with the method as described in Van Vlaardingen and Verbruggen (2007). For this calculation, the log K_{ow}, log K_{oc} and Henry coefficient are the same as used by De Jong et al. (2007). For the solubility, the value from table 3 has been used. This is the geometric mean of all solubility data presented in De Jong et al. (2007). 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. Uptake via root crops was determined to be the critical route. The calculated $MPC_{human, soil}$ is 0.66 µg.kg_{dwt}^{-1} for Dutch standard soil.

3.5.1.3 Selection of the MPC_{soil}

Since the $MPC_{human, soil}$ is the lowest value, the MPC_{soil} is 0.66 µg.kg_{dwt}^{-1} for Dutch standard soil.

3.5.2 Derivation of NC_{soil}

Negligible concentrations are derived by dividing the MPCs by a factor 100. This gives an NC_{soil} of 6.6 ng.kg_{dw}^{-1}.

3.5.3 Derivation of $SRC_{eco, soil}$

De Jong et al. (2007) derived an $SRC_{eco, soil}$ of 1.5 mg.kg_{dwt}^{-1} for Dutch standard soil.

3.6 Derivation of ERLs for groundwater

3.6.1 Derivation of MPC_{gw}

3.6.1.1 $MPC_{eco, gw}$

Since groundwater-specific exotoxicological information for the groundwater compartment is absent, the surface water $MPC_{eco, water}$ is taken as substitute. De Jong et al. (2007) derived an $MPC_{eco, water}$ of 17 $\mu g.L^{-1}$ Thus, $MPC_{eco, gw}$ = $MPC_{eco, water}$ = 17 $\mu g.L^{-1}$.

3.6.1.2 $MPC_{human, gw}$

The $MPC_{human, gw}$ is set equal to the $MPC_{dw, water}$.
Therefore the $MPC_{human, gw}$ = $MPC_{dw, water}$: 0.098 $\mu g.L^{-1}$.

3.6.1.3 Selection of MPC_{gw}

The lowest MPC_{gw} is the $MPC_{human, gw}$ which makes the MPC_{gw}: 0.098 $\mu g.L^{-1}$.

3.6.2 Derivation of NC_{gw}

Negligible concentrations are derived by dividing the MPCs by a factor 100. This gives an NC_{gw} of 0.98 $ng.L^{-1}$.

3.6.3 Derivation of $SRC_{eco, gw}$

The $SRC_{eco, gw}$ is set equal to the $SRC_{eco, water}$. Therefore the $SRC_{eco, gw}$ is: 1.25 $mg.L^{-1}$.

3.7 Derivation of ERLs for air

3.7.1 Derivation of the MPC_{air}

3.7.1.1 $MPC_{eco, air}$

In the RAR a $PNEC_{air}$ has been derived using LC50 data for a number of insect species and assuming a conservative figure of 0.5 $mg.L_{air}^{-1}$ for the LC50 gives. The derived PNEC is 0.5 $\mu g.L_{air}^{-1}$. This value can be taken over as an $MPC_{eco, air}$ of 0.5 $mg.m^{-3}$.

3.7.1.2 Derivation of $MPC_{human, air}$

In section 3.1.5 an inhalation limit value of 0.09 $\mu g.m^{-3}$ has been derived. This value will be set as the $MPC_{human, air}$. The $MPC_{human, air}$ is: 0.09 $\mu g.m^{-3}$.

3.7.1.3 Selection of the MPC_{air}

The lowest MPC_{air} available is the $MPC_{human, air}$ so the MPC for air will be the $MPC_{human, air}$: 90 $ng.m^{-3}$.

3.7.2 Derivation of NC_{air}

The MPC_{air} divided by 100 is the NC_{air}: 0.90 $ng.m^{-3}$

3.8 Comparison of derived ERLs with monitoring data

The RIWA (Dutch Association of River Water companies, www.riwa.org) does not present any surface water monitoring for acrylonitrile in their annual reports between 2001 and 2006. Also the Dutch Ministry of Transport, Public Works and Water Management does not present any monitoring data for acrylonitrile on their website (www.waterstat.nl). Therefore, no comparison of the derived ERLs with monitoring data is possible.

rivm

4 Conclusions

In this report, the risk limits Negligible Concentration (NC), Maximum Permissible Concentration (MPC), Maximum Acceptable Concentration for ecosystems (MAC_{eco}), and Serious Risk Concentration for ecosystems (SRC_{eco}) are derived for acrylonitrile in water, groundwater, soil and air. The ERLs that were obtained are summarised in the table below. Monitoring data for acrylonitrile in the Dutch environment are not available. Therefore it cannot be judged if the derived ERLs are being exceeded.

