Brine Workshop
How to make brine work for you!
Southwestern Pennsylvania Commission

Sam Gregory
Buffalobills1951 @gmail.com
717-903-8923

“ If you are not willing to learn no one can help you. If you are determined to learn no one can stop you.”
Brine Workshop
How to make brine work for you!
Southwestern Pennsylvania Commission

Topics
• Best Practices for an effective & efficient winter maintenance program
• How chemicals work
• Environmental concerns
• Anti-icing & Pre-wetting
• Sensible Salting Concepts
Why Winter Maintenance?

Snow Covered Roads

Unsafe Driving Conditions
Why Winter Maintenance?

- Slippery Snow-Covered Roads Create Havoc.
  - Vehicular crashes multiply
  - Congestion causes frustration & lost work
  - School closings & delays affect families
  - Emergency Operations are hampered
  - Businesses suffer lost profits
Stopping Distance

- **Dry Surface:**
  - S.D. = D

- **Wet Surface:**
  - S.D. = 1.7D

- **Slush:**
  - S.D. = 2.0D

- **Soft, Loose Snow:**
  - S.D. = 3.0D

- **Compacted Snow:**
  - S.D. = 4.0D
Creating a Winter Maintenance Plan

Goals and level of service for an effective & efficient operations
Liquid Chemicals

“Another tool for your toolbox”

• Liquids
  – Instant action
  – Not displaced by traffic
  – Residue remains effective
  – Versatile
    • Used directly
    • Treat solids
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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.
Chemicals: What do they do?

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
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Chemical Terms

• Concentration
  – % by weight of chemical in solution
• Eutectic Temperature
  – Lowest Temp solution will melt ice
• Endothermic
  – Requires heat when going into solution
• Exothermic
  – Gives off heat when going into solution
• Hygroscopic
  – Draws water from the air
Common Road Treatment Materials

- Salt (Sodium chloride)
- Calcium Chloride
- Magnesium Chloride
- Potassium Chloride
- Brines (by-product of gas production)
- Potassium Acetate
- Calcium Magnesium Acetate
- Urea
- Agricultural By-products
- Other Proprietary Materials
- Abrasives

Natural Occurring Salts
How Deicing Chemicals Work
Phase Diagram for Salt

- Freeze Point Occurs
- Melting Occurs
- Too Little Salt Refreezing Occurs
- Too Much Salt Refreezing Occurs
- Eutectic Temperature of Salt
- Too Cold Refreezing Occurs

Temp. (°F) vs. Temp. (°C) vs. Solution Concentration (% by Weight)
Dilution of Solution

- Explains why one application rate will not fit all winter events.
- Application effectiveness will depend on:
  - Road surface temperature
  - Application rate
  - Concentration
  - Moisture
Solid vs Liquid Advantages

• Solids
  – Less costly
  – Easier to handle
  – Dilute slower (retention)
  – Initial skid resistance (salt)

• Liquids
  – Instant action
  – Not displaced by traffic
  – Residue remains effective
  – Versatile
    • Used directly
    • Treat solids
Solid vs Liquid Disadvantages

• Solid
  – Need moisture
  – Takes time
  – Not good for anti-icing (bounce & scatter, displaced by traffic)

• Liquid
  – Mostly water
  – Not useful for thick ice
  – Rain will wash off pavement
  – Can cause slippery conditions
Salt

• Has been... (Sodium Chloride)
• Is...
  Our
#1 Deicer

“Use it sensibly!”
Salt: Advantages

• Melting action
• No cleanup (as with abrasives)

“Enhanced Safety & Reduced Liability”
Road Salt Basics for Sensible Salting

• The use of salt is an important part of strategies to keep roadways safe in the winter

• Any measure developed must never compromise human safety

• Options must be based on optimization of winter maintenance practices so as not to jeopardize road safety while minimizing the impact on the environment
Road Salt Basics for Sensible Salting

- Salt can result in adverse effects on the physical and chemical properties of soils
- Effects are associated with areas adjacent to stockpiles and roadsides
- Based on available data salts are entering the environment in a quantity and concentration that may have an immediate or long term harmful effect on the environment.
Characteristics of Salt & Melting Capacity
WHAT IS SMART SALTING?

