The Power and Challenges of Acetates
August 7, 2024

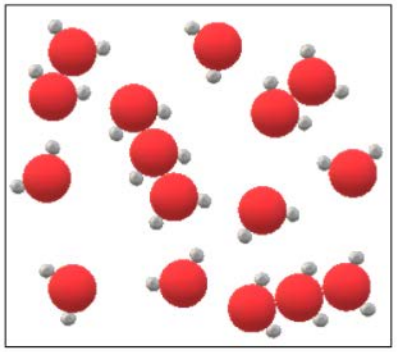
CRYOTECH

Outline

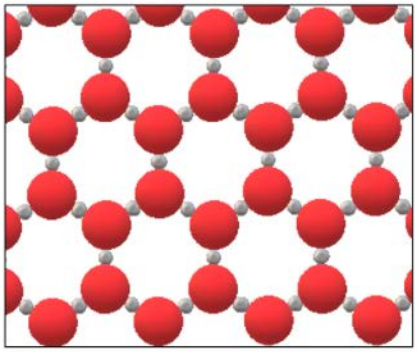
- **The Power of Acetates**
  - They work great—even in extreme conditions
  - They have low corrosivity and can even inhibit corrosion
  - They are environmentally sound
- **The Challenges of Acetates**
  - They are <expletive deleted> expensive

How Deicers Work

When water freezes, it goes from a mass of jumbled jiggling molecules gradually settling down to bond with each other in a lower energy ordered arrangement.

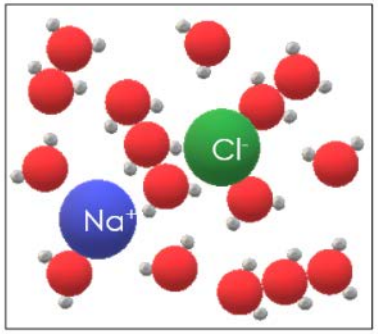


Liquid Water



Crystalline Ice

When chemical deicers are introduced, they work by attracting water molecules and interfering with their ability to bond with each other.



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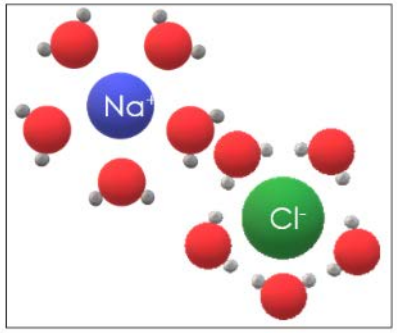

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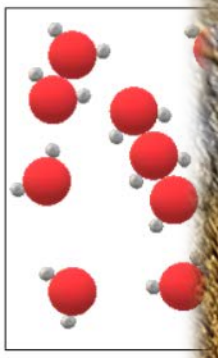

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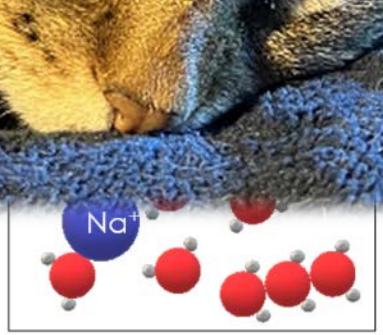

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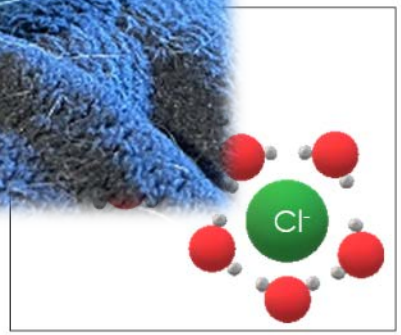

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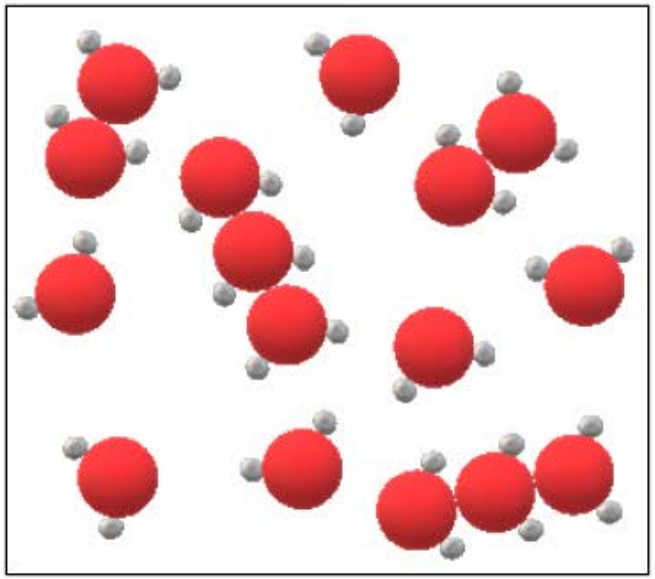

