The Science & Art of Brine

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CAMION

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Salt Brine

"Water saturated with or containing large amounts of a salt, especially sodium chloride"

Brine | Define Brine at

Dictionary.com

3 OUTSTANDING REASON FOR BRINE USE

- The safest thing we can do as a snow fighter

- Environmentally the most responsible product we can use

- Cost saving

Glossary of Terms

Eutectic Temperature

The lowest temperature at which a deicer solution remains in liquid form or can melt ice

Effective Temperature

The lowest temperature at which a deicer is cost effective for practical purposes, or where the results/time required to achieve them justify the costs.

Endothermic

Requires/absorbs heat to change from a solid to a liquid – Sodium Chloride

Exothermic

Releases or gives off heat when going into solution – Magnesium and Calcium Chlorides

Hygroscopic

Absorbs or attracts moisture from the air. All the basic chlorides are hygroscopic but sodium chloride is much less so making it better for events with high moisture content.

Glossary of Terms

Anti-Icing **(KEEPS ICE FROM FORMING)**

A proactive snow and ice control strategy to prevent a bond from forming between frost/snow/ice and the surface. Typically executed as a pretreatment, anti-icing can also be employed as a during/post storm strategy when conditions warrant.

Pretreatment: application before moisture has fallen

Post Treatment: application after surface is wet

Deicing

A reactive snow and ice control strategy of applying a deicer on top of compacted snow or ice to soften and break an existing ice-to-pavement bond to expedite clearing.

Cause and Effect…

One teaspoon of salt permanently pollutes 5 gal. of water[1]… 10 cu yd salt pollutes 8 million gal[2]

19 Million Tons

…road salt used in the US for winter deicing in 2014 alone… most of that salt is now in our water.[3]

Cause… New York

Excessive use of road salt for winter deicing has caused chloride levels in Lake George, NY to triple over the past 30 years.[1]

Est. 39 metric tons are applied per lane-mile, every winter – totaling more than 15,000 metric tons per year in the Lake George watershed.

Based on statistics from other locations, road salt application on private roads, driveways, and parking lots, for which amounts are not available, could actually double the total number to 30,000 tons.

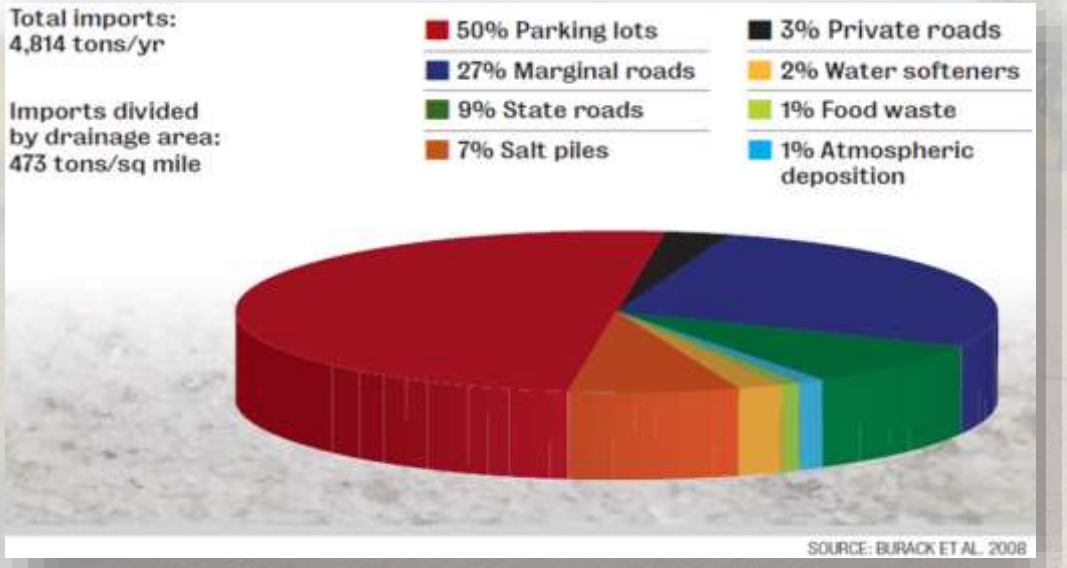
Uncurbed, the mounting threat posed by road salt is projected to have irreversible impacts for this $1 billion annual tourist economy.[1]

