AQUATIC TOXICITY OF CATIONIC POLYMERS

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Introduction

Cationic polymers are large, charged, surface active compounds that are widely used globally in various applications.

Polymers are currently exempted from REACH registration. Polymers are very diverse and often assumed they are not toxic due to high MW. Inclusion in REACH requires further scientific support.

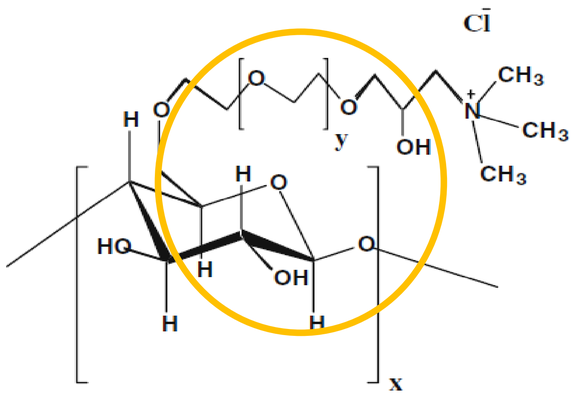
Due to their ability to bind to negatively charged surfaces, a cationic polymer can impair aquatic organisms. An effect that may not follow a well-defined internal dose-response relationship.

Hypothesis

Cationic polymers can impair aquatic organisms due to their charge-driven interaction with the surface of the organism. The test media will impact the effect of the polymer, making effects cationic polymers difficult to test.

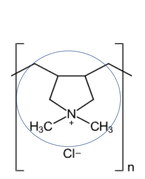
Materials and methods

To gain a detailed level of information and identify all relevant effect-predictors, the initial focus of the project is on four different polyquaterniums, starting with the different tradenames of Polyquaternium 10 (PQ-10).

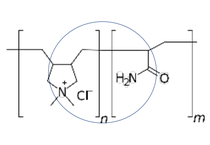


Polyquaternium 10

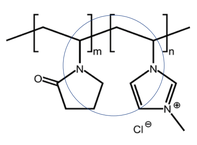
Toxicity was tested for the different PQ-10's listed in the table below. The standard methods applied were: ISO 11348-3, OECD 201, OECD 202 and OECD 236 test guidelines. Problematic areas in these tests were identified for when testing the toxicity of polyquaterniums. Ongoing changes of the methods will build upon the methods making them appropriate for testing polyquaterniums.



