

PROPER USE OF SALT & SAND FOR WINTER ROAD MAINTENANCE

To make winter roads passable, maintenance workers must either apply chemical deicers to melt ice and snow or spread sand to provide traction. Because chemicals and sand are costly and may have negative environmental effects, it is important to know how they work. This issue of StreetWise gives you basic information and practical tips on how to use deicing chemicals and sand.

DEICING WITH SALT

Plowing is the best way to remove snow and slush from pavements. However, clearing winter roads to bare pavement normally requires deicing chemicals. In Nevada, the most common chemical is salt (sodium chloride), usually mined rock salt that has been crushed, screened and treated with an anti-caking agent. Rock salt is relatively light — about one ton per cubic yard — and comes as a mixture ranging from 3/8-inch granules to fine crystals. The rock salt is mixed with sand after it is delivered to the stockpile location. But there are times when anti-caking is only used for rock salt that is not mixed with sand right away.

Deicing chemicals work by lowering the freezing point of water. A 23.3 percent concentration of salt water will remain liquid to -6 degrees F. Before a dry deicing chemical can act, it must dissolve into a brine solution. It uses moisture from water, snow or slush on the road surface.

Changing ice or snow into water also requires heat from the air, the sun or the pavement because chemicals only lower the melting temperature. Even when pavement is below freezing, it holds some heat that can help melt snow and ice.

Salt storage requirements

Localized environmental damage from salt has come largely from stockpile runoff due to the effect high concentrations of salt have on exposed environmental elements. It is necessary to prevent stockpile runoff from contaminating ground or surface water by covering the salt and storing it on an impermeable base so rain or melt runoff can't seep in.



This machine spreads abrasives and chemicals on roads for ice control.

SPREADING

Spreading rates

No two storms are alike, so no single set of standards will give the proper spreading rate for all storm conditions. Generally, however, apply only enough chemical deicer to permit plows to remove the snow or to melt glare ice. Experience shows it is most effective to spread 100 pounds to 300 pounds per single lane mile.

Do not use any deicer when temperatures are below its effective range. Normally, the lower limit for salt is 15 degrees F to 20 degrees F. If deicing is necessary at lower temperatures, it will take more salt and melting will take much longer (see Figure 2). Alternative chemicals, such as calcium chloride or magnesium chloride, may be a better choice for low pavement temperatures.

Other conditions that affect salt application rates:

- * **Precipitation type:** Additional salt is helpful if the snowfall is heavy and wet, or if freezing rain is expected.

- * **Snow accumulation:** Roads already covered with snow or ice require more salt.
- * **Time before next application:** If it will be two hours or more until the next plowing and salting, the section probably will need extra salt.
- * **Service level:** More salt may be justified on a road with heavy traffic requiring a higher service level than on lower-volume roads with slower speeds.

Melting action spreads across the pavement to lower areas, so concentrate deicers on the center (crown) of two-lane roads and on the high side of curves.

Chute vs. spreader

A spreader with a spinner is the most common way of applying deicers. A spinning circular plate throws the deicer out in a semicircle. Alternatively, a chute applicator can distribute the deicer in a windrow on the road, along or near its centerline.

Higher truck speeds will cause the salt to roll and spread further across the road. Tests have shown that a chute will do a better job of keeping salt on the road if spreading speed is 25 mph or greater.

Spreaders can be equipped with automatic or ground-oriented controls. These adjust application rates to changing truck speeds, so the driver need not alter the spreader settings. They effectively cut waste and are recommended for spreading straight salt.

Spreader calibration

It is important to apply the correct amount of salt for the current storm conditions. In order to control application rates, each spreader must be calibrated for each material you intend to use. Different materials will spread at different rates at the same spreader control setting and individual spreaders (even identical models) can vary widely in how much they spread at the same control setting.

PRE-WETTING

Pre-wetting salt is becoming common as it provides moisture to make brine and faster melting action may be expected. The wet salt will be less likely to bounce or be blown off the road by traffic. Savings in lost or wasted salt of 20 percent to 30 percent are possible.

Common pre-wetting liquids include salt brine, calcium chloride and magnesium chloride. Some chemicals may contain additives to inhibit corrosion. Applications of eight to 10 gallons of liquid per cubic yard of salt are recommended.