1 The State of the Lake: Thirty Years of Water Quality Monitoring on Lake George, NY 1980-2009, …Charles Boylen, Lawrence Eichler, Mark Swinton, Sandra Bauer, Imad Hannoun, Jeffrey Short …http://fundforlakegeorge.org

Cause… New Hampshire

Concern over chloride levels in adjacent watersheds holds up $800 million I-93 expansion project

2008 study points to where the chlorides impacting I-93 watersheds are originating.



Traffic moves south through a blasting zone, part of the Interstate 93 widening project in Derry. (DAVID LANE/UNION LEADER)

I-93: Lanes stay closed and pricetag grows while state, activists wrangle over salt

By MICHAEL COUSINEAU
New Hampshire Union Leader

The problem is so much salt is going into some brooks around the state that it's toxic. "We need to reduce the amount of salt in these watersheds by anywhere from 25 to 45 percent… a fairly tall order"[1]

1 NH NPR Nov. 2014, Eric Williams, New Hampshire Department of Environmental Services
14, Eric Williams, New Hampshire Department of Environmental Services

Cause… Canada

An Ontario river tested at 20,000 mg/L for chlorides during peak winter months making it much more suited to supporting this type of life than this. [2]

Chloride levels above 800 mg/L are harmful to most fresh water aquatic life[3]

⅓ of Canada relies on groundwater, including P.E.I., Kitchener-Waterloo, Cambridge and Guelph.

Less than 6% is renewable in 50 years.[1]

A seven day exposure of 1,000 mg/L is lethal to rainbow trout [4]

