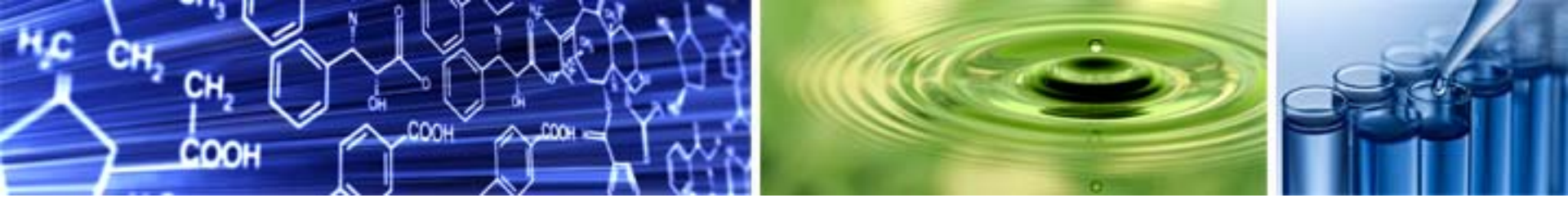

Ice Melters and the Environment

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September 20, 2012

All deicers present same basic environmental challenge

- We are dispersing chemical into the environment
- All chemicals affect the environment in different ways
- There is no “perfect” deicer chemical

Basic Ice Control Chemicals for Deicing Use

- Salt (sodium chloride)
- Potassium chloride
- Calcium chloride
- Magnesium chloride
- Urea
- CMA (calcium magnesium acetate)
- Potassium acetate
- Sand/abrasives

Commonly Used Performance Enhancing Additives

- “Agricultural Additives”
  - Molasses
  - Corn syrup
  - “beet juice”
  - Brewers condensed solubles
- Corrosion inhibitors
- Colorants

Basic Types of Environmental Impact

- Soil
- Air
- Vegetation (particularly roadside)
- Ground water/wells
- Surface waters
- Aquatic/animal life
- Infrastructure corrosion

Deicer Environmental Strategy

- Understand chemicals' environmental effects
- Understand chemicals' performance characteristics
- Choose the right chemical and application procedure for the right condition
- Maximize deicer efficiency!

