Liquids in Snow & Ice Control

What?  
When?  
Why?  
How?

Bryan Pickworth  
Road Maintenance Supervisor  
City of Farmington Hills, MI  
Dept. of Public Works

• 24 years as an employee of the City beginning as a Laborer in 1991, moving up the ranks to Equipment Operator III/Crew Leader and promoted to Road Maintenance Supervisor in 2004.  
• 2009 graduate of Michigan APWA's Michigan Public Service Institute  
• 2016 Midwest Advanced Public Service Institute  
• Member of national APWA Snow & Ice Committee

Current Responsibility's:
• Snow and Ice control, Liquids production, Storm-water drainage maintenance, Forestry operations, ROW mowing maintenance, Irrigation, Gravel road and shoulder maintenance, Street sweeping and various other in-house & contracted services.
Agenda

- Impacts of Winter
- Overview
  - Why we use chemicals
  - How they work
  - Solids & Liquids
- Brine Production
  - Making Salt Brine
  - Considerations
  - Blending
  - Transport
- How Liquids are Used
  - Pre-wetting
  - Anti-icing
- Benefits of Liquids
- Opportunities & Risk
- High Volume Output
Economic Costs of Poor Service

According to a Global Insight study:

- A one-day major snowstorm can cause a state $300-$700 million in direct and indirect costs.
- The economic impact of snow-related closures far exceeds the cost of timely snow removal.
- Snow related shutdowns harm hourly workers the worst.

Source: Salt Institute
Slip and Falls….

25% Snow & Ice Related Due to lack of Friction

Source: Zurich Service Corporation

25% to 45% Of the Total Operating Budget

For the average year……
MATERIAL COSTS

UP TO 50%
Of the TOTAL COST of Snow & Ice Operations

For the average year……………

Infrastructure Impacts

- Structures (bridges, buildings)
- Roadway pavement & walkways
- Vehicles & equipment
Bridges

Freeze and Thaw (Frost Heave)
Concrete Surfaces

Vehicles & Equipment
Corrosion…on Metal

- More corrosive
  - Calcium Chloride
  - Sodium Chloride
  - Magnesium Chloride
  - CMA
  - Urea
- Less Corrosive

Environmental Impacts

- Soil
- Animals
- Vegetation
- Water
- Air
- Human Health

5 Gal
Snow and Ice Resource Management

- Effective - Defined by the Level of Service
  - What end result are we trying to achieve?
    - Bare and wet surfaces?
    - Prioritized areas?
    - Access around major traffic generators?

- Efficiency - Available Resources
  - Labor, Equipment, and Materials
  - How is the outcome or performance measured?
Winter Maintenance

• Storm Management
  – Doing the right thing at the right time
  – Timely Assessments
  – Proper Adjustments
  – Flexible Operations Strategy

Snow and Ice Control
Spreading Rock Salt……or a Mix

Treating Surfaces…..Pavements, Walkways and Paths

Surface Temperature
• Determines the **Timing, Type & Duration** of Snow and Ice Treatment Operations
• Impacted By:
  • Air Temperature Trends
  • Subsurface Temperatures
  • Time of Day
  • Cloud Cover
  • Wind Speed
Chemicals applied to:

• **prevent** bonding of ice and snow to road surface
• **prevent** ice or frost from forming
• **prevent** buildup of snowpack
• melt ice that has formed

**Bonding Prevention**

It takes 4 times more salt to remove ice than prevent it!
MATERIALS

Solid | Liquid

- Salt (Sodium chloride)
- Calcium Chloride
- Magnesium Chloride
- Potassium Chloride
- Brines
- Potassium Acetate
- Calcium Magnesium Acetate
- Urea
- Agricultural Products
- Other Proprietary Materials
- Abrasives

Common Treatment Materials

Chemicals

Natural Occurring Salts
Chemicals: How do they work?