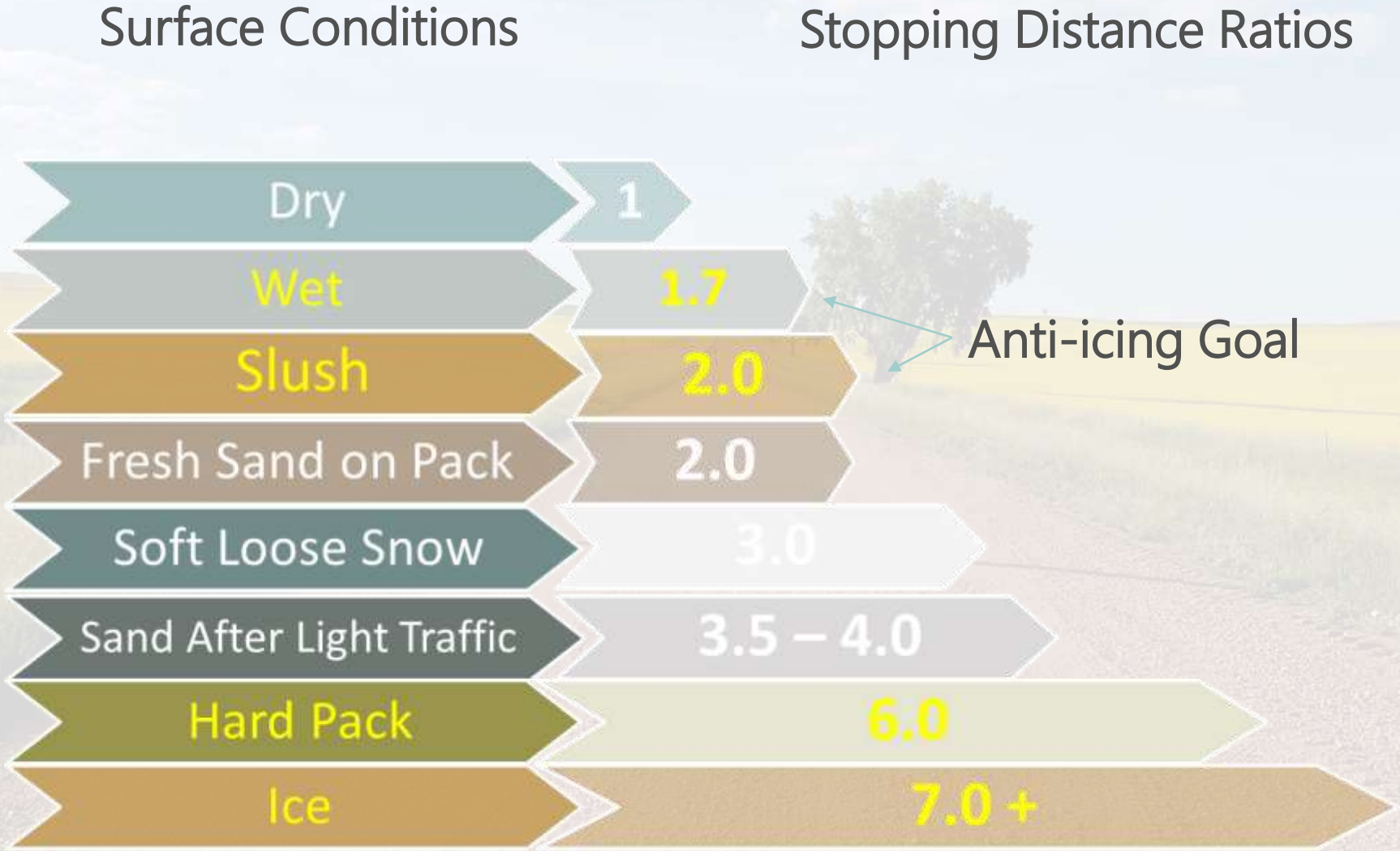
1 *The Global Volume and Distribution of Modern Groundwater*, Journal Nature Geoscience, Gleeson, ….Befus, Jasechko, Luijendijk, Cardenas, 2015
2 *Being Smart About the Salt,* Paul Johnson, Operations Mgr. Wellington Co. Ontario, APWA April 2015
3 *What Happens to All the Salt We Dump on the Roads,* Joseph Stromberg, Smithsonian Mag. Jan 2014

Our Mission as Snowfighters…is to use as much salt as needed to provide…

Safe and Dependable surfaces for the public during winter…

But Not One Pound More!

Stopping Distance Comparisons






Anti-ice
Pre

DLA Anti-Icing - Prevent Ice

Surfaces pretreated prior to the storm are protected long before plowing measures begin.

Friction / Traction
With vs. Without
Anti-icing Pretreatment

Anti-Icing Pretreatment

Compare the levels of service. After deicing measures commence on the left property note the est. difference in cost/profit margin from that of the pretreated property where results were achieved much sooner.

Un-treated
Pretreated

Neighboring properties, no plowing, pictures taken 10 min apart

David Eddy, Prescription Landscape, Minneapolis, MN

cing is the most environmentally safe and cost effective ce in winter maintenance.

It requires about 1/4th the material and
1/10th the overall cost of deicing."

Safe and Sustainable Snowfighting, Snowfighter's Handbook, Salt Institute 2013 Edition

Winter Parking Lot and Sidewalk Maintenance Manual, 2015, published by the MPCA, University of Minnesota, MnDOT, Minnesota LTAP, Fortin Consulting

Deicing

DLA Post-treatment vs. Deicing

Date: 1/31/2013 11:02:46 AM
Direction: South
Speed: 16 MPH
Scraper: Down
Wing-Plow: Down
Granular Material Name: SALT
Granular Set Rate: 350 LB/MI
Prewet Set Rate: 18.0 GAL/TON
Direct Set Rate: 0 GAL/MI
Direct Lanes Active: 0
Road Temperature: 22 °F
Air Temperature: 21 °F
Spreader Status: S
Driver ID: D REID
Vehicle ID: 613
Granular Spread Rate Index: 5
Prewet Spread Rate Index: 3
Direct Spread Rate Index: 0
Granular Mode: C