Liquid Deicers – very important tool for minimizing chemical use

- Liquid deicers allow chemical to be spread in a very thin layer on the road

- Allows application of a small amount of chemical to prevent ice from bonding

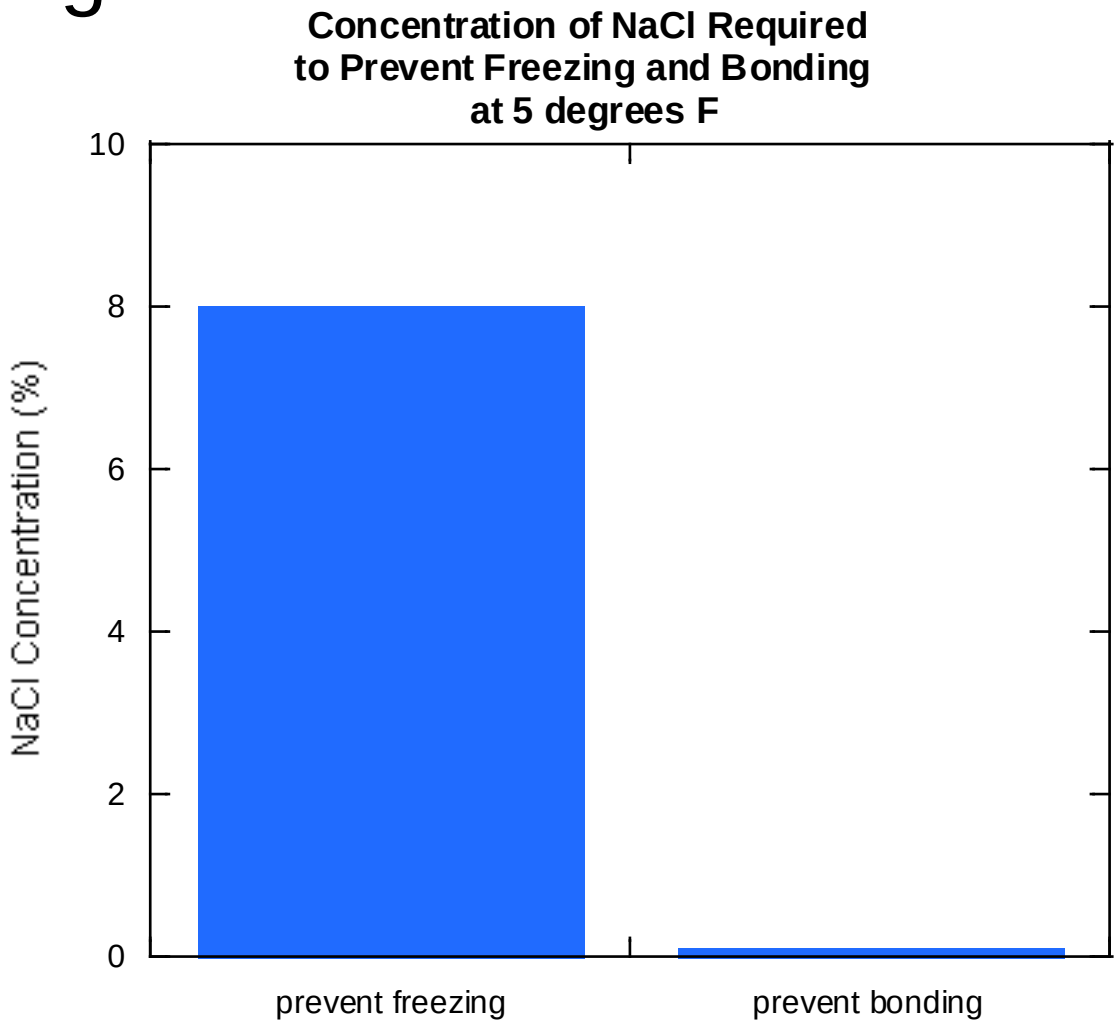
The Importance of Anti-Icing

Applying salt to an existing snow pack

- Often unavoidable
- Always inefficient

- Most of the salt is “wasted” melting through the snow pack to reach the pavement

Very little salt is required to prevent ice from bonding!



Sodium Chloride Brine

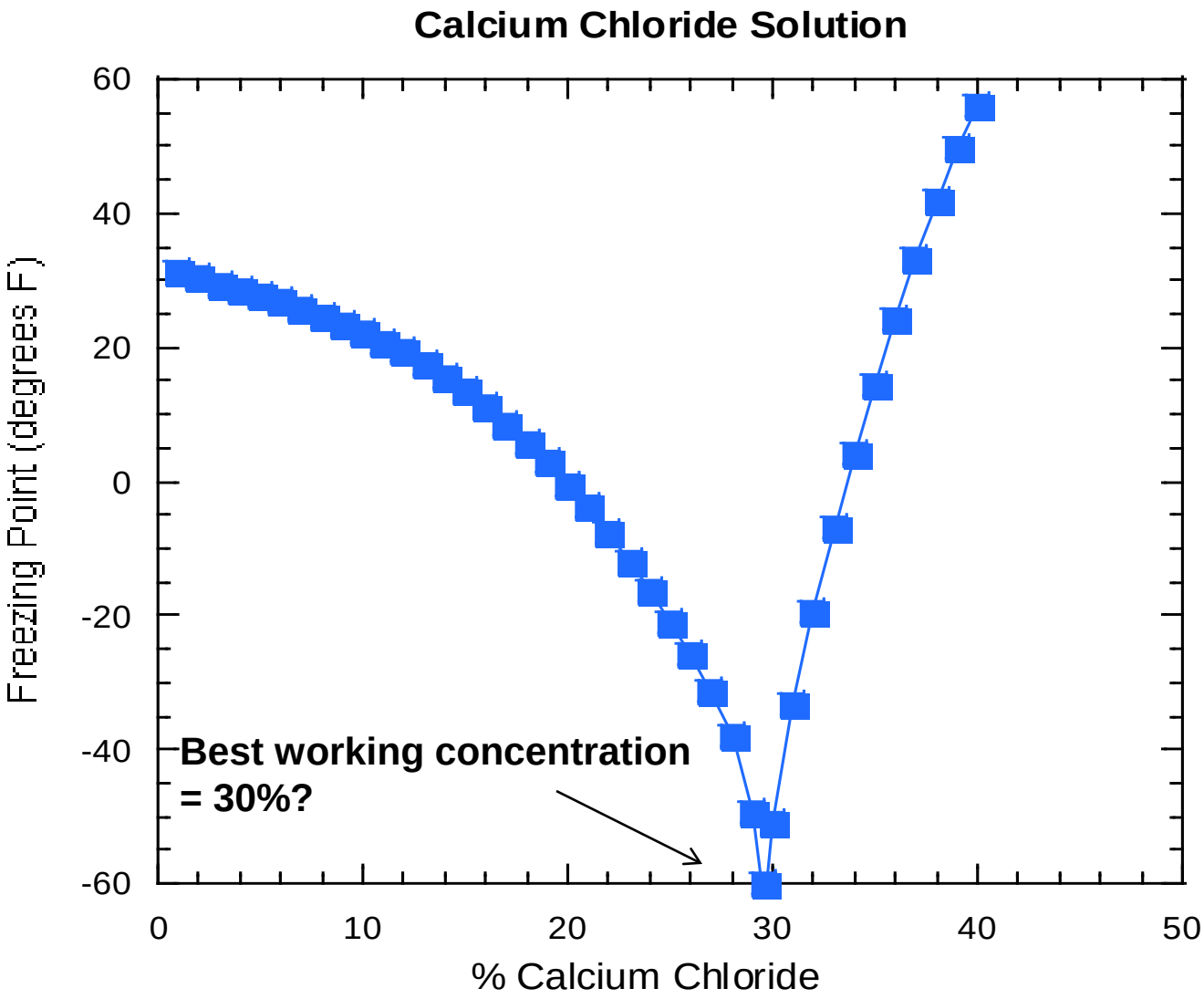
- Lowest Cost
- Saturated brine “freezes” at 32 ^{0}F
- Eutectic brine (23.3%) freezes at –6 ^{0}F
- Not hygroscopic (will dry out)
- No slipperiness formation
- Best used for
  - Anti-icing at warmer temps (> 20 ^{0}F)
  - Prewetting at the spinner
- Not a good choice for a stored, pre-treated salt product