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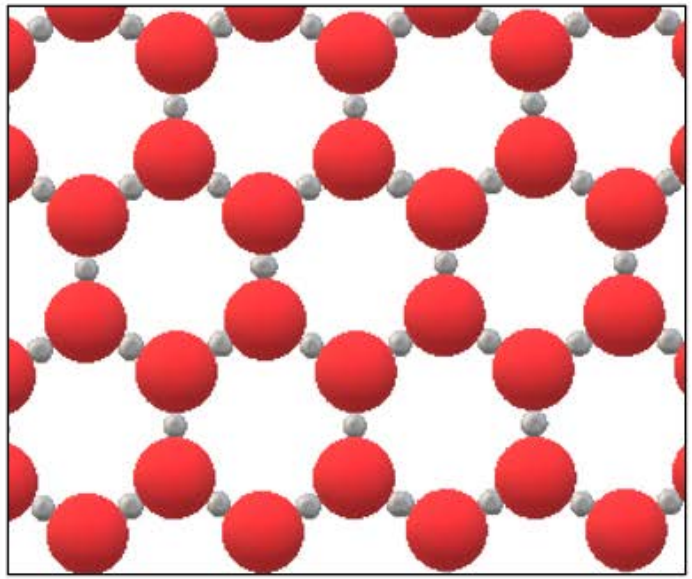

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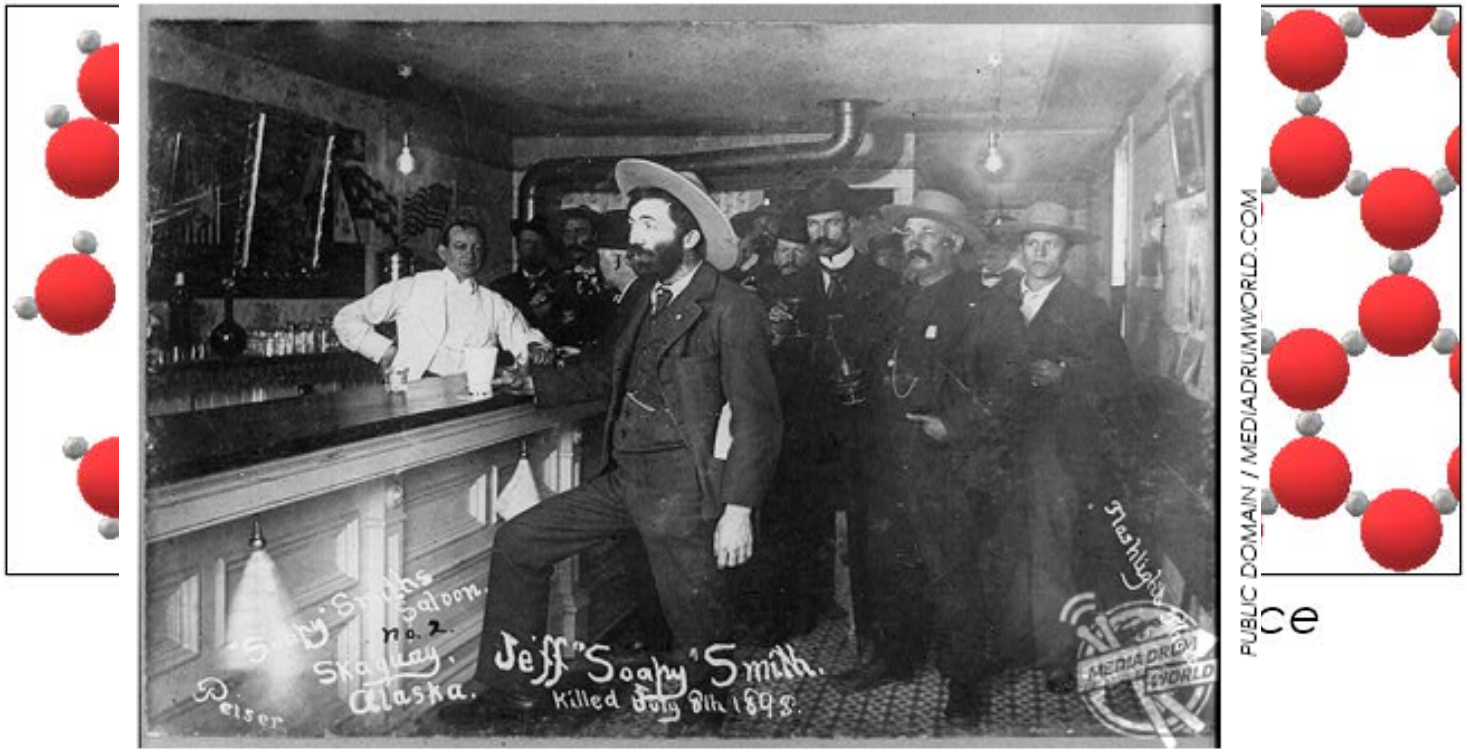