Some agencies spray the salt as it is loaded into the

truck or pre-treat the salt. However, it is most common to use truck-mounted equipment to spray the salt as it leaves the spreader.

ANTI-ICING

Anti-icing is a pro-active road maintenance strategy that tries to keep the bond between ice and the pavement surface from forming. It involves applying ice control chemicals before or at the very beginning of a storm. Using this strategy often reduces the total chemical used and allows a higher level of service to motorists.

The strategy most commonly used now is deicing – breaking the bond between the ice and pavement. Obviously, this technique is required once the snow or ice covers the pavement. More chemicals are needed to cut through the ice and break the bond than presumably would be needed to prevent the initial formation of the ice to pavement bond.

Various ice control chemicals being used for anti-icing include liquid salt, liquid magnesium chloride, liquid calcium chloride, CMA and potassium acetate.

ABRASIVES

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

Abrasives are normally used on gravel roads because chemicals will soften the surface and cause plows to scrape off the gravel. Low-volume roads commonly receive only abrasives. Sand is the most common abrasive, but slag, cinders and bottom ash from power plants also are used.

Abrasive quality and application

For better traction, use material with crushed or angular particles. Material larger than the #50 sieve is most effective. To minimize windshield damage, use materials that have particles less than 1/8-inch diameter.

Abrasives are applied only at hazardous locations such as curves, intersections and railroad crossings at rates of 500 pounds to 2 cubic yards per mile. It is important to calibrate spreaders to control application rates.

Combining chemicals with sand

Treating sand with 50 pounds to 100 pounds of salt per cubic yard is necessary to prevent freezing and to keep it workable. Some agencies mix more salt with their abrasive than is needed for freeze proofing. This practice is often wasteful and ineffective. Sand and salt often work against each other. If the goal is for sand to stay on the surface for traction, the salt in the mix either blows off and gets wasted or does its job and melts the snow. However, tires can then push the sand down into the slush, making it ineffective for improving traction. If the goal is for salt to melt snow and ice so plows can clear the pavement, then sand gets removed too, wasting it.



Higher truck speeds will cause the salt from a deicing machine to roll and spread across the road.

FACTORS AFFECTING DEICING ACTION

Many factors affect the process of melting snow and ice. Decisions on how and when to apply materials are best left to field supervisors and operators who can assess conditions and adjust to changes.

Concentration

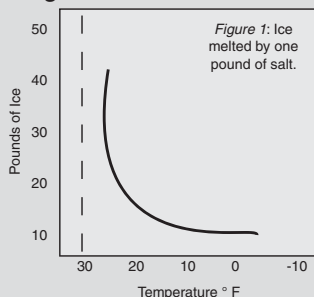
If too much chemical is used, not all of it will dissolve into solution, and some will be wasted. Too little chemical may not sufficiently lower the solution's freezing point. When salt is dissolved into brine on the road, it is near 23 percent concentration and freezes at -6 degrees F.

As snow and ice melt, the extra water dilutes the solution, raising its freezing point. For example, a 10 percent salt brine solution will stop melting ice and can re-freeze at about 20 degrees F, which may require more salt.

Temperature

Salt's affectiveness is directly related to the surface temperature of a snow-covered or ice-covered road. As temperatures go down, the amount of deicer needed to melt a given quantity of ice increases significantly.

Figure 1 shows that salt can melt five times as much ice at 30 degrees F as at 20 degrees F. Small differences in pavement temperatures have a noticeable affect. Truck-mounted temperature sensors give operators information to make better application decisions.



Time

The longer a deicing chemical has to react, the greater the amount of melting. At temperatures above 20 degrees F, both salt and calcium chloride can melt ice in a reasonable time. However, at 10 degrees F it takes an hour for salt to melt 1/8 inch of ice.

Weather

When sun warms the pavement, the heat speeds up melting. Radiant heat may raise pavement temperature 10 degrees F or more above the air temperature. On clear nights, pavements will be colder than the air. Use less chemical when temperatures are rising and more when they are falling.

Applying chemicals during blowing snow and cold temperatures will cause drifting snow to stick to the pavement. If chemicals are not used, the dry snow is more likely to blow off the cold road surface.