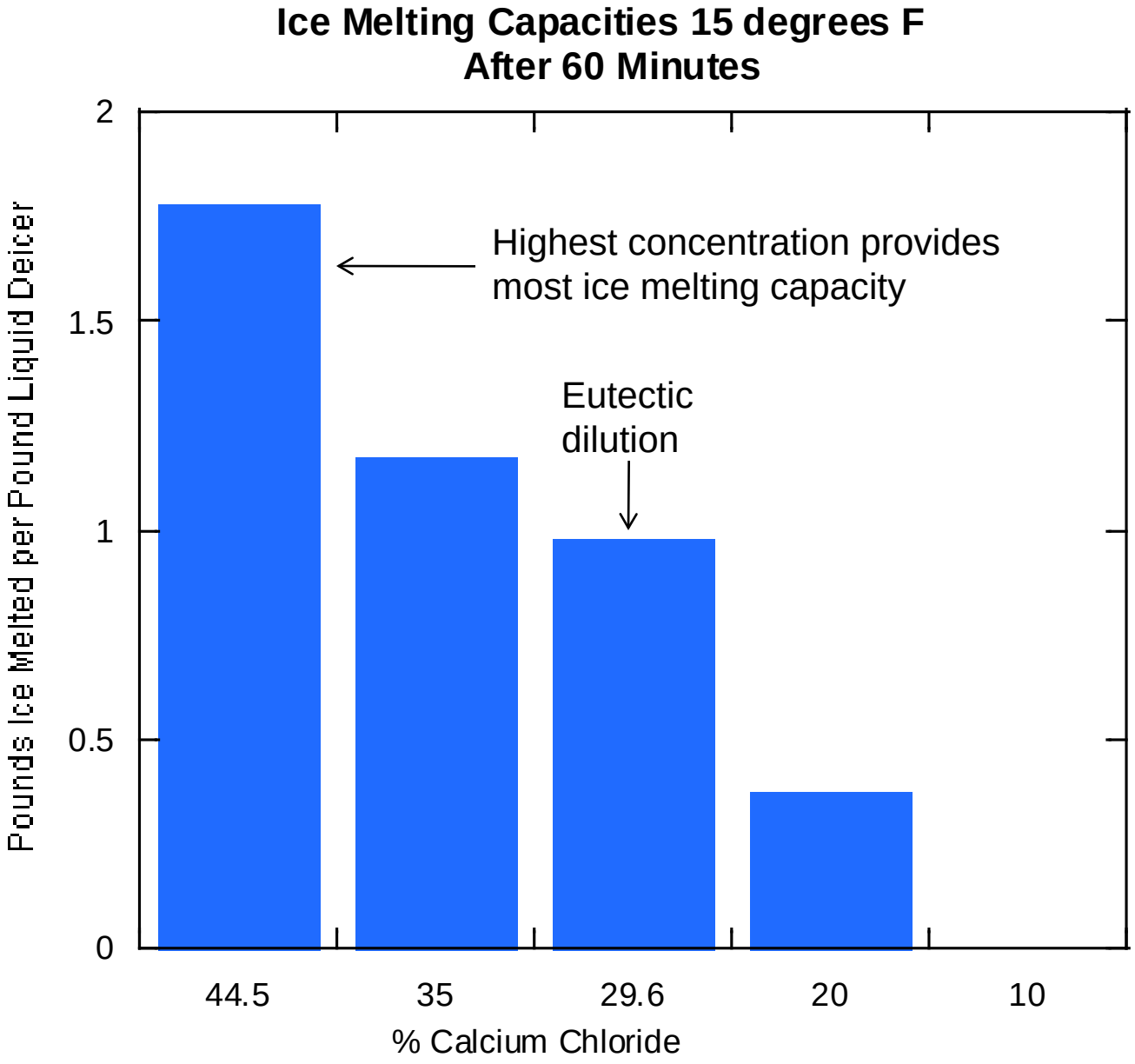
Mag and Calcium Chloride Brines

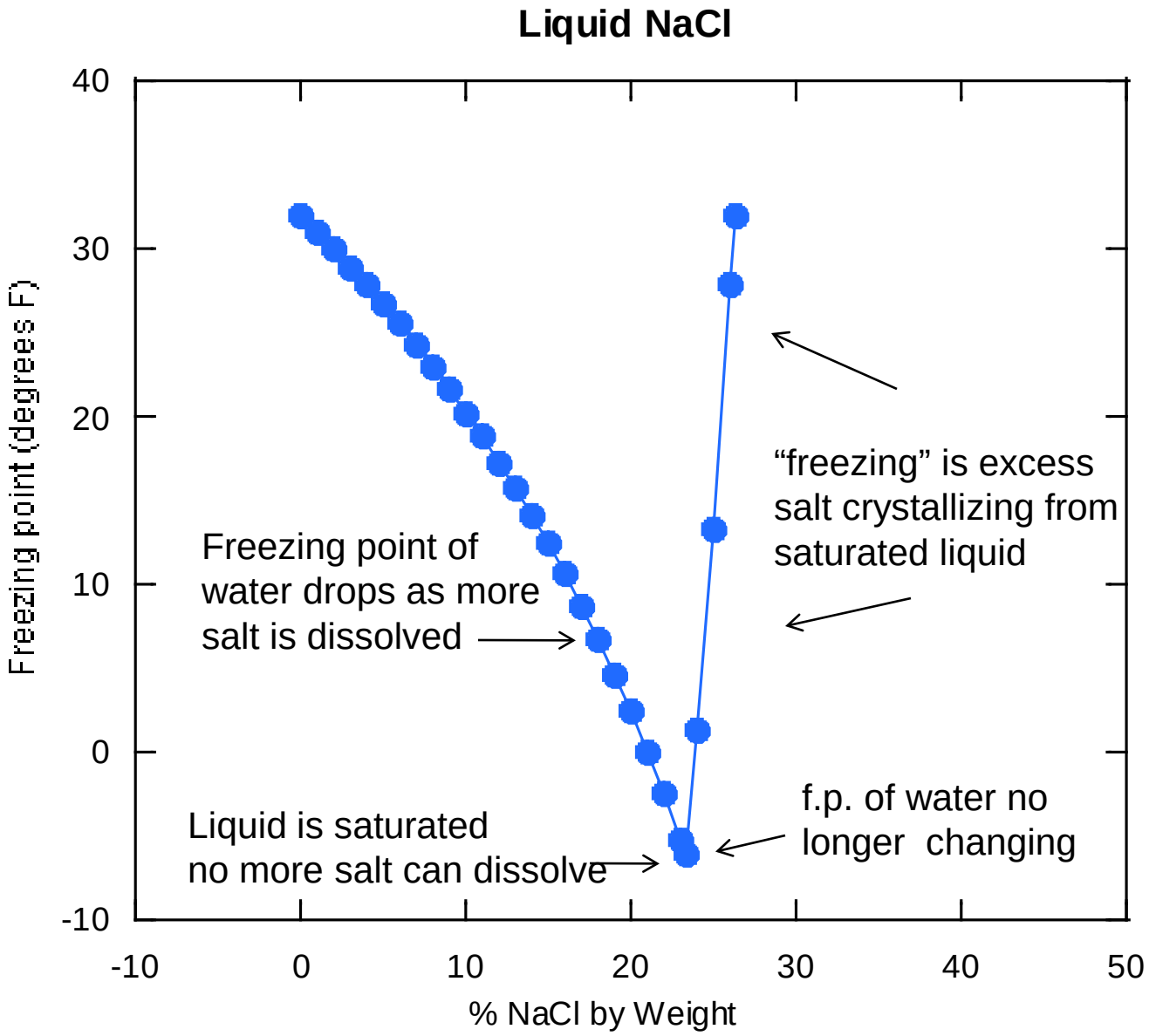
- Higher Cost
- 30% mag chloride freezes at 2 ^{0}F
- 30% calcium chloride freezes at –60 ^{0}F
  - Very low fp is because 30% is the eutectic
- hygroscopic (will stay moist down to ~ 30% RH)
- Best used for anti-icing and prewetting at colder temps (< 20 ^{0}F)
- Best choice for a stored, pre-treated salt product (because of resistance to freezing and drying out)

Cautions in Mixing Brines

- Mag chloride + calcium chloride -----> sulfate precipitation
- Mag/Calcium chloride + salt brine -----> salt crystal precipitation
- Mag/Calcium chloride + potassium acetate -----> hydroxide precipitation