THE RULE OF RIGHT

The \textit{RIGHT} amount of
The \textit{RIGHT} material at
The \textit{RIGHT} time

Smart Salting
Characteristics of Salt & Melting Capacity

<table>
<thead>
<tr>
<th>Temperature Degrees F</th>
<th>One Pound of Sodium Chloride (Salt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>46.3 lb of ice</td>
</tr>
<tr>
<td>25</td>
<td>14.4 lb of ice</td>
</tr>
<tr>
<td>20</td>
<td>8.6 lb of ice</td>
</tr>
<tr>
<td>15</td>
<td>6.3 lb of ice</td>
</tr>
<tr>
<td>10</td>
<td>4.9 lb of ice</td>
</tr>
<tr>
<td>5</td>
<td>4.1 lb of ice</td>
</tr>
<tr>
<td>0</td>
<td>3.7 lb of ice</td>
</tr>
<tr>
<td>-6</td>
<td>3.2 lb of ice</td>
</tr>
</tbody>
</table>
Other Natural Salts

- Calcium Chloride
  - Natural State - Liquid
- Magnesium Chloride
  - Natural State - Liquid
- Potassium Chloride
  - Natural State - Solid

Common Use:
- Prewetting
- Anti-icing
Other Natural Salts

• **Calcium Chloride**
  – Exothermic: gives off heat
  – Hygroscopic: attracts moisture
  – Eutectic Temp: -60°F
  – 30-33% concentration in solution

• **Magnesium Chloride**
  – Exothermic: gives off heat
  – Hygroscopic: attracts moisture
  – Eutectic Temp: -28°F
  – 22-26% concentration in solution
AGRICULTURAL PRODUCTS

BEET JUICE

• All natural, agricultural product
• Anti-icing @ 20 gallons/lane mile
• Mixed with salt brine lowers freezing point to -15F
• Prewetting agent
• Treat mix piles
• Less corrosive than salt brine
# Eutectic vs Effective Temp

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Eutectic</th>
<th>Effective*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>°C</td>
<td>°F</td>
</tr>
<tr>
<td>NaCl (salt) sodium chloride</td>
<td>-21</td>
<td>-6</td>
</tr>
<tr>
<td>CaCl calcium chloride</td>
<td>-51</td>
<td>-60</td>
</tr>
<tr>
<td>MgCl magnesium chloride</td>
<td>-33</td>
<td>-28</td>
</tr>
<tr>
<td>KCl potassium chloride</td>
<td>-11</td>
<td>+13</td>
</tr>
<tr>
<td>KAc potassium acetate</td>
<td>-60</td>
<td>-76</td>
</tr>
<tr>
<td>CMA calcium magnesium acetate</td>
<td>-27</td>
<td>-17</td>
</tr>
<tr>
<td>Urea</td>
<td>-12</td>
<td>+10</td>
</tr>
</tbody>
</table>
Corrosion

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

- Less Corrosive
MS4 Requirements & Environmental Stockpile

Pollution Prevention and Good Housekeeping for Municipal Operations
MCM #6: Pollution Prevention/Good Housekeeping for Municipal Operations

The following are the requirements for MCM #6 that are included in the Federal Regulations:

- Develop and implement an operation and maintenance program that includes a training component and has the ultimate goal of preventing or reducing pollutant runoff from municipal operations (40 CFR Part 122.34(b)(6)(i)).

- Provide employee training to prevent and reduce stormwater pollution from activities such as parks and open space maintenance, fleet and building maintenance, new construction and land disturbances, and stormwater system maintenance (40 CFR Part 122.34(b)(6)(i)).

The following requirements, Best Management Practices (BMPs) and Measurable Goals are to be implemented and achieved:
Winter Material Storage and Use

- Material stored in buildings
- Containment
- Run off control
- Impermeable pads
- Clean up
- Equipment calibrated
Overview:

• Salt brine use is a best practice for fighting winter storms
• Municipalities can use liquid fuels funds to purchase equipment to make brine
• Municipalities can sell brine to other municipalities
Salt Brine

Overview:
Cost of making salt brine includes
• Equipment
  • Brine maker
  • Storage tank
• Labor
  • Loader operator
  • Brine maker
  • Clean out of tank
• Materials
  • Salt
  • Water
  • Electricity
Salt brine is now eligible for liquid fuels funds

MS-0470-0010

Salt Brine

I. DESCRIPTION — Salt Brine is a liquid mixture of potable water and approved Sodium Chloride.

II. MATERIAL— Approved Sodium Chloride is mixed with potable water in a specially designed machine which circulates the water through the salt, in one tank, to a holding tank which holds the finished product. The machine can be purchased from a vendor or can be constructed locally but must have two tanks. One for mixing and one for holding the finished product. When product is stored it must be remixed every thirty days, or before its use, or sale to insure the solution is in proper condition.
Overview:

- Various methods have been used
- Batch - Water passes through a bed of rock salt producing a solution saturated at the water
- Continuous Flow – Water is forced under pressure through a bed of salt, solution flows into storage receptacle
- Brine strength is checked with a hydrometer or a salometer
- Rock salt can contain impurities
- Quality control is essential!
Salt Brine

Salt Brine Production Units

% of concentration at the eutectic temperature

<table>
<thead>
<tr>
<th>% Salt</th>
<th>Salometer Using 0 - 100%</th>
<th>Hydrometer Specific Gravity</th>
<th>Eutectic Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
<td>32</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
<td>1.007</td>
<td>31</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
<td>1.014</td>
<td>30</td>
</tr>
<tr>
<td>3</td>
<td>11</td>
<td>1.021</td>
<td>29</td>
</tr>
<tr>
<td>4</td>
<td>15</td>
<td>1.028</td>
<td>27</td>
</tr>
<tr>
<td>5</td>
<td>19</td>
<td>1.036</td>
<td>26</td>
</tr>
<tr>
<td>6</td>
<td>22</td>
<td>1.043</td>
<td>25</td>
</tr>
<tr>
<td>7</td>
<td>26</td>
<td>1.051</td>
<td>24</td>
</tr>
<tr>
<td>8</td>
<td>30</td>
<td>1.059</td>
<td>23</td>
</tr>
<tr>
<td>9</td>
<td>33</td>
<td>1.067</td>
<td>21</td>
</tr>
<tr>
<td>10</td>
<td>37</td>
<td>1.074</td>
<td>20</td>
</tr>
<tr>
<td>11</td>
<td>41</td>
<td>1.082</td>
<td>19</td>
</tr>
<tr>
<td>12</td>
<td>44</td>
<td>1.089</td>
<td>17</td>
</tr>
<tr>
<td>13</td>
<td>48</td>
<td>1.097</td>
<td>15</td>
</tr>
<tr>
<td>14</td>
<td>52</td>
<td>1.104</td>
<td>13</td>
</tr>
<tr>
<td>15</td>
<td>56</td>
<td>1.112</td>
<td>12</td>
</tr>
<tr>
<td>16</td>
<td>59</td>
<td>1.119</td>
<td>9</td>
</tr>
<tr>
<td>17</td>
<td>63</td>
<td>1.127</td>
<td>7</td>
</tr>
<tr>
<td>18</td>
<td>67</td>
<td>1.135</td>
<td>4</td>
</tr>
<tr>
<td>19</td>
<td>70</td>
<td>1.143</td>
<td>2</td>
</tr>
<tr>
<td>20</td>
<td>74</td>
<td>1.152</td>
<td>0</td>
</tr>
<tr>
<td>21</td>
<td>78</td>
<td>1.159</td>
<td>-2</td>
</tr>
<tr>
<td>22</td>
<td>81</td>
<td>1.168</td>
<td>-4</td>
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<tr>
<td>23</td>
<td>85</td>
<td>1.176</td>
<td>-6</td>
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<tr>
<td>24</td>
<td>89</td>
<td>1.184</td>
<td>2</td>
</tr>
<tr>
<td>25</td>
<td>93</td>
<td>1.193</td>
<td>16</td>
</tr>
<tr>
<td>26</td>
<td>96</td>
<td>1.201</td>
<td>30</td>
</tr>
<tr>
<td>27</td>
<td>100</td>
<td>-</td>
<td>32</td>
</tr>
</tbody>
</table>
Prewet Equipment:
Salt Brine Production Units

- Commercial Units available
- Converts road salt to salt brine automatically
Salt Brine Making Process
Salt Brine Making Process & Storage
Storage of Liquid Deicers
Salt Brine Making Process & Storage

Liquid Storage tanks should have containment & or spill prevention plans

Containment may be the easiest means of Addressing pollution prevention
Handling of Liquid Deicers
Prewetting Salt with Brines

• Prewetted Salt: Salt which has been coated with a liquid solution prior to being spread.