357 lbs. Salt
$12.5lane mile
@$70 per ton

Date: 1/31/2013 11:03:17 AM
Direction: North
Speed: 13 MPH
Scraper: Down
Wing-Plow: Down
Granular Material Name: SALT
Granular Set Rate: 0 LB/MI
Prewet Set Rate: 0 GAL/TON
Direct Set Rate: 60 GAL/MI
Direct Lanes Active: 0
Road Temperature: 22 °F
Air Temperature: 22 °F
Spreader Status: S
Driver ID: D REID
Vehicle ID: 613
Granular Spread Rate Index: 0
Prewet Spread Rate Index: 0
Direct Spread Rate Index: 9
Granular Mode: C

138 lbs. Salt
$4.83 per lane mile
@$70 per ton

Michigan's Local Technical Assistance Program: LTAP - Bridging the Gap Between Research and Practice, SE MI Winter Maintenance Team 2013
Bryan Pickworth, City of Farmington Hills - Matt Wiktorowski, City of Novi – Mark Clancy, City of Wixom - & Mark Cornwell, Sustainable Salting Solutions, LLC

DLA Results

[C-3]2-17-13 SM mix (80%brine20%SM) 50 gplm -wind 22mph-west/6 dp/pave+ 11 / 8:04am-prior to application-Pt-Cloudy—Asphalt -Sporadic Traffic

11:00am-3 hrs. after application-Clear—Asphalt -Sporadic Traffic-ATTN: Shaded Area

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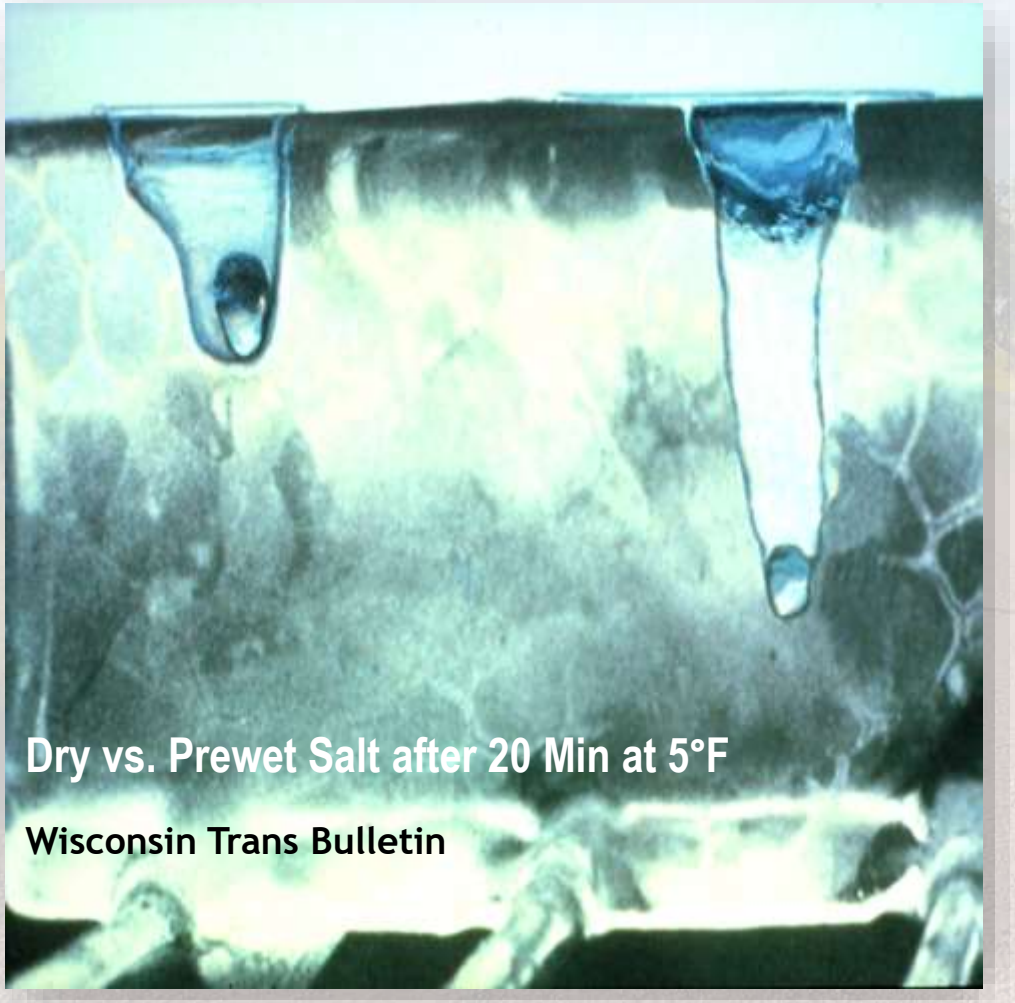
When Deicing Is Required - Pre-Wet Salt Accelerates the Brining Process…