Road surface type

Snow and ice may melt more rapidly on a concrete surface because asphalt absorbs more solar radiation. Bridges cool down and warm up faster than road surfaces because air reaches both sides of the deck. This can create varying conditions, such as icing on the bridge deck when the adjacent road is clear.

Topography

Ice tends to form where topographic conditions, such as high banks or dense vegetation, screen the road surface from the sun. The longer the area is shaded, the more likely that ice will form. Because pavement temperatures are lower in shaded areas, you may need more chemicals there. Road cuts may cause snow to drift and blow across the road; the snow will lower pavement temperatures.

Traffic effects

Traffic aids deicing by spreading and mixing chemicals into the snow and ice. Tire action also breaks up ice layers weakened by salt and can throw slush off the road. Roads with light traffic can be more difficult to maintain because they lack this mixing and breaking action. However, traffic also can trap blowing snow or can melt snow and cause it to re-freeze in the wheel tracks, if not treated again.

Application width

Studies show that snow melts faster when salt is applied in narrow strips. The total amount of snow melted over several hours is the same, however, regardless of application width. If you concentrate spreading (windrowing), you can expose a portion of road surface to the sun quickly. It can then absorb heat and speed up the melting rate.

After a road is first plowed, deicing chemicals are usually applied in a windrow 2 inches by 4 inches wide down the middle of a two-lane road. To remove glare ice or keep snow in a plowable condition, apply chemicals across a broader portion of the roadway.

Timing of application

Timing is the most important factor in successfully clearing snow by chemical treatment. Early application is critical. Spreading a small amount of chemical deicer when snow is loose and unpacked melts a little snow and turns the rest to slush. Traffic cannot pack down slushy snow, which is 15 percent to 30 percent water. This lets plows remove it, and plowing is the best way to clear roads. If snow continues to fall, more salt may be needed.



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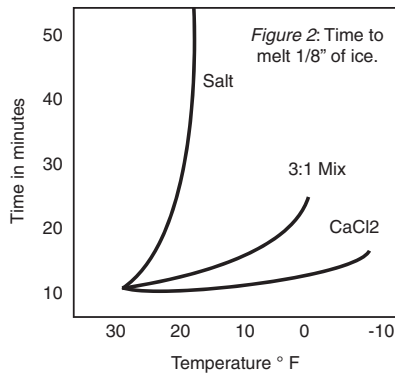
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ALTERNATIVE CHEMICALS

Salt is the most efficient deicing chemical if road temperatures remain above 20 degrees F. Calcium chloride and magnesium chloride are common alternatives for use in colder temperatures. Figure 2 shows how effectively calcium chloride melts ice at low temperatures. Because these alternative chemicals cost up to 10 times more than salt, mixing some dry calcium chloride or magnesium chloride with dry salt can be an efficient approach.

Figure 2 shows the benefits of a mixture of three parts salt to one part calcium chloride. These alternative chemicals are effective at road temperatures below 0 degrees F.

Dry calcium chloride and magnesium chloride require special handling. They actually give off heat when they dissolve into brine — a very beneficial characteristic. They also draw moisture from the air, providing water for the initial brine formation. These unique properties make them a valuable tool during severe conditions.



ENVIRONMENTAL IMPACT

A major concern in using chemicals for winter road maintenance is environmental impact. Studies show that soils, vegetation, water, highway facilities and vehicles are all affected, so it is very important to use these chemicals wisely. Most soil and vegetation effects occur within 60 feet of the road and are greatest close to the pavement.

Deicing chemicals are highly soluble and tend to follow water flow. In some reported cases, groundwater carrying deicing chemicals contaminated wells and carried heavy salt concentrations into nearby streams.

Deicing chemicals can accelerate deterioration in concrete and steel structures. New construction methods are reducing this impact, but highways and bridges do suffer from chemical damage. Corrosion on vehicles and structures is estimated to be the largest cost effect of chloride-based chemicals. Even relatively small amounts of chloride will significantly accelerate existing corrosion.

For information, contact the Nevada T² Center at the address shown below. *StreetWise* is published periodically by the Nevada Transportation Technology Transfer Center at the University of Nevada, Reno. The publication contains rewritten material compiled from reliable sources, but it assumes no responsibility for their correctness. The Nevada T² Center is part of the nationwide Local Technical Assistance Program. It is financed jointly by the Nevada Department of Transportation and the Federal Highway Administration.

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