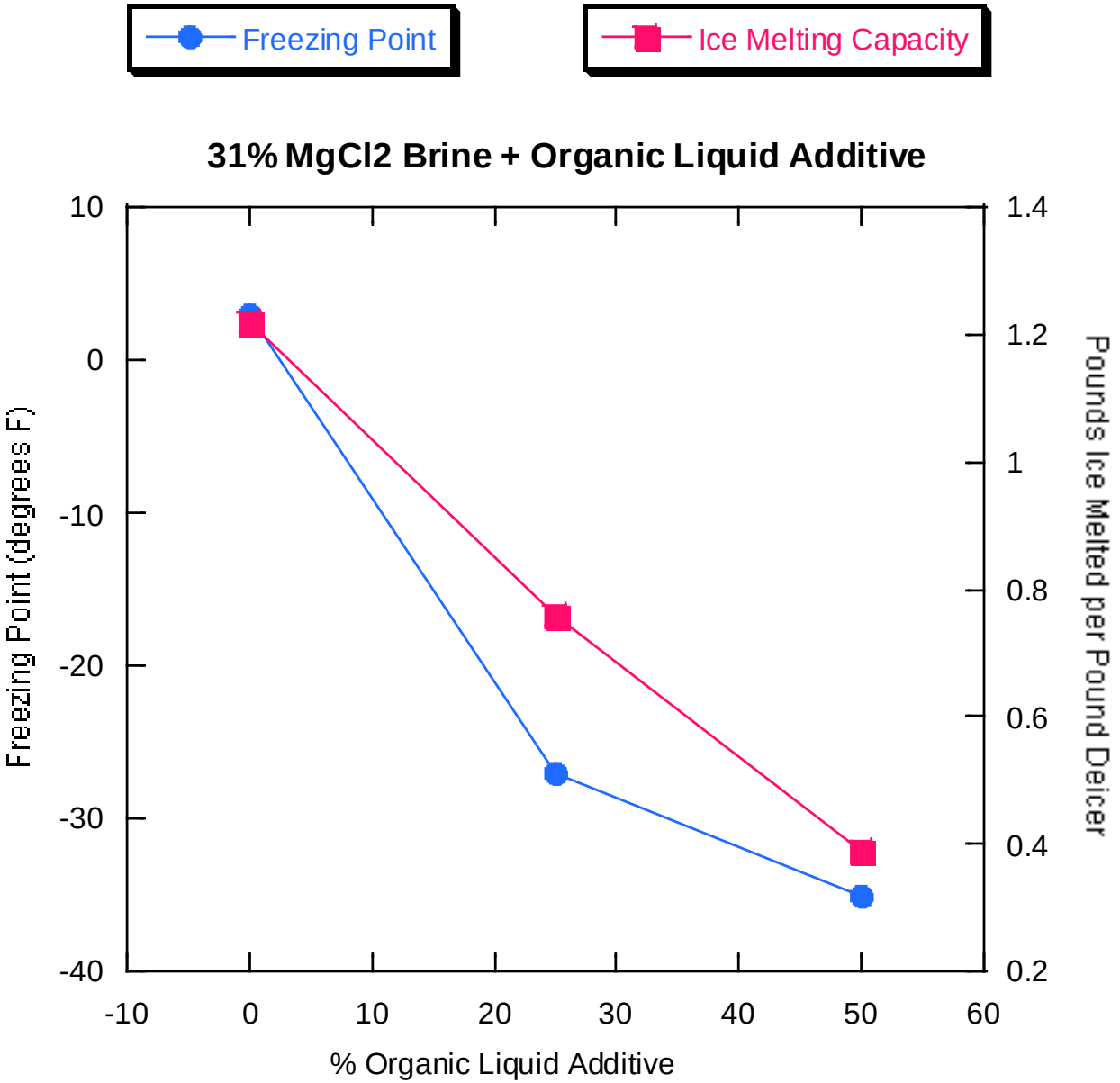


So what happens if we put “too concentrated” liquid on cold road?

Excess solid deicing chemical crystallizes out
Will solid deicer still melt ice? Of course!

Deicer dilution can have some value

- Better low temperature storage stability
  - 26.4% salt brine “freezes” at 32 ^{0}F
  - 23.3% salt brine stable to – 6 ^{0}F
- But higher concentrations will always give more ice melting capacity



Potential Organic Additive Value

- Improved residual effect/anti-icing?
- Corrosion inhibition
- Leaching inhibition
- Lower temperature ice melting???
  - Unlikely
  - Must be verified by a performance test
  - Lower liquid “freezing point” does not indicate lower temp ice melting
  - ASTM D1177 is not accurate for f.p. of liquids containing cryoprotectant type additives

The Value of Pre-wetting

- Pre-wetted salt permits 20-30% lower application rates of chemical
- Pre-wetting appears to make salt usable at colder temperatures
- Above 20 ^{0}F salt is most efficient ice melter
- Below 20 ^{0}F salt benefits from pre-wetting with mag or calcium chloride