• Prewetting solutions:
  – Sodium Chloride
  – Calcium chloride
  – Magnesium chloride
Prewetting Salt

Iowa Department of Transportation Video (click on picture to start)
Definition and Advantages of Pre-wetting
Prewetting Salt: Benefits

- Less bounce & scatter
- Faster reaction time
- More effective melting action
- Less salt needed resulting in:
  - reduced costs
  - reduced environmental concerns
Melting Action: Untreated Salt vs. Prewetted Salt

Salt

Prewetted Salt

Ice

1 cm 5°F
Melting Action: Untreated Salt vs. Prewetted Salt

Salt

Prewetted Salt
Melting Action: Untreated Salt vs. Prewetted Salt

Salt

Prewetted Salt

1 cm 5°F
Melting Action: Untreated Salt vs. Prewetted Salt

Salt

Prewetted Salt
Definition and Advantages of Pre-wetting

100% dry salt spread in center 1/3 of road
Definition and Advantages of Pre-wetting

100% pre-wetted salt spread in center 1/3 of road
Example: Data

- Usage: 1000 Tons Per Year of Salt
- Cost of Salt: $65.00 Per Ton
- Cost of Salt Brine: $0.15 Per Gallon
- Rate: 10 Gallons Per Ton of Salt
- % Reduction of Salt: 26%
Material Cost Savings

• Amount of Salt Saved: 1000 Tons x 26% = 260 Tons/Year
• Cost of Salt Saved: 260 Tons x $65.00/Ton = $16,900
• Cost of salt brine used: 740 Tons x 10 Gal/Ton x $0.15/Gal = $1,110
• $16,900 – $1,110 = $15,790 savings
Material Cost Savings

• Annual Net Material Savings:
  $20,500 - $5,950 = $14,550

• + Annual Labor Cost Savings:
  - Less Salt to Spread
  - Return Trips to Re-Salt Eliminated
Definitions and Advantages of Pre-wetting
# Application Rates

<table>
<thead>
<tr>
<th>Pre-wetting Application Rates</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Liquid Chemicals at Eutectic Concentration</strong></td>
</tr>
<tr>
<td><strong>Surface Temperature Above 25°</strong></td>
</tr>
<tr>
<td><strong>Surface Temperature Between 0° and 25°</strong></td>
</tr>
</tbody>
</table>
Pre-wetting Methods & Equipment

Iowa DOT photo
Pre-wetting Methods & Equipment
Anti-icing with Brines
Definition and Advantages of Anti-icing
Definition and Advantages of Anti-icing
Anti-icing
Anti-icing Decision Tree

Start here every day!

Does weather forecast predict ice, sleet, snow, freezing rain or frost affecting roadways within 24-48 hours?

YES

Is the road dry?

NO

Will road be dry before projected start time of storm?

NO

Do NOT anti-ice

YES

Is salt residue clearly visible?

NO

Will road surface temperature be above 15°F at onset of the event?

NO

YES

Will there be DRY blowing/drifting snow before and/or during the event?

NO

Anti-ice at a minimum of 45/gal (salt Brine) per snow lane mile. Continue treating when/where applicable.
## Salt Brine, Additives, and Enhancers

<table>
<thead>
<tr>
<th></th>
<th>NaCl (Sodium Chloride)</th>
<th>MgCl₂ (Magnesium Chloride)</th>
<th>CaCl₂ (Calcium Chloride)</th>
</tr>
</thead>
<tbody>
<tr>
<td>23.3% Concentration</td>
<td>21.6% Concentration</td>
<td>29.8% Concentration</td>
<td></td>
</tr>
<tr>
<td>2.3 lb. of Salt* per gallon of water</td>
<td>Proprietary liquid mixtures available containing 20% to 25% MgCl₂</td>
<td>4.1 lb. of 77% Flake/Solid* per gallon of water. Proprietary liquid mixtures available.</td>
<td></td>
</tr>
</tbody>
</table>
# Salt Brine, Additives, and Enhancers

<table>
<thead>
<tr>
<th>Brine Additive Solution Ratios</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NaCl (Sodium Chloride)</strong>*</td>
</tr>
<tr>
<td>NaCl (Sodium Chloride) with MgCl₂ (Magnesium Chloride) Additive*</td>
</tr>
<tr>
<td>NaCl (Sodium Chloride) with CaCl₂ (Calcium Chloride) Additive*</td>
</tr>
<tr>
<td><strong>No Additive</strong></td>
</tr>
<tr>
<td>80% Sodium Chloride with 20% Magnesium Chloride</td>
</tr>
<tr>
<td>80% Sodium Chloride with 20% Calcium Chloride</td>
</tr>
</tbody>
</table>
Salt Brine, Additives, and Enhancers