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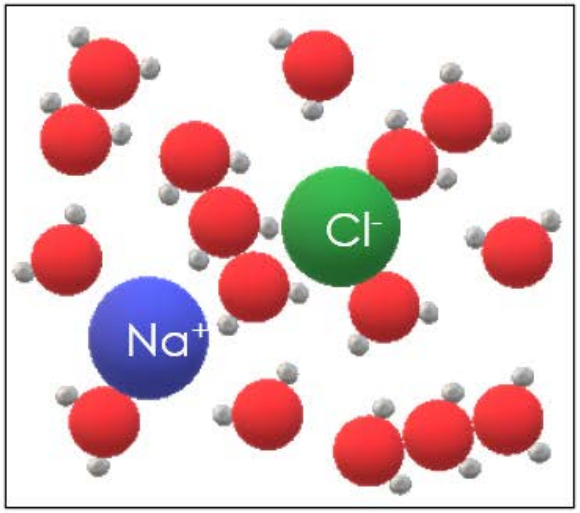

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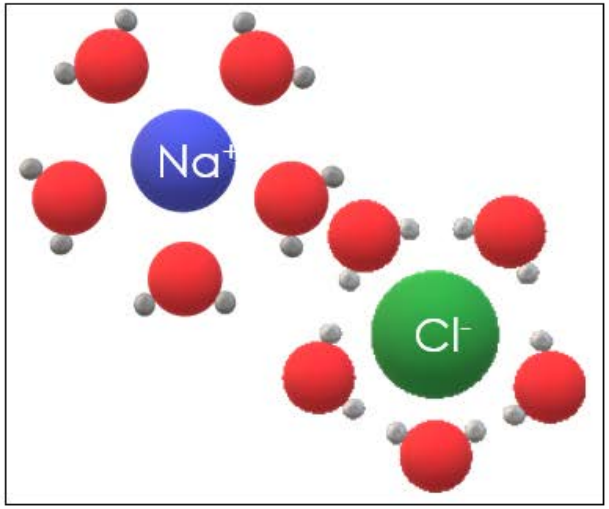

