UNH T² Center Technical Note

Winter Maintenance Tips

Chemical anti-icers or de-icers are valuable tools to fight winter storms. They are costly and may have negative environmental impacts therefore, highway agencies need to understand how they work. This publication provides basic information and tips to use chemicals effectively.

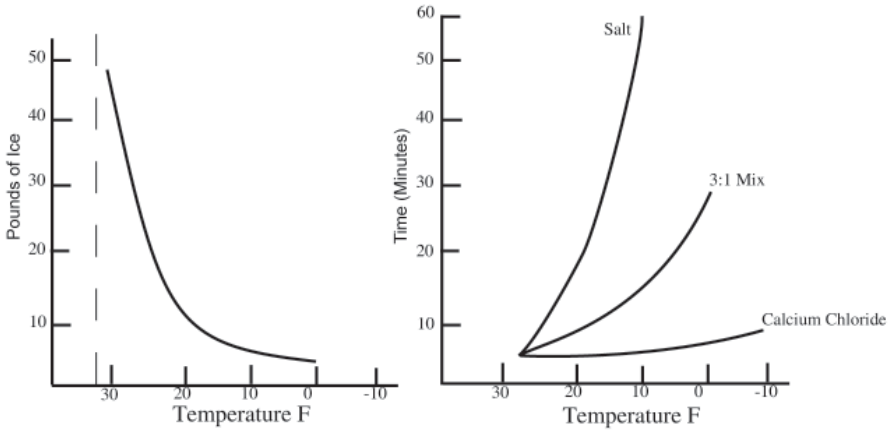
De-Icing with Chemicals

Many agencies use de-icing chemicals to achieve bare pavement during winter storms. Salt (sodium chloride) is the most widely used. Salt is mined and crushed, screened, and treated with an anti-caking agent.

Calcium Chloride (CaCl) is sold as pellets, flakes, or liquid.

Calcium magnesium acetate (CMA) has fewer negative environmental impacts than salt and calcium chloride. Additives reduce the chemicals' corrosive properties. CMA is more expensive, but a good solution in special situations.

De-icing chemicals work by lowering the freezing point of water. A 23.3% concentration of salt water freezes at -6o F and a 29.8% solution of calcium chloride freezes at -67 F. Low freezing points makes salt and calcium chloride effective.



The graph on the left shows that salt melts more ice per pound at higher temperatures. The graph at right shows the comparative time for different compounds to melt 1/8" of glare ice.

Before a dry de-icing chemical becomes effective, it must form a brine. Snow on the road or humidity can provide the moisture to create the brine.

Heat is also necessary to melt snow or ice. Heat may come from a number of sources: air temperature, sun, pavement, or traffic friction. Even when the pavement temperature is below freezing, it will hold heat.

Factors affecting de-icing

Chemical concentration, time, pavement temperatures, weather conditions, type of road surface, topography, traffic volume, width of application, and, most importantly, time of chemical application all affect the process of melting snow and ice.

Concentration Using too little chemical may not sufficiently lower the solution's freezing point. Ice will not melt; or melted snow may refreeze.

When too much chemical is used, it will not fully dissolve and some will be wasted.

Temperature The road surface temperature determines de-icing chemical and melting rates. As temperatures go down, the amount of de-icer needed to melt a quantity of ice significantly increases. The effectiveness of de-icing is sensitive to small differences in pavement temperatures. The graph on page one shows that salt can melt five times as much ice at 30F as at 20F.

Time The longer a de-icing chemical has to react, the greater the amount of melting (see page one). At temperatures above 20F both salt and calcium chloride melt ice in a reasonable time. At lower temperatures salt takes much longer than CaCl.

Weather The sun's heat warms the pavement and speeds melting. Radiant heat increases pavement temperature 10F or more above the air temperature. On clear nights, pavement temperatures are lower than air temperatures. Use less chemical when temperatures are rising and more when they are falling.

The lower limit for using salt is 15-20 F. At lower temperatures more salt is needed and melting takes longer. Use other chemicals such as calcium chloride and magnesium chloride.

