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Environmental Risk Assessments for Topical Antiseptic Ingredients: Benzalkonium Chloride

american cleaning institute®

Benzalkonium chloride risks to aquatic and benthic invertebrates are uncertain, depending on bioavailability. Exposures via biosolids are not of concern.

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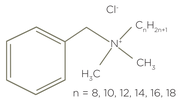
INTRODUCTION

- Benzalkonium chloride (BAC) is a cationic surfactant used in cleaning and personal care products, as well as agricultural and industrial applications
- Now being used to replace triclosan and triclocarban in soaps and hand washes
- BAC is a group of quaternary ammonium salts with this structure:



n = 8, 10, 12, 14, 16, 18

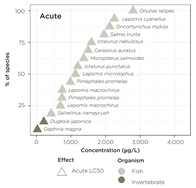
Objectives

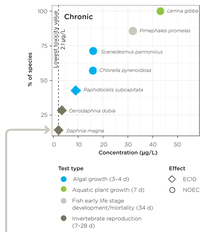
- Compile occurrence, fate and effects data
- Assess environmental risks from down-the-drain disposal for recent past and projected future scenarios
- Identify key uncertainties and options to refine the assessment

EFFECTS ASSESSMENT

Identified lowest toxicity value (LTV) by media. Target margin of safety set to 10 based on availability of chronic data for most sensitive organism types (USEPA 1984).

Aquatic species sensitivity

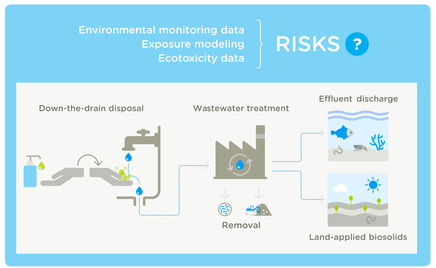




Geometric mean of 4 values, ranging from an EC10 of 0.06 µg/L to an unbounded NOEC of 40 µg/L (McIntyre and Pate 1992, NITE 2001, Lavorgna et al 2016, Castro et al 2018).

EXPOSURE ASSESSMENT

Conceptual model

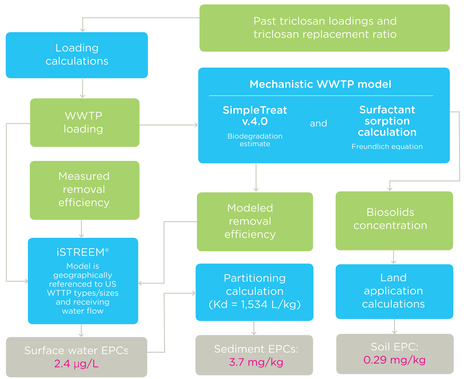


Recent past

- Exposures estimated from monitoring data to the extent possible
- Compiled surface water and sediment data for US and Western Europe
- No data for biosolids-amended soil, so applied same model as in future scenario, with median and 95th percentile of measured influent BAC concentrations as input

Projected future scenario

Exposures estimated through modeling (95th percentile exposure point concentrations [EPCs] shown)



Why so much variability among studies?

Surfactants sorb to surfaces and dissolved organic matter can affect reproducibility of toxicity studies.

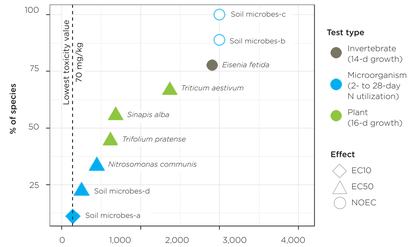
In acute studies, adding dissolved organic carbon increased *D. magna* EC50s based on total BAC, while EC50s based on freely dissolved BAC remained constant (Chen et al 2014). No comparable chronic data was available.

Sediment toxicity

One spiked sediment toxicity study available (England and Leak 1995), provides NOEC and LOEC of 260 and 520 mg/kg for 28-day *Chironomus dilutus* growth.

Also extrapolated the surface water LTV to sediment (3.2 mg/kg), using a partition coefficient calculated from paired surface water and sediment data (Martínez-Carballo et al 2007a,b).

Terrestrial species sensitivity



Letters indicate separate microbial tests, assumed to represent distinct microbial communities. Open symbols indicate unbounded values.

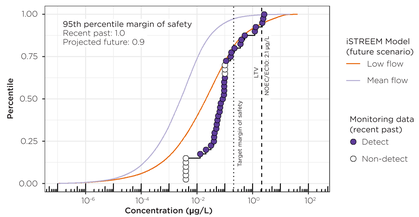
RISK CHARACTERIZATION

Surface water

Essentially no margin of safety at the high end for current LTV.

Why are past and future concentrations so similar?

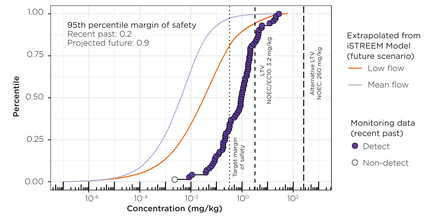
- Increased use is incremental
- Monitoring tends to target areas where analytes most likely to be found



Sediment

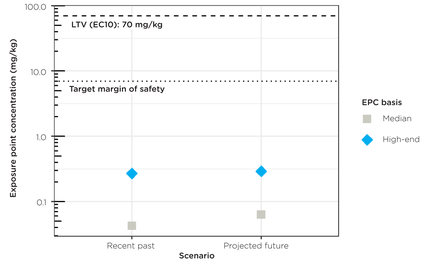
High-end concentrations exceed the LTV extrapolated from surface water, but spiked sediment NOEC is 100x higher. Bioavailability of BAC in sediment is uncertain.

Sediment monitoring data primarily represent New York/New Jersey Harbor area; concentrations elsewhere are likely lower than in this major urban area.



Soil

Ample margins of safety for BAC in biosolids-amended soil.



RISK CONCLUSIONS

BAC concentrations in effluent-dominated systems might impair reproduction of sensitive invertebrates, but this finding is highly uncertain.

- High variability in critical toxicity endpoint
- BAC bioavailability to zooplankton in a laboratory setting may not be representative of field conditions, where organic matter is prevalent

No adverse ecological effects are predicted from BAC in biosolids-amended soil.

OPTIONS TO REFINE ASSESSMENT

- Investigate factors that affect chronic BAC toxicity to invertebrates, to support LTVs that apply to real-world conditions
- Refine sediment hazard profile (toxicity, bioavailability)

Want to know more?
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