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Acetates Performance

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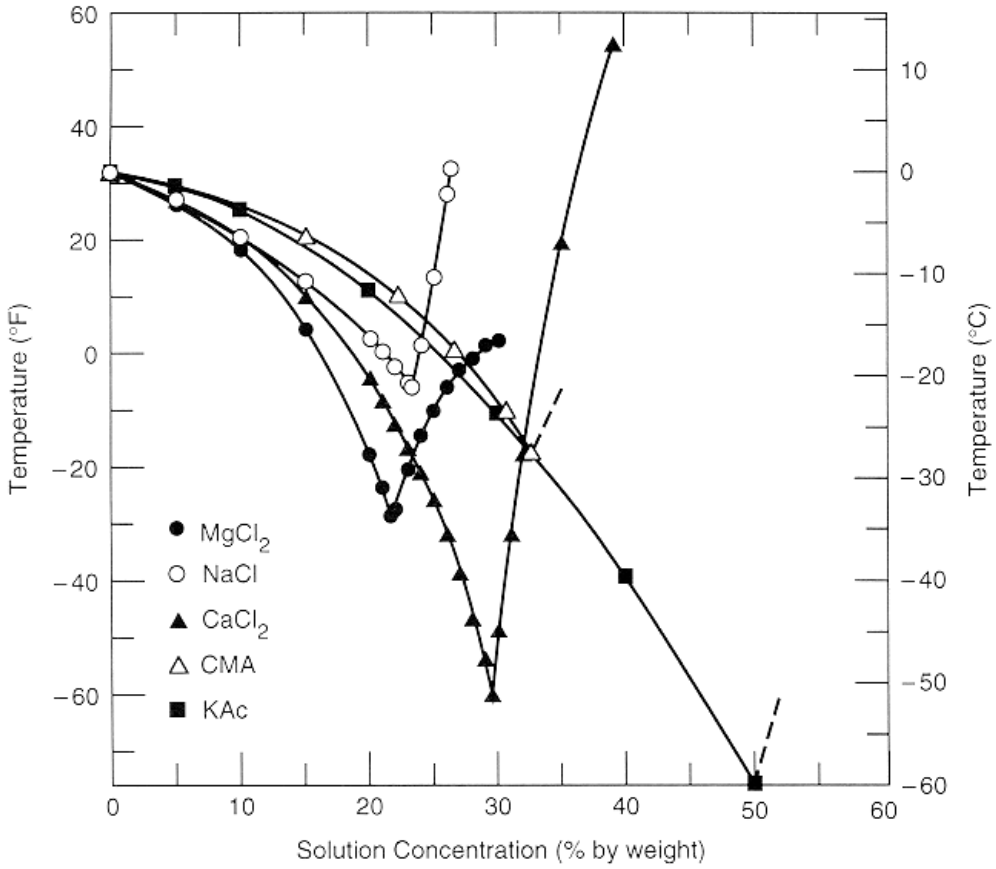
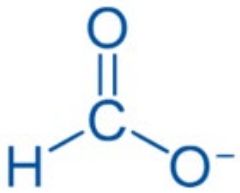


https://www.fhwa.dot.gov/publications/research/safety/95202/005.cfm

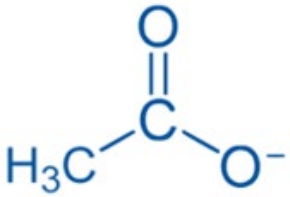
Acetates/Formates Liquids

- Formate deicers start melting ice a little faster
- Acetate deicers last a little longer to protect ice from adhering to the pavement