Approved Brine Enhancers

AQUASALINA+  http://naturesownsource.com/

BEET HEET CONCENTRATE  http://www.ktechcoatings.com/

GEOMELT 55  http://snisolutions.com/

BIOMELT AG  http://snisolutions.com/

AMP by EnviroTech Services  http://envirotechservices.com/

Tom Welker | Municipal Services Specialist
PA Department of Transportation|Bureau of Planning & Research
Municipal Research and Outreach Section | Research Division
400 North Street, 6th Floor | Harrisburg, PA. 17120
Phone: 717.783.3721
twelker@pa.gov
## Anti-icing Application Rates

<table>
<thead>
<tr>
<th>Anti-Icing Application Guidelines</th>
<th>Liquid Chemicals</th>
<th>NaCL (Salt) 23.3%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relative Humidity</td>
<td>Any Snow Event</td>
<td></td>
</tr>
<tr>
<td>Surface Temperature 25° and Above</td>
<td>45 Gallons per Snow Lane Mile</td>
<td></td>
</tr>
<tr>
<td>Surface Temperature 15°-24°</td>
<td>64 Gallons per Snow Lane Mile</td>
<td></td>
</tr>
<tr>
<td>Surface Temperature 14° and Below</td>
<td>Pre-treatment at lower temperatures could lead to trapping the first snow on the roadway surface and is not recommended.</td>
<td></td>
</tr>
</tbody>
</table>
Anti-icing Equipment
Anti-Icing

Upper Leacock Township
Sensible Salting & Winter Operations
Remember!!!!
Calibration is the Key to Sensible Salting!

- Using the right amount to make the roads safe!
- Preventing excessive salt use
  - Saving $$$$$$
  - Protecting the environment

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**WANTED**

**SNOWPLOW OPERATORS**

Don’t forget to calibrate the spreader control system on your horse before saddling up this winter.

**THE CALIBRATION KID**

Is your spreader control system calibrated?

A spreader controller over-applying materials by 5 percent on a truck that applies 225 tons of salt per year will waste 11.25 tons of salt. At $63 per ton, that costs the department an extra $708. Multiply that by 900 snowplows and the DOT would spend an extra $637,875 per year.

A spreader controller over-applying salt by 10 percent would cost an extra $1,417 per year for each snowplow. Multiply that by 900 snowplows, and the DOT would waste $1,275,750 per year.

**REWARD:**

Saving $1,275,750
Calibrating the Spreader = Sensible Salting
Manual Spreader Control

Manual Controls
Automatic Spreader Control
Computer Spreader Control
Calibrating the Spreader = Sensible Salting
Calibrating the Spreader = Sensible Salting
Spreader Calibration Process Walk Through
Spreader Calibration Step 1
Spreader Calibration Step 2
Spreader Calibration Step 3
Calibrating a V-box
Spreader Calibration Step 4

- Set engine RPMs at normal operation range

- Set Auger control at setting to be measured

- Use stopwatch to count auger shaft revolutions per minute (60 seconds)
Spreader Calibration Step 4
Spreader Calibration Step 5
Spreader Calibration Step 6
## Spreader Calibration Step 7

### CALIBRATION CHART

| Control Setting | Shaft RPM (Loaded) | Discharge Per Revolution (Pounds) | Discharge Rate (Lbs/Min) | 5 mph | 10 mph | 15 mph | 20 mph | 25 mph | 30 mph | 35 mph | 40 mph |
|----------------|-------------------|-----------------------------------|--------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1              |                   |                                   |                          |       |       |       |       |       |       |       |       |       |
| 2              |                   |                                   |                          |       |       |       |       |       |       |       |       |       |
| **3**          | **5**             | **20**                            |                          | **100** | **1200** | **600** | **400** | **300** | **240** | **800** | **171** | **150** |
| 4              |                   |                                   |                          |       |       |       |       |       |       |       |       |       |
| 5              |                   |                                   |                          |       |       |       |       |       |       |       |       |       |
| 6              |                   |                                   |                          |       |       |       |       |       |       |       |       |       |
| 7              |                   |                                   |                          |       |       |       |       |       |       |       |       |       |
| **8**          | **20**            | **20**                            |                          | **400** | **4800** | **2400** | **1600** | **1200** | **960** | **800** | **689** | **600** |

*Sample Calculations*

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Note: The values for Discharge Rate and Discharge Per Revolution are placeholders and should be calculated based on actual measurements. The chart includes options for different speeds and corresponding travel times per mile.
Spreader Calibration
Making Brine Work for You

• Questions / Comments