• Depress the freezing point of water, turning ice or snow into liquid or slush
• Solid salts dissolve to form brine solution

Salt: Disadvantages

• Effectiveness drops with temperature
  – Below 25°F
• Requires time to go into solution (about 20 minutes)
• Corrosive
• Environmental concerns
  – Excessive use
  – Improper Storage
Rock Salt Facts

At 30°, 1 Lb of salt can dissolve 46.3 Lbs of ice

At 25°, 1 Lb of salt can dissolve 14.4 Lbs of ice

At 20°, 1 Lb of salt can dissolve 8.6 Lbs of ice

At 15°, 1 Lb of salt can dissolve 6.3 Lbs of ice

At 6°, 1 Lb of salt can dissolve 3.2 Lbs of ice

<table>
<thead>
<tr>
<th>Pavement Temp °F</th>
<th>One Pound of Ice Salt (NaCl) Melts...</th>
<th>Melt Times</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>46.3 lbs of ice</td>
<td>5 min.</td>
</tr>
<tr>
<td>25</td>
<td>14.4 lbs of ice</td>
<td>10 min.</td>
</tr>
<tr>
<td>20</td>
<td>8.6 lbs of ice</td>
<td>20 min.</td>
</tr>
<tr>
<td>15</td>
<td>6.3 lbs of ice</td>
<td>1 hour</td>
</tr>
<tr>
<td>10</td>
<td>4.9 lbs of ice</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>4.1 lbs of ice</td>
<td>Dry salt is ineffective and will blow away before it melts anything.</td>
</tr>
<tr>
<td>0</td>
<td>3.7 lbs of ice</td>
<td></td>
</tr>
<tr>
<td>-6</td>
<td>3.2 lbs of ice</td>
<td></td>
</tr>
</tbody>
</table>
Liquids in Snow & Ice Control

- Pre-wetting solids
- Direct application – Anti-icing

Liquid Considerations

- Produce brine
- Purchase
  - Neighboring agencies
  - Vendors….natural brine
  - Other proprietary products
- Storage needs
- Blending
- Application
- Maintenance
Brine Makers

Salt Brine Production Units

- Commercial Units available
- Converts road salt to salt brine automatically
Automated systems……

Homemade production……
Brine Making Basic Components

Step 1

Source: Iowa DOT
Step 2

Step 2 – Add water to the salt. A manifold or other type of mechanism controls the flow of water.

Source: Iowa DOT

Step 3

Step 3 – As the controlled flow of water percolates up through the rock salt, the solution becomes more and more concentrated.

Source: Iowa DOT
Checking Salinity......

- Salometer or Hydrometer: Used for traditional measurements.

- Refractometer: Used for more accurate salinity, which automatically accounts for temperature, air bubbles and calibration which improves productivity. 2 functions-Saturation & Temp.
• Brine maker or supplier of liquids and granular materials
• 800-1K gal’s of salt brine from 1 ton salt(cost/labor)
• Additives, organics, blending
• Use what’s available to you in your area
• Start out small/Simple-ask your neighbors……
• Maintenance – Clean Out Issues
Manual or Automated

- Initial equipment costs – $ per gal, labor, water, electricity – quality of salinity vs well brines
- Water supply crucial to manufacturing brine (3/4” vs 1-1/2”+ 2 - 3” recommended depending on volume)

Considerations for Production and Storage

- Water Supply “CRITICAL”
  - ¾” vs 1 ½” or 2 - 3” supply line
  - Separate water meter to avoid sewer charges
  - Load requirements on wells
- Salt
  - Standard gradation with few impurities
  - Fine salt prohibits circulations and promotes lumping
  - Impurities negatively impact production (Check your contract for % of Inert Debris and/or allowable materials)
- Facilities
  - Consider corrosive nature of salt on electrical components and overhead doors
- Storage
  - Secondary containment?
  - UV inhibitor for outdoor tanks
  - Additional weight of brine (2 lbs/gal more than water)
Blending

Splash Blending

Homemade system includes the blending manifold, flow meter, anti-foam/test port

Automated Blending Systems

Transport....

• CDL Requirements – Tanker Endorsement – Typically 1K Gallons and above

• Anti-Surge - Spheres or Balls to increase safety, minimize driver fatigue, wear & tear on hauling vehicle
Pre-wetting

Pre-wetting salt as it is discharged

Pre-wetting Requirements

• Salt Brine or Other Liquid
  – Production Unit for making brine
  – Purchase product
  – Storage
• Pre-wetting Application Systems
  – Overhead Spray Pre-wet Systems
  – Truck-Mounted Pre-wet Systems
  – Pre-treat Stock Pile (with agg product only)
• Application Rates
  – Roughly 8 gallons per ton (less for stockpile treatment)
Pre-wetting Systems

Truck-Mounted for V-box, Pick-ups & Flat Beds

Top Dressing

Truck mounted tanks......
Stock Pile Treating

Agriculture based products
- 3 to 5 gallons per ton
- Separate storage

Prewetting Salt: Benefits

- Less bounce & scatter
- Faster reaction time
- More effective melting action
  - Less resources to achieve goal
- Less salt needed resulting in:
  - Reduced costs
  - Reduced environmental concerns
Typical Scatter of Road Salt