Road surface type Snow and ice melt more rapidly on an asphalt surface. Asphalt absorbs more solar radiation and is warmer for melting. This explains why snow melts more rapidly next to bare asphalt pavement.

Topography Ice tends to form where conditions such as high banks or vegetation, shade the road surface from the sun. The longer an area is shaded, the more likely that ice will form. Pavement temperatures are lower in shaded areas, so it becomes necessary to use more chemical.

Application width. The amount of snow melted over a long period of time is the same regardless of application width of salt. However, in the short-term, snow melts faster when salt is applied in narrow strips.

Concentrated spreading (windrowing), exposes the road surface more quickly to the sun. Then, the pavement absorbs solar heat and increases the melting rate on the rest of the roadway.

Time of Application Timing of application is the most important factor when using chemicals. Early application is critical. Spread a small amount of de-icer when snow is loose to turn it into slush. Slush is easy to plow and traffic cannot pack it (slush is 15% to 30% water).

After a road is plowed, apply de-icing chemicals in a windrow two to four feet wide down the middle of a two-lane road.

To remove black-ice or keep snow in a plowable condition, apply chemicals across a broader portion of the road. It is better to reapply chemicals as needed than to over-treat. Do not plow off chemicals until they have an opportunity to work.

Environmental impact

Environment is a concern with any maintenance activity, particularly winter maintenance. Studies show that soils, vegetation, water, highway facilities, and vehicles are affected. Most soil and vegetation damage occurs within 60 feet of the road.

Localized environmental damage from salt is largely due from stockpile runoff. Stockpiles are at maximum concentration and any exposed environmental element receives a very large dose. To prevent stockpile runoff contamination, cover salt and store it on an asphalt base.

Spreading

Spreading rates No two storms are alike, so no one set of standards provide the proper spreading rate for all conditions. Generally, only apply enough chemical de-icer to permit plows to remove snow or melt black-ice. The most effective rate to spread de-icers are between 100 and 300 pounds per single lane mile. Do not use any de-icer when temperatures are below its effective range.

Concentrate spreading de-icers in the center of two-lane roads and on the high side of curves because melting action spreads across the pavement to lower areas.

Chute vs. Spreader A spreader with a spinner is the most common way to apply de-icers. A spinning circular plate spreads the materials in a semi-circle. A chute can distribute de-icer in a windrow, usually on

the center line.

Spreaders can be equipped with automatic or ground-speed controls. These automatically regulate application rates as truck speeds fluctuate, so the driver need not adjust the spreader controls. They are an effective tool to reduce wasted chemicals.

Spreader calibration Calibration is essential for control application rates. Different materials will spread at different rates using the same spreader control setting. Calibrate spreaders for their intended use. Calibrate each spreader; even individual spreaders of the same model. Spreaders are used in a hostile environment--low temperature, lots of moisture, corrosive chemicals—therefore, clean and inspect routinely.

Calcium Chloride

Dry calcium chloride requires special handling and is more costly than salt. It is effective at temperatures below 0F and is fast-acting. CaCl releases heat as it dissolves into brine. It also draws moisture from the air, which provides water for initial brine formation. These unique properties make it valuable in severe conditions.

Store CaCl in moisture proof bags. Otherwise its ability to draw moisture may cause it to cake and form large chunks.

A mixture of CaCl and salt can be very effective, even a small amount of CaCl will start melting snow and ice at lower temperatures. The resulting brine and heat allow the salt to start working. The graph (on page one) shows how well a mixture (three parts salt to one part calcium chloride) works at lower temperatures.

Pre-wetting

Pre-wetting salt is common. Pre-wetting provides the moisture to make salt brine and is faster acting than materials not pre-wetted. Additionally, wet salt is less likely to bounce or be blown off the road. Savings in lost or wasted salt of over 20% to 30% are possible. These savings will pay for pre-wetting equipment. However, savings only result with lower application rates.

Any liquid can be used to pre-wet although, liquid calcium chloride is most widely used. Applications of 6-10 gallons CaCl per cubic yard of salt are recommended.

Salt brine as a pre-wetting agent is becoming more common because of its low cost. Some agencies produce their own salt brine (23% solution).