Table 9. Derived MPC, NC, MAC_{eco}, and SRC values for acrylonitrile.

ERL	unit	value			
		MPC	NC	MAC_{eco}	SRC_{eco}
water [a]	$ng.L^{-1}$	36	0.36	1.7×10^4	1.3×10^6
drinking water [b]	$ng.L^{-1}$	98			
marine	$ng.L^{-1}$	36	0.36	1.7×10^3	1.3×10^6
sediment	$\mu g.kg_{dwt}^{-1}$	n.d.			
soil [c]	$\mu g.kg_{dwt}^{-1}$	0.66	6.6×10^{-3}		1.5×10^3
groundwater	$ng.L^{-1}$	98	0.98		1.3×10^6
air	$ng.m^{-3}$	90	0.90		

[a] From the $MPC_{eco, water}$, $MPC_{sp, water}$ and $MPC_{hh, food, water}$ the lowest one is selected as the ‘overall’ MPC_{water}.

[b] The exact way of implementation of the $MPC_{dw, water}$ in the Netherlands is at present under discussion. Therefore, the $MPC_{dw, water}$ is presented as a separate value in this report.

[c] Expressed on the basis of Dutch standard soil.

n.d. = not derived.

References

Biodynamics. 1980. A twenty-four month oral toxicity/carcinogenicity study of acrylonitrile administered to Fischer 344 rats in the drinking water, Vol. 1-2. Prepared by Biodynamics Inc., Division of Biology and Safety Evaluation, East Millstone, NJ, for Monsanto Company, St. Louis, MO.

De Jong FMW, Posthuma-Doodeman CJAM, Verbruggen EMJ. 2007. Ecotoxicologically based environmental risk limits for several volatile aliphatic hydrocarbons. Bilthoven, The Netherlands: National Institute for Public Health and the Environment (RIVM). Report no. 601782002. 217 pp.

European Commission. 2004. Acrylonitrile. Risk Assessment Report, Vol. 32. Luxembourg: Office for Official Publications of the European Communities. EUR 20857 EN.

European Commission (Joint Research Centre). 2003. Technical Guidance Document in support of Commission Directive 93/67/EEC on Risk Assessment for new notified substances, Commission Regulation (EC) No 1488/94 on Risk Assessment for existing substances and Directive 98/9/EC of the European Parliament and of the Council concerning the placing of biocidal products on the market. Part II. Ispra, Italy: European Chemicals Bureau, Institute for Health and Consumer Protection. Report no. EUR 20418 EN/2.

Lepper P. 2005. Manual on the Methodological Framework to Derive Environmental Quality Standards for Priority Substances in accordance with Article 16 of the Water Framework Directive (2000/60/EC). 15 September 2005 (unveröffentlicht) ed. Schmallenberg, Germany: Fraunhofer-Institute Molecular Biology and Applied Ecology.

Quast JF, Wade CE, Humiston CG, Carreon RM, Hermann EA, Park CN, and Schwetz BA. 1980. A two-year toxicity and oncogenicity study with acrylonitrile incorporated in the drinking water of rats. Prepared by the Toxicology Research Laboratory, Health and Environmental Sciences, Dow Chemical USA, Midland, MI for the Chemical Manufacturers Association, Washington, DC.

Van Vlaardingen PLA, Verbruggen EMJ. 2007. Guidance for the derivation of environmental risk limits within the framework of the project 'International and National Environmental Quality Standards for Substances in the Netherlands' (INS). Bilthoven, The Netherlands: National Institute for Public Health and the Environment (RIVM). Report no. 601782001.

RIVM

National Institute
for Public Health
and the Environment

P.O. Box 1
3720 BA Bilthoven
The Netherlands
www.rivm.com