100% salt spread in center 1/3 of road

1/3 1/3 1/3

Typical Scatter of Prewetted Road Salt

100% prewetted salt spread in center 1/3 of road

1/3 1/3 1/3
Solid Material Application

- Effectiveness is Largely Impacted By ……

MDOT Bounce & Scatter Study 2012
MDOT Bounce & Scatter Study
2012

MDOT Bounce & Scatter Study
2012
Anti-icing

Direct application to the surface prior to the event

Walk Behind Liquid Applicators- 12 gallons - Utilized pickup w/tank for nurse truck
Anti-icing

• Anti-icing is a *proactive* operation: Spreading material before the storm starts – prevents snow and ice from bonding to the road and preventing frost

  versus

• Deicing is a *reactive* operation: Spreading material after storm starts – allows bonding of snow and ice to road surface causing use of more salt and more time to break the bond and achieve melting

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Anti-icing Equipment

• Liquid - Salt Brine or Other
  – Production Unit for making brine
  – Purchase product
  – Storage

• Anti-icing Application Equipment
  – Chassis-mounted units
  – Slip-in units
  – Tow-behind units
  – Walk behind units
  – Ground Speed equipped preferred

• Application Rates
  – 40 to 50 Gal/Lane Mile
  – 8 to 10 Gal/1000 SY (1 oz per SY)
When Conditions Warrant

A. Surfaces are dry

B. Rain is not forecasted for the next 24 hours.

C. Forecasted low temperature to fall within the range of 20 to 35 degrees Fahrenheit or within critical dew point range.

D. Sufficient time exists for pavement to dry before pavement temperature falls below 20 degrees Fahrenheit.

E. Blowing snow is not anticipated.

F. Visual observation indicates sufficient material residue does not exist.

G. High winds are not anticipated.

Anti-icing

PARKS Dept. anti-Iced Day
Before w/cars parked, they were able to use their resources at other locations
Anti-icing Results

- 27 F - Events that had no De-icers applied except for Anti-Iced area’s the day before

A Test Run......
Snow event January 12, 2012 a blended material still worked after 7 days
These are low volume roads

Opportunities and Risks……

• Alternative Treatments
  – Manage resources during supply shortages
  – Expand upon service options
  – Flexible and timely treatments
• Economical
  – Increase effectiveness and efficiency
  – Cutting cost
• Risks
  – Learning curve for a new tool
  – Test on your site or a low volume road
  – Investment in new or upgraded equipment
  – User buy-in from the employees, administrators and customers/citizens
Parking Lots, Sidewalks, Foot Paths

- Highly effective in preventing bond of snow, i.e., improving friction levels. \textit{friction gains from 10\% to 70\%}
- Liquid treated sites out performed dry salt treated sites
- Performs well for light snow events
- Less effective for colder surface temperatures (below 20F)
- Apply at 1 gal/1000 SF or 10 gal/1000 SY
- Concrete surfaces require 20\% more than asphalt
- Rates can be decreased in higher traffic areas

Source: University of Waterloo
### Anti-icing Adjustments For Various Weather Conditions

<table>
<thead>
<tr>
<th>Condition</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>For the 1st and 2nd winter precipitation events of the year (or after extended “dry” periods)</td>
<td>Cases have been observed where anti-icing chemicals “scrub” the oils up from the pavement and can worsen the road conditions by making the road slippery. It is suggested that anti-icing be adjusted by reducing application rates by 1/2 for these events.</td>
</tr>
<tr>
<td>Dry road and blowing snow conditions</td>
<td>Liquid or solid on a dry road may worsen road conditions. Blowing snow may stick to the wetted road causing icy spots and snow-pack spots.</td>
</tr>
<tr>
<td>Respect colder temperatures and chemical dilution potential</td>
<td>Respect cold temperatures. Experience has found anti-icing is most effective with pavement temperatures above 10°F. No matter what the chemical freezing point is, always consider chemical dilution potential (added moisture from melting snow), which makes the chemical more “water-like” and more susceptible to re-freeze.</td>
</tr>
</tbody>
</table>

Source:

- [CHLORIDE CONSCIOUS](#)
- [Midwest Salt](#)
- [DW Clonch, LLC](#)
What Do Others Say?