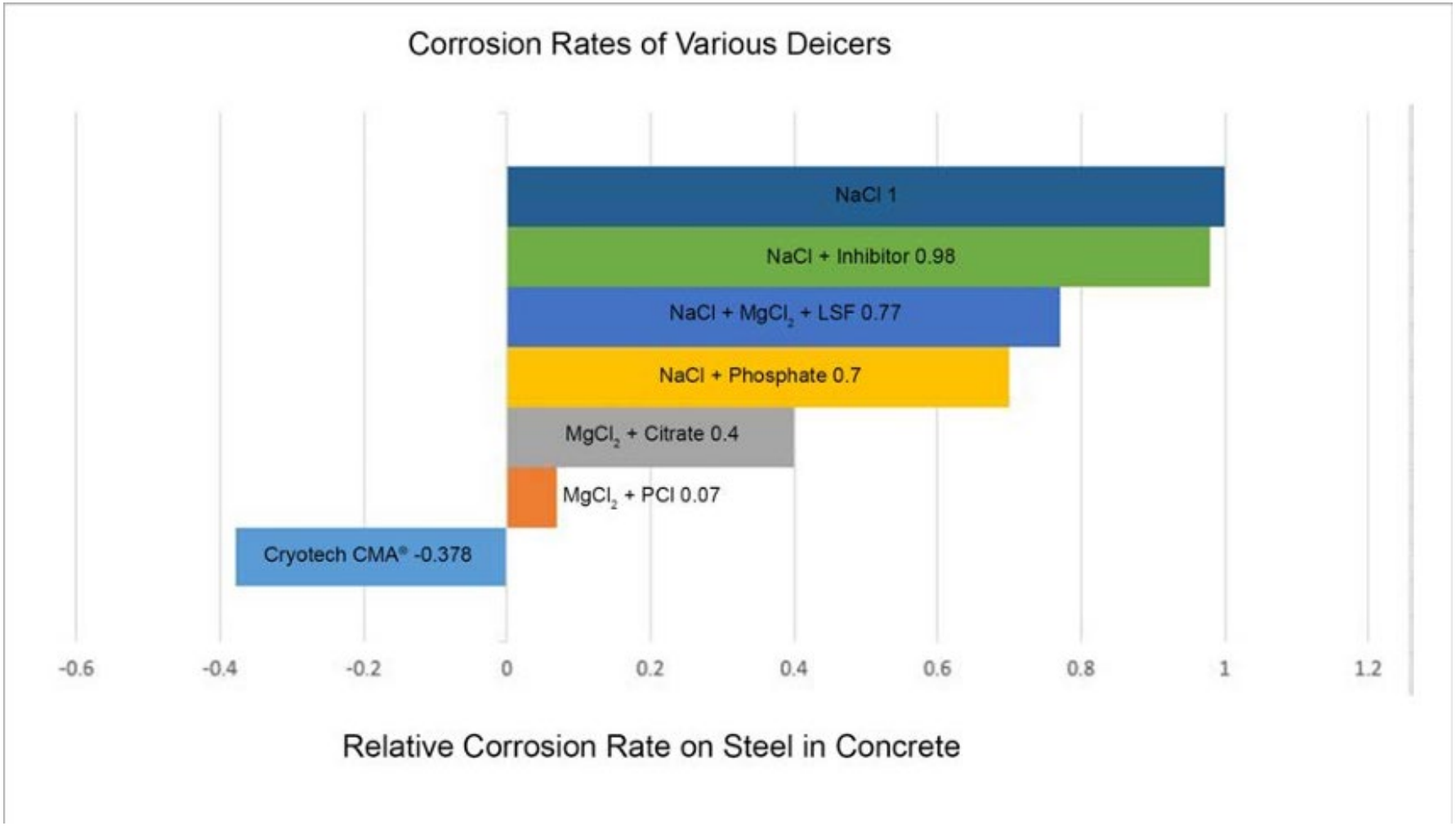
Formate



Acetate



Corrosion



Corrosion

Corrosion

PAVEMENTS

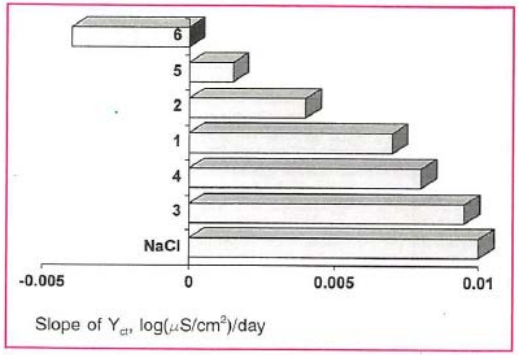
CMA Cancels Corrosion

Whether or not calcium magnesium acetate (CMA) can inhibit corrosion in chloride-contaminated reinforced concrete was the subject of an FHWA-National Academy of Science/National Resource Council postdoctoral associate study. This study evaluated the inhibiting/passivating effects of CMA when compared with other proprietary additives used as corrosion inhibitors in reinforced concrete. Sodium chloride (road salt) was included in the study for comparison purposes.

The corrosion inhibitive potential of the various materials was evaluated using electrochemical impedance spectroscopy (EIS) procedures. An experimental set-up simulated field conditions of salt-contaminated reinforced concrete. In this simulation, EIS measurements were carried out on steel rods embedded in concrete. Rebar specimens were exposed by immersion to various inhibitor-containing deicers. The measurements were taken over a period of 11 months, generating a picture of the progress of corrosion. This afforded the opportunity to determine whether or not corrosion was accelerating with time.

The corrosovity of the various inhibitors and CMA were measured. From the data it is apparent that, as a corrosion inhibitor, CMA is superior to all other materials tested; in fact, a passivating effect is suggested (negative corrosion rate). This property, passivation, is of particular interest and significance when considering older bridge decks that are contaminated with salt. Analyses of the measurements made are detailed in the final report *Impedance Spectroscopy for the Evaluation of Corrosion Inhibitors in Highway Deicers* (FHWA-RD-96-178). To order a copy of the report, please contact the following person. — *Bob Kogler, (703) 285-2018, bob.kogler@fhwa.dot.gov*

	Main Constituants	Form	Concentration	Inhibitor	pH of Solution
1	NaCl	solid	13 g/L	Mg phosphate	7.0
2	$MgCl_2$	liquid	30 g/L	citrate	9.3
3	NaCl	solid	13 g/L	?	6.1
4	NaCl 83% $MgCl_2$ 10%	solid	13 g/L	PCI™	6.8
5	$MgCl_2$	liquid	35 g/L	PCI™	6.0
6	$Ca(Ac)_2$ 30 % + $Mg(Ac)_2$ 70%	solid	100 g/L	none	9.7
7	NaCl		0.2 mol/L	none	6.8



PAVEMENTS

CMA Cancels Corrosion

Whether or not calcium magnesium acetate (CMA) can inhibit corro-

CRYOTECH

Corrosion

Don't fall for this…..