Penetrates /softens ice faster

Hastens breaking the bond

Expedites plowing

Returns surfaces to safe conditions sooner.

*Data: MDOT Bounce and Scatter Study Nov. 2012


Effective and Efficient!

Brine vs. Granular Salt

Anti-icing Efficiency

10 Tons of Salt or the Equivalent in Salt Brine Can Pretreat[1]

67 – miles at 300 lb per lane-mile – Salt

495 – miles at 20 gal per lane-mile – Salt Brine

1 MnDOT Anti-icing Guide by EVS, 2010

Application Rates

Application of melting agents are both

SCIENCE

and

ART

Application Rates as the Temperature

Pavement Temp °F / (°C)	Pounds of Ice Melted by One Pound of Salt	Dry Salt Melt times
30 (-1)	46.3	5 min
25 (-4)	14.4	10 min
20 (-7)	8.6	20 min
15 (-9)	6.3	1 hour
10 (-12)	4.9	Dry salt is Ineffective*
5 (-15)	4.1	
0 (-18)	3.7	
-6 (-21)	3.2	

Over application of salt will not speed up melt time.[1]
It can postpone dilution/refreeze to extend cycle times.

1 Winter Maintenance Supervisor Certification Workshop, APWA 2015
**Note: Salt will melt to -6°F but its 'effective' temperature (15°F) refers to cost effectiveness/time and amount of product required to achieve desired results*

Salt Brine Concentration/Dilution FAQs

Science: Phase Diagram

- Salt Brine at 50% dilution retains some melting capacity at pavement temps. above 18°F
- 23.3% is the highest concentration at which salt brine will absorb solids at its eutectic temperature (lowest temp. at which it can melt salt)

Art: Judging how fast a .....deicer will dilute

- Given the existing moisture on a particular surface and rate of accumulation
- At the current pavement temperature