- Farmington Hills, Michigan – Cut overall material usage on average by 25-30%
- Plain Twp Stark County, Ohio – 40% reduction in salt use
- Auglaize County, Ohio – 20% reduction in overall cost
- Private Contactor – Salt savings of a minimum of 25% and up to 40%
- Private Contractor – Reduced salt application by 50% through pre-treating stock pile
Training

High volume output.....
High capacity tanks......

Franklin County Engineer
240 Gallon

Approximately 25 Gallon per ton....
400 Gallon

Approximately 30 Gallon per ton….

Modifications

Changes to the pre-wetting bar inside the auger to eliminate problems with salt clumping and to improve saturation.
Cuyahoga Falls, Ohio

60 Gal to 90 Gal per ton

Direct Liquid Applications

Farmington Hills, Michigan
Applied at a rate of 40-70 Gal/LM
80 to 100 Gal per LM

Cuyahoga Falls, Ohio

Farmington Hills, Michigan
- Roads, Roundabouts, Parking Lots, Sidewalks
- Anywhere we apply Granular Salt
12-24-12 Xmas Eve (100% brine) 55 gpm-lm wind 8mph NE/dp 22/pave +28/-7:45pm - No Blading 1/2 inch of snow prior to application - Concrete Surface

12-25-12 Xmas Next Morning (100% brine) 55 gpm-lm wind 6mph NE/dp 22/pave +28/-7:45am - No Blading - Concrete Surface - Additional Lt Dusting - Residual - No Traffic

1/25/13 (80% brine 20% Organic) 45 gpm-lm wind Smph W/dp 11/pave +16/-7:45 am - Snow during application - Lt Traffic - 2nd Pass - DAS Application - Asphalt Surface - Plowing with underbody

1/25/13 - 12:20pm - 3 hrs after Application (80% brine 20% Organic) 45 gpm - wind 5 mph - W/dp 12/pave +18/2 Hrs after application - Lt Traffic - Lt Snow After DAS Application - Testing Residual - Some snow back on edges - Roads were safe and passable.

1/31/13 DLA - SM mix (70% brine 30% SM) 45 gpm - wind 30 mph - NW/dp 15/pave +22/ - 1:45pm - prior to application - Asphalt

1/31/13 DLA - SM mix (70% brine 30% SM) 45 gpm - wind 30 mph - NW/dp 15/pave +22/ - 2:30pm - 45 Miss After application - Asphalt - Light Traffic
3/19/13 - (100%brine) 45 gplm-wind 21mph-WSW/dp 18/pave +16/1/3” snow-9:45 pm in progress
App. - Concrete Surface – No Plowing

25 mins-After App.

11:00am-After application-Clear—Asphalt-Sporadic Traffic-ATTN: Shaded Area

11/8:04am-prior to application-Pl.Ciruida—Asphalt-Sporadic Traffic
1-9-13 - DPW Parking Lot-Low Traffic (80%brine-20% Organic)-wind 12-39mph WSW/w26/pave +27/7:45am- No Blading dusting of snow prior to application-Concrete Surface-OKA

[3-12-21:13] G&A- City Hall Parking Lot/Sidewalks- (100%brine)-wind 22mph WNW/w27/pave +26/12:5pm- No Blading ¼ inch of snow prior to application- Concrete Sidewalk-Lt Snow during App.-Residual Kept area safe
Benefits of Liquid Vs. Solids

1-8-13- DPW Parking Lot-Low Traffic: (Granular Salt) - wind 10-30mph-WSW/dp 24/pave +29/- 12:26pm - Concrete Surface - No Mess.

8-8-13- DPW Parking Lot-Low Traffic (Brine-20% Organic) - wind 10-30mph-WSW/dp 24/pave +29/- 12:24pm - Concrete Surface - No Mess.

Sidewalks……..

Cuyahoga Falls, Ohio
Summary

- Impacts of Winter
- Overview
  - Why we use chemicals
  - How they work
  - Solids & Liquids
- Brine Production
  - Making Salt Brine
  - Considerations
  - Blending
  - Transport
- How Liquids are Used
  - Pre-wetting
  - Anti-icing
- Benefits of Liquids
- Opportunities & Risk
- High Volume Output
Questions - Discussion

“There are many ways of going forward, but only one way of standing still.”

— Franklin D. Roosevelt

Diana Clonch
614-989-0316
dwclonch@gmail.com

Bryan Pickworth
bpickworth@fhgov.com
(248) 871-2865