Cryotech E36® Potassium Acetate Application on a Runway

Cryotech CF7® Potassium Acetate Bridge FAST System

Cryotech CMA® Used for Decades

CMA works differently—
keeps snow from packing

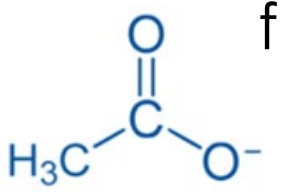
…helps avoid this!

CRYOTECH

“Environmentally Friendly” Recycled Spray Dryer at the Cryotech Iowa Production Plant

Biochemical Oxygen Demand

Acetate



Why is Oxygen Depletion <u>not</u> a problem from acetate biodegradation?

…Because deicing is a *winter* thing!

1. Cold water holds more O_2 than warm water
2. Cold-blooded critters metabolisms slow.
3. Flowing stormwater aerates readily.

Aquatic Toxicity

University of MN study measured LC50 for Daphnia Magna at ~900 mg/L…

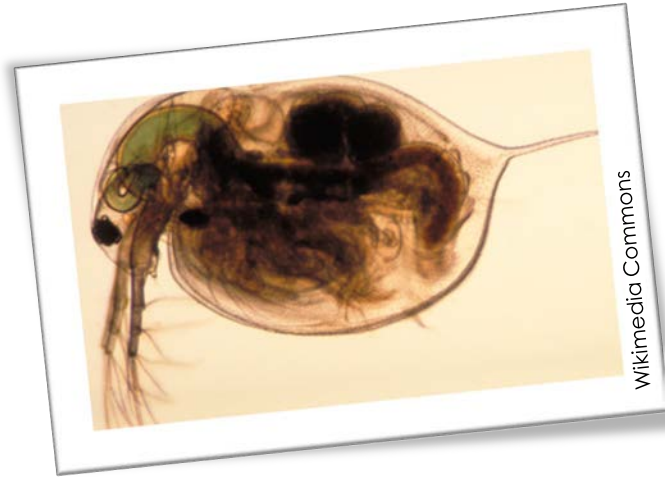
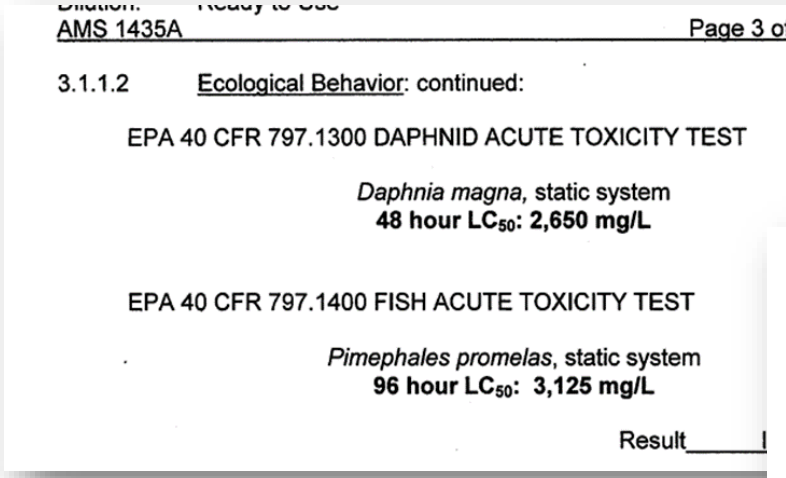


Table 4.1a. Acute-Toxicity Rating Scales

	Aquatic	Avian	Mammalian
Relative Toxicity	EC or LC50 (mg/L)	LC50 (mg/kg food)	LD50 (mg/kg BW)
Super Toxic	<0.0	<1	<5
Extremely Toxic	0.01-0.1	<40	5-50
Highly Toxic	0.1-1	40-200	50-500
Moderately Toxic	1-10	200-1000	500-5000
Slightly Toxic	10-100	1000-5000	5000-15,000
Practically Nontoxic	100-1000	>5000	>15,000
Relatively Harmless	>1000	--	--

Aquatic Toxicity



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3.1.1.2 Ecological Behavior: continued:

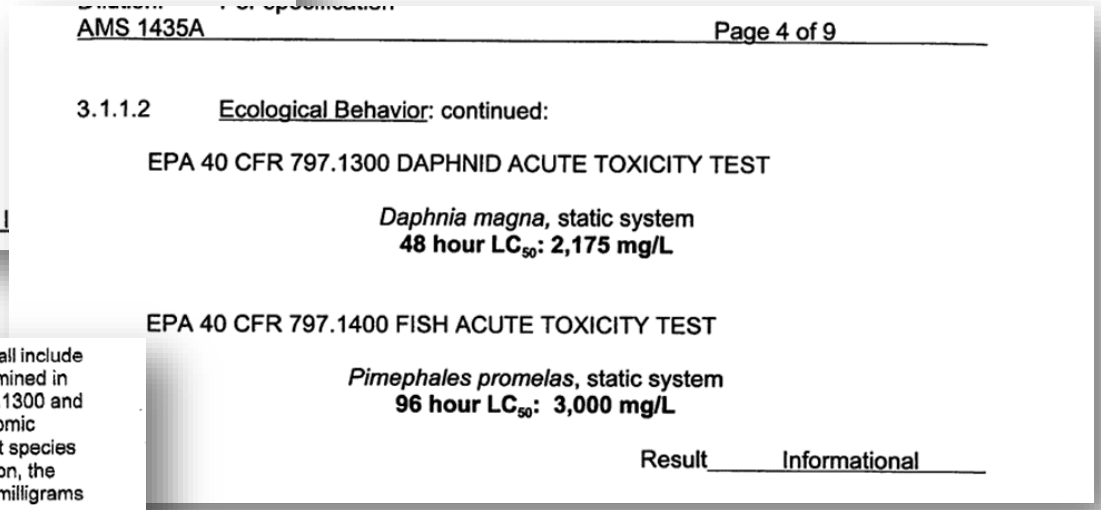
EPA 40 CFR 797.1300 DAPHNID ACUTE TOXICITY TEST

Daphnia magna, static system
48 hour LC_{50}: 2,650 mg/L

EPA 40 CFR 797.1400 FISH ACUTE TOXICITY TEST

Pimephales promelas, static system
96 hour LC_{50}: 3,125 mg/L

Result



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3.1.1.2 Ecological Behavior: continued:

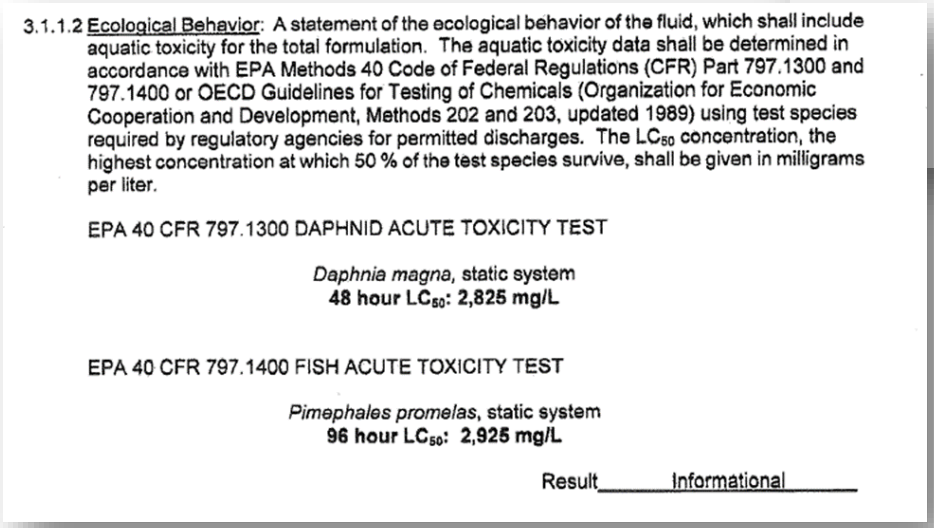
EPA 40 CFR 797.1300 DAPHNID ACUTE TOXICITY TEST

Daphnia magna, static system
48 hour LC_{50}: 2,175 mg/L

EPA 40 CFR 797.1400 FISH ACUTE TOXICITY TEST

Pimephales promelas, static system
96 hour LC_{50}: 3,000 mg/L

Result Informational



3.1.1.2 Ecological Behavior: A statement of the ecological behavior of the fluid, which shall include aquatic toxicity for the total formulation. The aquatic toxicity data shall be determined in accordance with EPA Methods 40 Code of Federal Regulations (CFR) Part 797.1300 and 797.1400 or OECD Guidelines for Testing of Chemicals (Organization for Economic Cooperation and Development, Methods 202 and 203, updated 1989) using test species required by regulatory agencies for permitted discharges. The LC_{50} concentration, the highest concentration at which 50 % of the test species survive, shall be given in milligrams per liter.