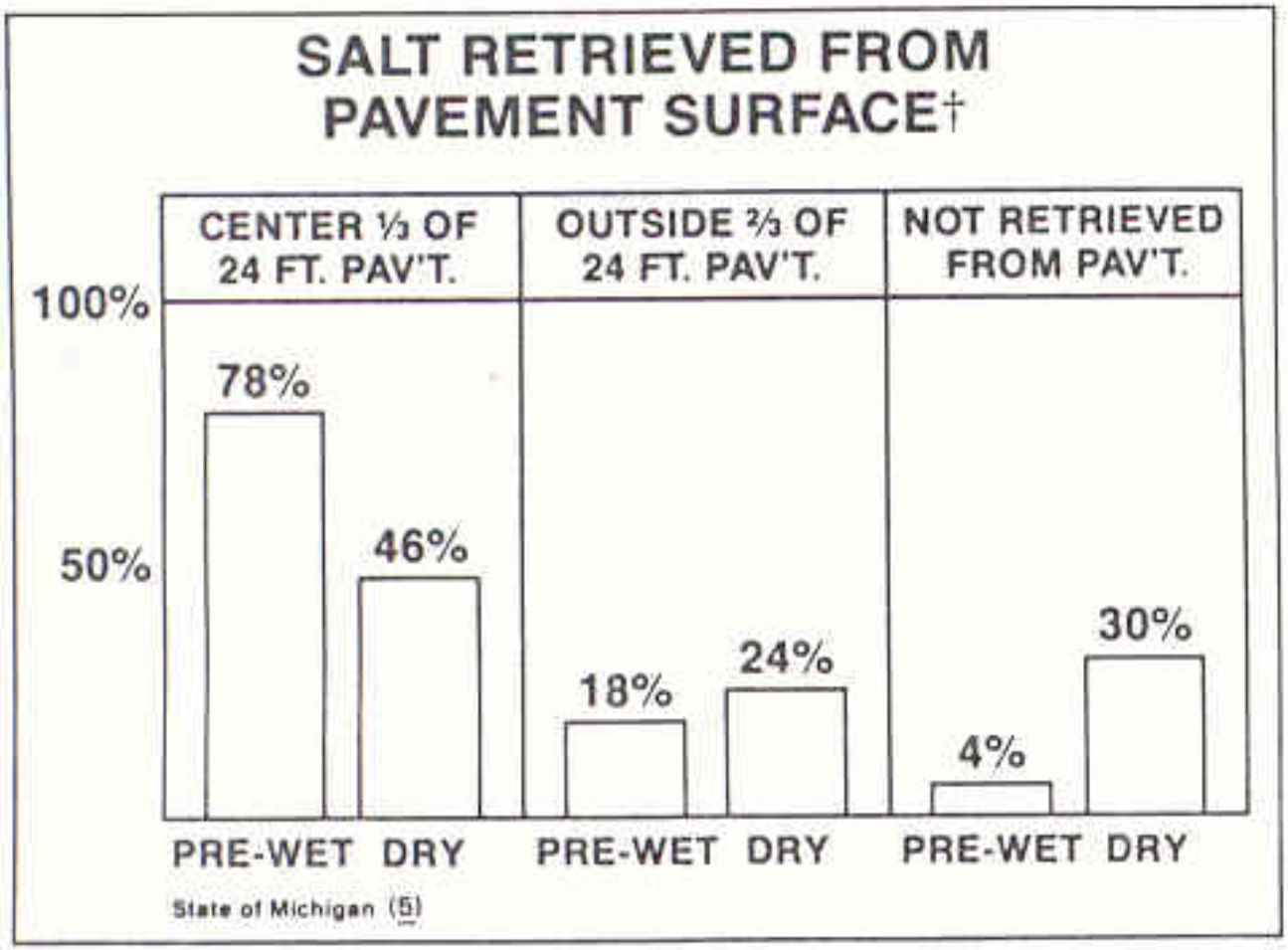


FIGURE 1

Salt pre-wet with liquid calcium chloride
From Michigan Dept. of State Highways Study 1972-73
H. Lemon, *Better Roads,* July, 1974, pp 20-21.