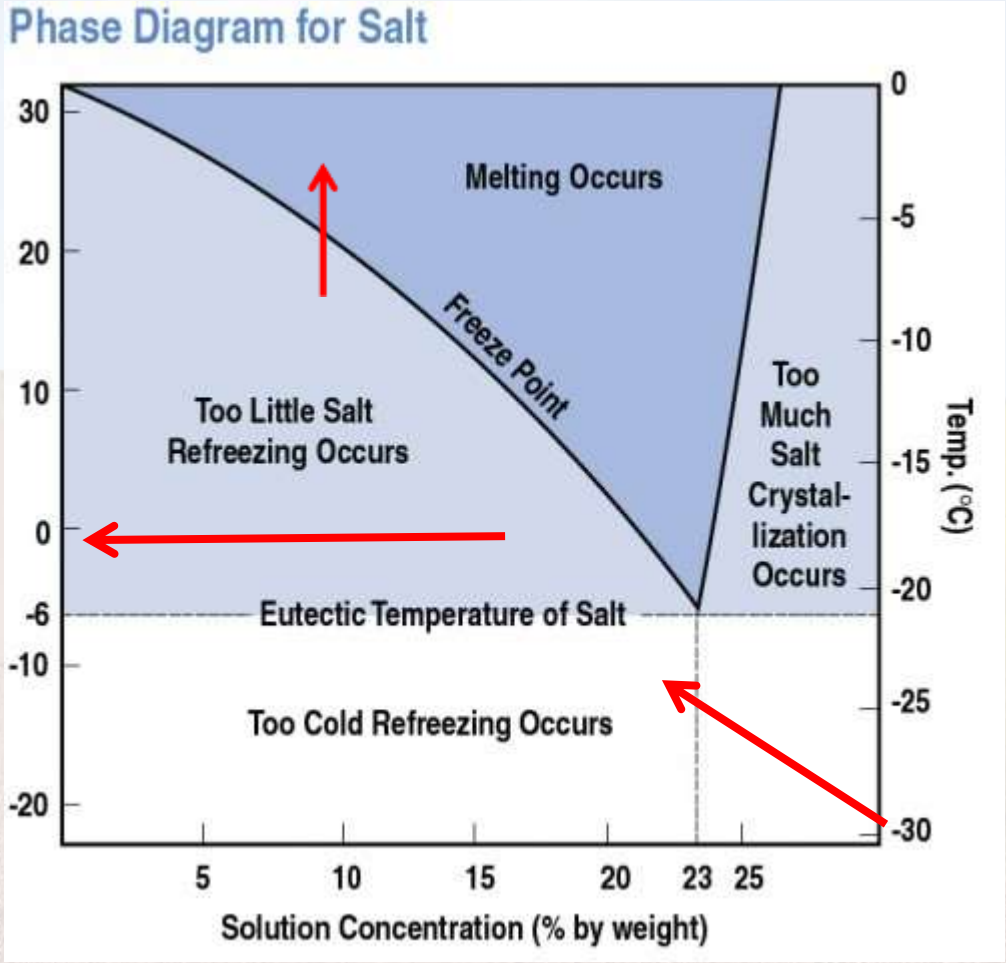


Diagram: Snowfighter's Handbook, Safe and Sustainable Snowfighting 2013, Salt Institute

