Determining the Toxicity of Deicing Materials

FACT SHEET **December 2013**

Need for Research

The potential aquatic toxicity of liquid deicing products has not been thoroughly studied and thresholds at which these products adversely affect aquatic biota are largely unknown.

Objectives and Methodology

The goal of this project was to develop a ranking of the relative toxicity of eight liquid deicing products. The study included a range of deicing products and commercially available inhibitors. Researchers examined the acute and chronic toxic effects (survival, growth, and young production) of the deicing products on test species *Ceriodaphnia dubia* (a crustacean), *Pimephales promelas* (a fish), and *Selenastrum capricornutum* (an algae). Acute and chronic toxicity was established in a controlled laboratory setting using US EPA standardized laboratory aquatic toxicity testing techniques.

Study Results

As part of this study a total of seven acute and chronic toxicological thresholds were developed. Two of these thresholds, the LC50 for acute survival and the IC50 for chronic growth or reproduction are provided in Table 1. The LC50 is the concentration of deicing product at which there is 50 percent mortality for the test organisms. The IC50 is the concentration of deicing product at which there is a 50 percent reduction in growth or reproduction. Additional thresholds are provided in the final report.

These thresholds can be used to estimate toxicity potential of deicing chemicals. Retention of product along the roadway buffer, the rates of product release from land, as well as dilution with precipitation on the roadway and the receiving stream will need to be considered when assessing potential effects. These tests measure only short term toxicity. They do not measure long term toxicity nor do they consider biodegradability or half-life of the products.

Relative Toxicity

Below is a figure that shows the ranking of the deicing products from lowest to highest toxicity based upon product mass tested. This ranking was developed from test results for all three test species and all seven toxicity endpoints calculated as part of this study.

In general deicing product composition had a bearing on observed toxicity and the following trend from most to least toxic was identified: K-Acetate > $MgCl_2$ > $CaCl_2$ > NaCl.

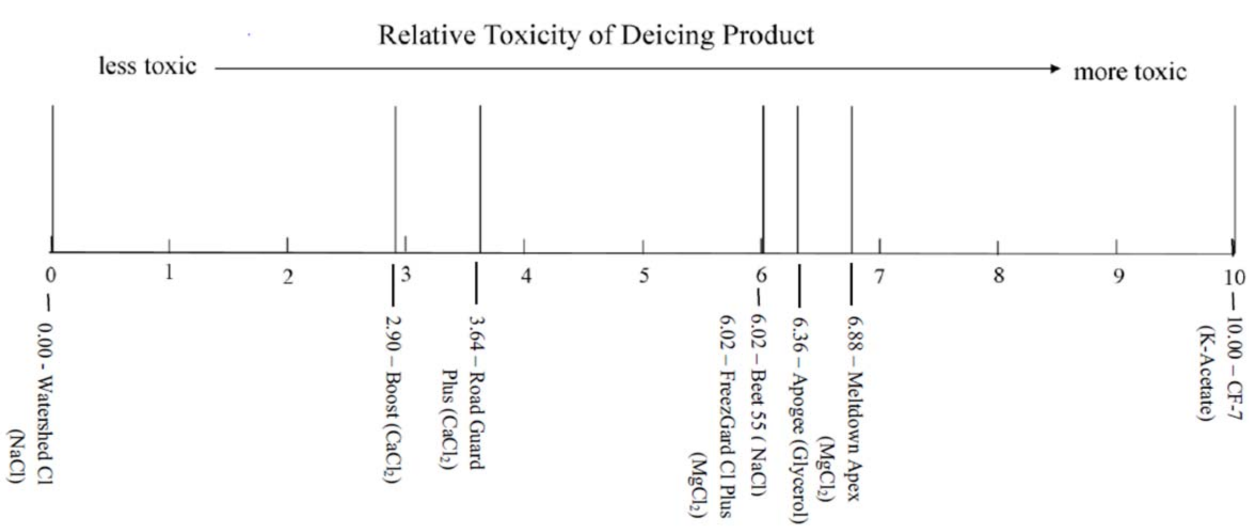

Table 1. Toxicity Testing Results

Product	Relative Toxicity	C. dubia Acute LC50[1]	C. dubia Chronic IC50[2]	Fathead Minnow Acute LC50[1]	Fathead Minnow Chronic IC50[3]	S.Capricornutum Chronic IC50[4]
Watershed CI(NaCl)	0.00	13	2.7	23	26	19
Boost($CaCl_2$)	2.90	6.0	2.2	3.7	3.2	5.0
Road Guard Plus($CaCl_2$)	3.64	6.5	2.7	2.1	2.5	4.0
Beet 55(NaCl)	6.02	12	0.29	2.5	2.5	5.1
FreezGard CI Plus($MgCl_2$)	6.02	14	0.15	1.7	3.3	6.6
Apogee(Glycerol)	6.36	>8.0	1.2	>16	0.31	0.08
Meltdown Apex($MgCl_2$)	6.88	5.8	0.046	3.3	7.0	3.1
CF-7(K-Acetate)	10.00	1.0	0.0035	1.3	2.1	0.44

All toxicological endpoints as mL of product per liter of diluent
Values rounded to two signficant digits
1. Endpoint is survival
2. Endpoint is reproduction
3. Endpoint is growth
4. Endpoint is cell growth

Corrosion Inhibitors

Each of the products tested contained a corrosion inhibitor. Inhibitors influence the toxicity. This can be seen by looking at the relative toxicity of two corrosion inhibited liquid NaCl products. The relative salt brine concentration for Watershed CI is 22% and Beet 55 is 17%, but Watershed CI's relative toxicity is 0.00 whereas Beet 55's relative toxicity is 6.02. Why is this? Because the toxicity is based on more than the salt being used. It depends on the type of inhibitor in the product and on the quantity of inhibitor added. Watershed CI product has a 5% (V/V) inhibitor added while the Beet 55 product has a 30% (V/V) inhibitor addition. As can be seen with the NaCl products, the inhibitor can have a large impact on the toxicity. Inhibitor ingredients were not supplied for this study and were not studied independently of the salt in the deicer.

Benefits and Future Research

To better understand the effects of deicing chemicals in the environment, the following research is recommended:

1. Evaluation of long term persistence of deicing products in water
2. Isolation of corrosion inhibitor contribution to aquatic toxicity
3. Toxicity of rock salt without inhibitor
4. Development of a science-based methodology that allows maintenance professionals to calculate impact to aquatic systems based on applications rates and materials selected so they can make the best choices
5. Development of an optimization decision-based methodology that includes ice melt capacity, acute and chronic aquatic toxicity, and other environmental considerations

Where do I get more information?

The full report can be found at www.clearroads.org

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