Faster Ice Melting at Colder Temperatures

- “At 2^0 above zero (calcium chloride) wet salt section was cleared 4 to 6’. . .when dry salt was just starting to work” (Lemon, 1974)
- At 3 ^{0}F MgCl2 treated salt resulted in a markedly higher friction than NaCl wetted salt (Torgier Vaa, Norway field test, 2001-2002)
- At 14 ^{0}F pre-wetted salt showed significantly faster recovery of friction in lab tests over 6 different pre-wetting agents based on CaCl2 and MgCl2*

*C. Luker, B. Rokosh, T. Leggett, Transportation Research Circular, Number E-C063, June 2004, pp. 585-601

Michigan Field Ice Melting Observations (1974-75)

Prewet Salt*	Temperature	Dry Salt
• Starts immediately	28 ^{0}F – 32 ^{0}F	minor delay
• Starts immediately	25 ^{0}F – 28 ^{0}F	10-20 minutes delay
• Minor delay	Below 20 ^{0}F	> 30 minutes delay

* Prewet with liquid calcium chloride. H. Lemon, 1974-75 Prewetted Salt Report. Michigan Dept. of State Highways and Transportation, 1975

Pre-wet = Less Salt Needed

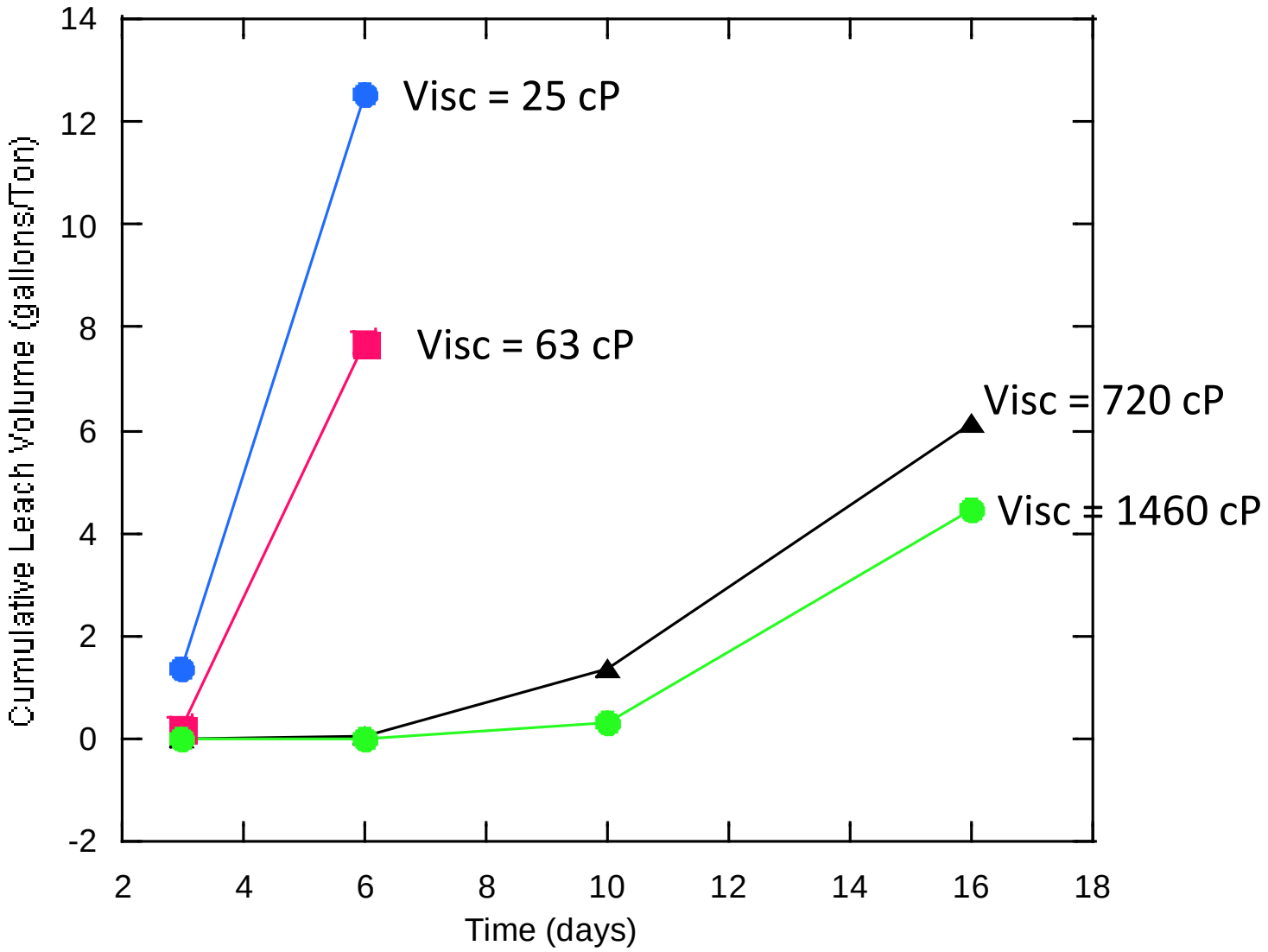
- 15% less salt used (James Sprang, Milwaukee County, WI, 1975)
- 24-44% saving in salt consumption (Horst Hanke, Wiesbaden, Germany 1994)
- 40% less salt used at low temperatures (C.L. Huisman, Iowa State Highway Commission, 1973)
- 28-38% less salt used (S. Kahl, Michigan D.O.T., 1999-2002 field tests, Transportation Research Circular, Number E-C063, June, 2004, pp. 552-554)