EPA 40 CFR 797.1300 DAPHNID ACUTE TOXICITY TEST

Daphnia magna, static system
48 hour LC_{50}: 2,825 mg/L

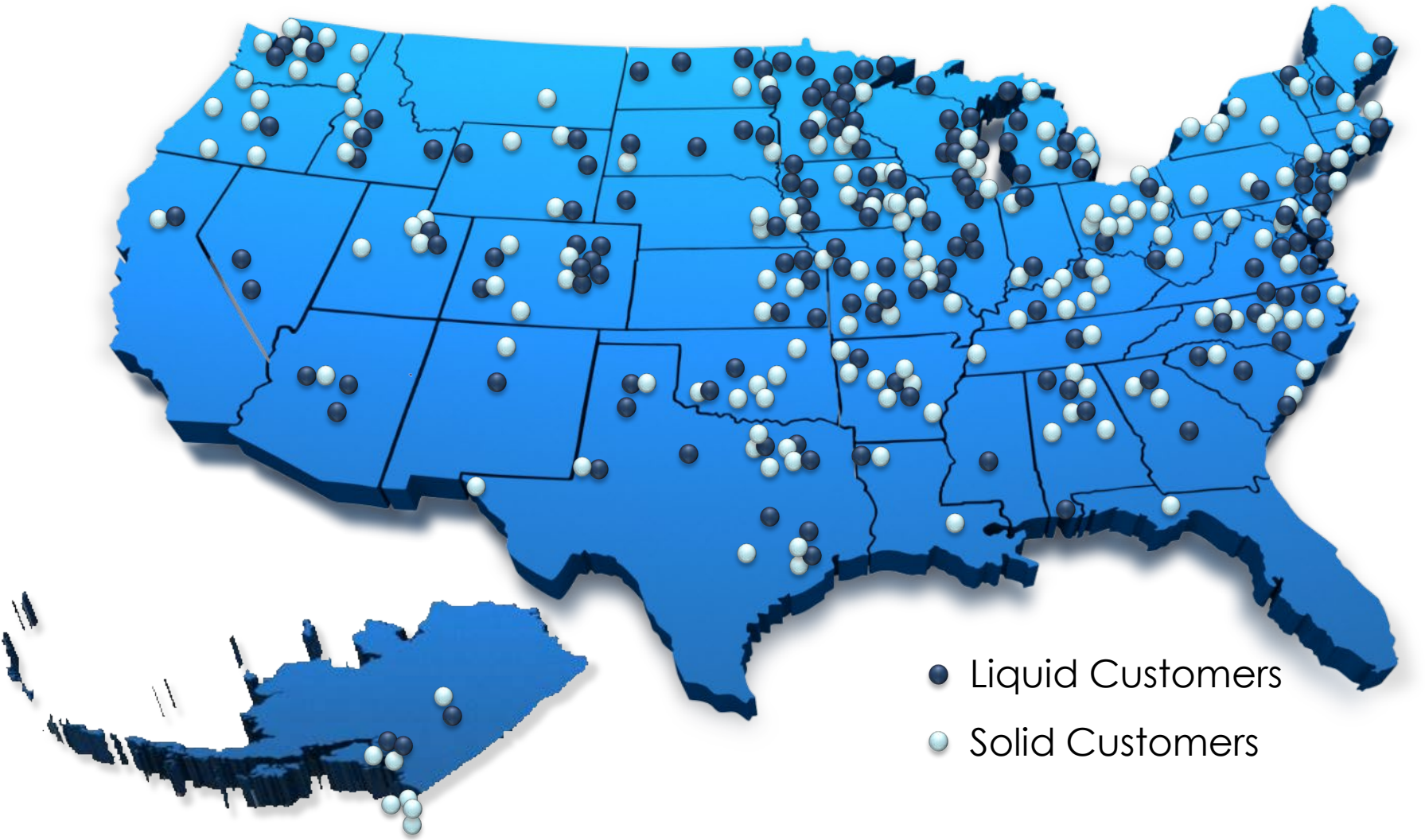
EPA 40 CFR 797.1400 FISH ACUTE TOXICITY TEST

Pimephales promelas, static system
96 hour LC_{50}: 2,925 mg/L

Result Informational

KAc deicer consistently measures more than double the Univ. of MN results!

Where Are Acetates Used?



Cryotech Deicing Technology

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319-371-6012

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