Polyquaternium 6



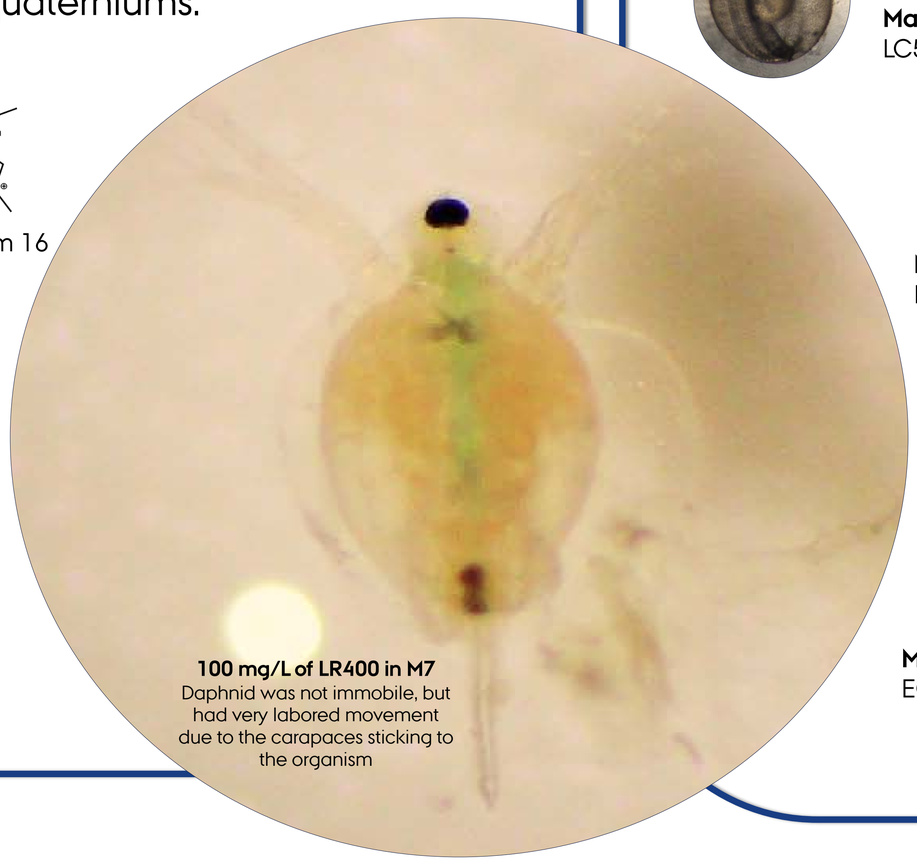
Polyquaternium 7



Polyquaternium 16

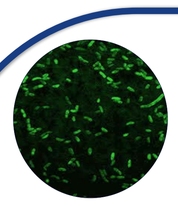
Properties of Polyquaternium 10

Tradename	MW	Charge density (CD)
UCARE JR125	Low (250 kDa)	Medium
UCARE JR30M	High (600 kDa)	High
UCARE JR400	Low	Medium
UCARE LR30M	High	Low
UCARE LR400	Low	Low



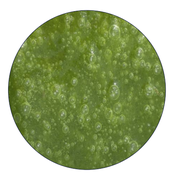
100 mg/L of LR400 in M7
Daphnid was not immobile, but had very labored movement due to the carapaces sticking to the organism

Results Rangefinders, acute (mg/L)



Aliivibrio fischeri

Material	JR30M	JR125	JR400	LR30M	LR400
IC50	>1000	>1000	>1000	>1000	>1000



Desmodesmus subspicatus

Material	JR30M	JR125	JR400	LR30M	LR400
ECr50	>100	>100	>100	>100	>100

Danio rerio **embryo**

Material	JR30M	JR125	JR400	LR30M	LR400
LC50	9	89	9	>1000	321

Ceriodaphnia dubia Reconstituted water

Material	JR30M	JR125	JR400	LR30M	LR400
EC50	<1	<1	<1	10-100	1-10

Daphnia magna Reconstituted water

Material	JR30M	JR125	JR400	LR30M	LR400
EC50	23	100-1000	100-1000	>1000*	93

Daphnia magna M7 water

Material	JR30M	JR125	JR400	LR30M	LR400
EC50	100-1000	>1000*	100-1000	>1000*	100-1000

* Labored movement

Discussion

Toxicity varied between different tradenames of PQ-10 following patterns of high charge density, high toxicity, pointing towards charge density as a descriptor of toxicity. *Ceriodaphnia* were the most sensitive test organism and *Danio rerio* were in general more sensitive than *Daphnia magna*. The differences are possibly linked to the surface "mode of toxicity" of the polymer.

All impairments of the daphnids and fish embryos could be visually seen as a surface-polymer interaction leading to mortality or labored movement.

For the *Daphnia magna*-range finders different test waters gave different results, indicating an influence of water parameters as e.g. hardness when assessing toxicity of cationic polymers.

HA

The effect of water type points toward the importance of investigating other water components effect on toxicity – e.g. the effect of humic acid.

Conclusions

- Charge density is a possible driver for toxicity
- Impairments are caused by surface-polymer interaction
- Water parameters could impact effect
- Further testing will add to more scientific support for these claims
- More PQ's need to be tested

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Project webside

LRI ECO46

References:
Biesinger & Stokes 1986, Cumming 2008, Cumming et al 2011, DOW TDS, DOW Product brochure, Hall & Mirenda 1991, Muir et al 1997, Pereira et al 2018