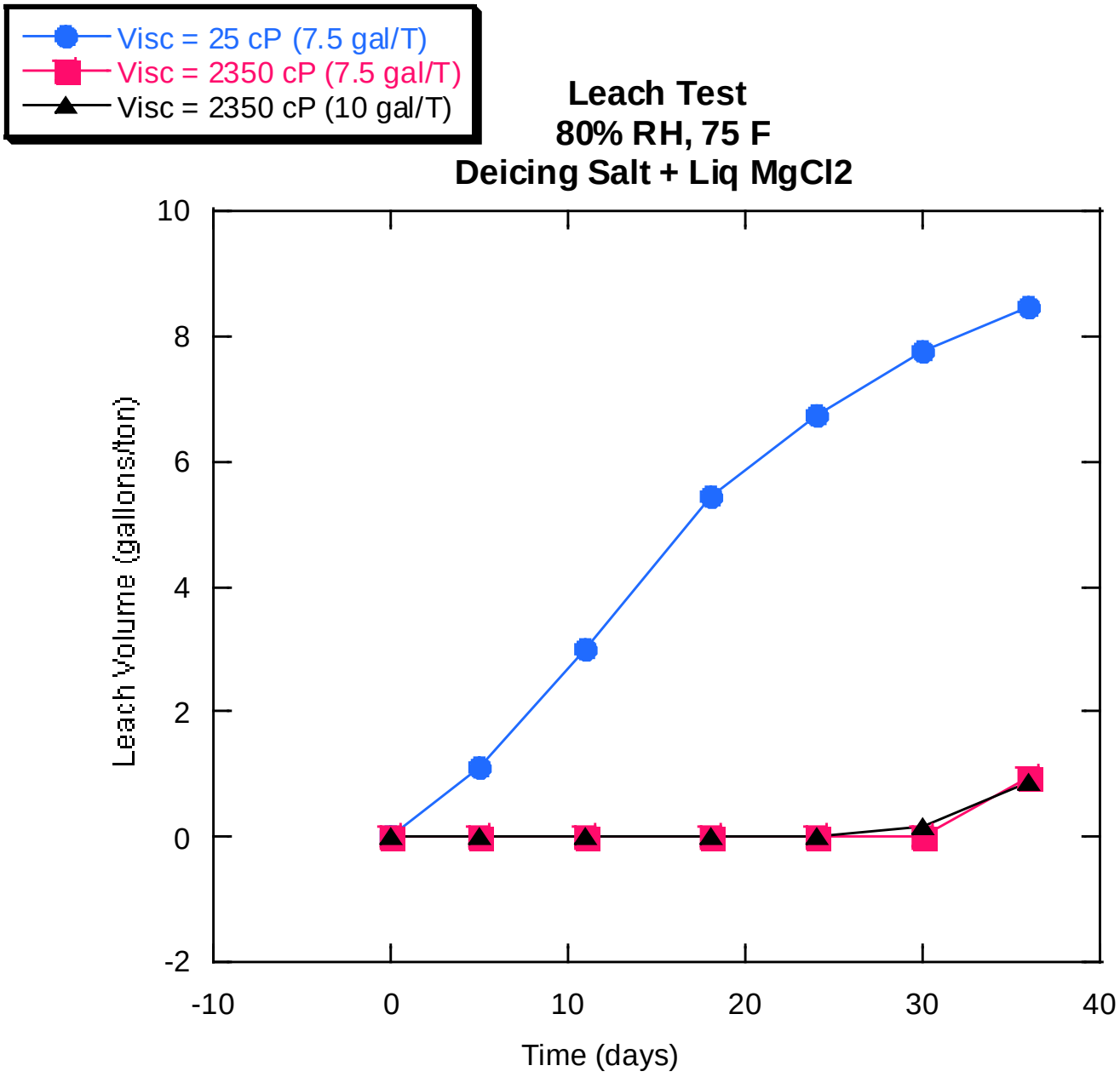
Proper Salt Storage

Salt Storage Best Practices

- Provide good drainage away from stockpile
- Contain drainage in reservoir – use for prewetting if possible
- Outdoor piles must be securely tarped
- Leaching from pre-wetted salt piles can be minimized by using a viscous pre-wetting liquid

Leaching Test
Deicing Salt + 8 gal/T Liq MgCl2
80-90% RH





Conclusions

- Chemical deicers provide enormous value in preventing accidents, saving lives, and keeping transportation open in the winter.
- As urbanization increases, the possibility of increasing environmental impact exists
- Over application of chemical deicers can have a variety of potential negative environmental effects

Conclusions

- A major key to environmentally conscious deicing is minimizing application rates
- Liquid deicers have proven to be highly effective at reducing application rates over long experience in highway deicing
  - Direct liquid application anti-icing
  - Pre-wetting of salt