Comparative Dilution of Ice Control Chemicals

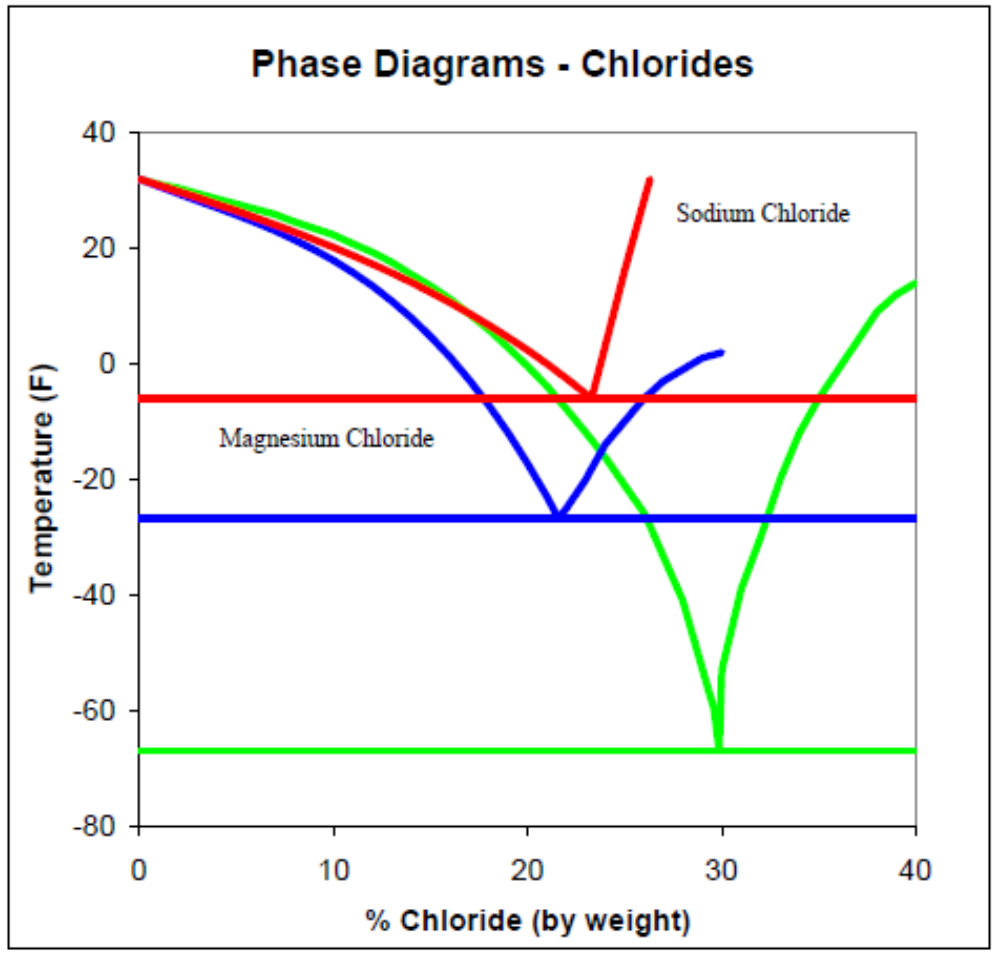


Figure 1 - Phase Diagram for Ice Control Chemicals

The **refreeze temperature of NaCl rises slower with dilution** than do the refreeze temperatures of either $CaCl_2$ or $MgCl_2$.[1]

At 50% dilution – refreeze temp.

- **Calcium Chloride… 10°F** [2]
- **Magnesium Chloride… 15°F** [1]
- **Sodium Chloride… 18°F**

Image: Snow and Ice Control, Duane Amsler, Sr., P.E. Cornell Roads Program, 2006

1 Federal Highway Administration, Manual of Practice for an Effective Anti-Icing Program, 1996 Appendix B

2 The Calcium Chloride Handbook, A Guide to Properties, Forms, Storage and Handling, DOW

Suggested Application Rate Range for Salt Brine

These guidelines are a starting point. Reduce or increase rates incrementally based on experience…. The 'Art'

- Anti-icing Pretreatment*
  - 18 to 35 gallons per
    - Some are using as high as 110 gallons per

- Anti-icing Post-treatment** (after precipitation)
  - 20 to 60 gallons per (or double your Pretreat rate)

*Salt Institute, **The Snowfighter's Handbook 2013** - MPCA 2015 **Parking Lot & Sidewalk Handbook**, Fortin Consulting - **NH-DES Green SnowPro Anti-icing BMPs** - University of Waterloo Report **Optimal Snow & Ice Control of Parking Lots & Sidewalks 2015**

**LTAP - Bridging the Gap Between Research and Practice, DLA - SE MI Winter Maintenance Team 2013

HUGE SAVINGS

Lane miles/Acres Serviced Per 1 Ton Salt or the Equivalent 870 Gallons Salt Brine (To show the comparison)

- Anti-ice Pretreating DLA@ 25 gallons (Brine) per LN mile / acre 35
- Anti-ice Post-treat DLA @ 60 gallons (Brine) per LN mile / acre 14.5
- Deicing with prewet pre-treated salt per LN miles /acre 8
- Deicing with Prewet or Pretreated salt per LN miles / acre 6
- Deicing with Dry Salt per LN miles / acre 4

HUGE SAVINGS

2.28 lbs. of Salt per gallon of 23.3% Salt Brine

- Average Application Rate per Lane Mile / Acre 350 lb. At $70 per ton $12.25 per lane mile / Acre
- Average Brine Application Rate 40 gallons per lane mile / Acre
  - At $.08 per gallon $3.20 per lane mile / Acre
  - Saves 350 (granular)-91.2(brine)=207.93 lbs. of salt per lane mile

Saving $9.05 and 207.93 lbs. of salt per lane mile/acre