To pre-wet salt with a liquid, use truck-mounted equipment to spray the salt as it leaves the spreader to create a more uniform application. This eliminates the problem of handling pre-wetted salt not immediately used. Some agencies spray salt as it is loaded into the truck. This is not as effective as spraying salt at the spreader.

Anti-Icing

Anti-icing prevents the formation of a bond between ice and the pavement surface. An accurate pavement condition forecasts anticipates condition to make anti-icing effective. Apply the chemicals before, or at the on-set, of the storm. This reduces total chemical use and provides a higher level of service to the public. Use anti-icing on high service pavements. Liquid chemical applications are the most successful method in anti-icing. Pre- wetted dry chemicals are also used.

Studies show that anti-icing produces equal or better road conditions using few chemicals. Apply liquid chemicals at fairly low rates (25 to 50 gallons per mile). The fairly light application rates produce a damp rather than wet surface. Liquid chemicals remain on the pavement long enough to work. The pavement temperatures must be compatible with the air temperature for the chemical being applied.

Problems can develop if heavy precipitation continues and the storm gets ahead of anti-icing efforts. Heavy rain, freezing rain, or intense snowfall rates can cause a problem. Under these conditions switch to de-icing to accomplish cleanup.

Abrasives

Sand and other abrasives may improve vehicle traction on snow and ice-covered roads. They can be used at all temperatures, especially when it is too cold for chemical de-icers to work.

Environmental impacts

Abrasives have a negative environmental impact. They can clog storm water inlets and sewers. Abrasives may wash downstream, ending up in streams and lakes. Cleanup may be necessary in urban areas, on bridge decks, and in ditches.

Air pollution from particles less than 10 microns in size (pm 10) has been documented from winter abrasive use. Therefore, cleaner abrasives and quicker cleanup after the storm are required in areas with air pollution issues.

Abrasive Quality

Some sand and abrasives are more effective than others. To increase traction, use materials with crushed or angular particles. Very small particles and dirt actually reduce traction. Materials larger than the #50 sieve are most effective. To minimize windshield damage, use materials with particles size smaller than 3/8 inch.

Combining with Chemicals

Treat sand with 50-100 pounds of salt per cubic yard to keep it from becoming frozen and unworkable. It helps to anchor the sand into the ice surface, makes the sand easier to load from the stockpile, and makes it spread more evenly from mechanical spreaders.

Pre-wet sand with a liquid de-icing chemical just before spreading has proven effective to embed the abrasive on icy pavements.

Sources:

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Ten Commandments for Snow Fighters

1. Thou shalt present thyself to thy job physically and mentally fit and properly clothed in order to withstand the rigors of thy task.
2. Thou shalt always inspect thy lights, windshield wipers, defrosters, flares, and other safety equipment before entering thy cab.
3. Thou shalt know thy spreading and plowing routes, as well as the performance of thy spinner and the life of thy plow blade.
4. Thou shalt faithfully remain alert in order to avoid guardrails, headers, stalled cars, manhole covers, railroad tracks, and mailboxes. Otherwise thee may smite thy windshield with thy head.
5. Thou shalt contain thy temper, even though cars and trucks pass thee on both sides and tailgate thee too close for comfort. Anger only multiplies thy prospects of coming to grief by accident.
6. Thou shalt use thy radio as briefly as possible—assuming thee is fortunate enough to have one. Remember thy fellow workers may need to communicate in an emergency.
7. Thou shalt interrupt the flow of power to thy spreader before attempting to free any foreign objects or blockage if thee treasures thy fingers.
8. Thou shalt render thy truck and spreader out of gear and stoutly set thy brakes before dismounting from thy cab.
9. Thou shalt govern thy speed according to conditions; else thee may wind up with thy truck upside down.
10. Thou shalt mind thy manners on the roadway, clearly signal thy intentions, and remember that it is more blessed to give than to receive.

Sources:

Adapted from the National Local Technical Assistance Program/Salt Institute. Rural & Urban Roads, 1980

http://www.t2.unh.edu/pubs/maint_work_manual.pdf