CREATING A CLEAR PATH
Volume 1, September 2016

A Strategic Guide to De-Icing for Municipalities & Contractors

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A STRATEGIC GUIDE TO DE-ICING FOR MUNICIPALITIES & CONTRACTORS

Creating A Clear Path

Providing safe streets, sidewalks, driveways and highways during winter storms is not an easy job, but it certainly is an important job to protect lives and keep traffic safely moving.

Each winter, more than 115,000 people are injured and more than 1,000 are killed in the United States on snowy or icy roads. Road salting and effective plowing can reduce injury crashes by as much as 88 percent. The economic impact of snow-related road, business and other facility closures greatly exceeds the cost of timely snow removal, with de-icing paying for itself within the first 25 minutes after applying salt.[1]

Using ice melting compounds to clear snow and ice from walks, drives and entrances near public buildings is equally important. Providing safe surfaces—regardless of the type of surface—in the shortest time with the least total cost requires ice melting compounds, which maintenance personnel have long known.

With a wide variety of materials available for use in winter operations and more than 100 brands of ice melters on the market today, it can be confusing to pick the best option for one particular location or environment.

While most de-icing materials work in the same way, they vary widely in performance. Performance involves several factors, including eutectic temperature (the lowest melting point temperature of a mixture of components) and effective temperature (speed to melt ice and snow), amount of material required, and duration of melting action.

In this guide, you'll find an overview of de-icing materials and how these materials work, a comparison of their features and benefits, information on how to apply ice melting materials, and commonly used terminology.

[1] The Salt Institute. *The Snowfighters Handbook – A Practical Guide for Snow and Ice Control,* 2013

Common Road Treatment & De-Icing Materials

As mentioned on the previous page, there are many brands of ice melters, but the number of commonly used materials (both granular and liquid) is much shorter, typically including one or more of about a dozen compounds:

NATURALLY OCCURRING SALTS

- Sodium chloride (rock salt)
- Calcium chloride
- Magnesium chloride
- Potassium chloride

OTHER ICE MELTING COMPOUNDS

- Urea
- Sodium acetate
- Potassium acetate
- Calcium magnesium acetate
- Ammonium nitrate
- Ammonium sulfate
- Various blends of the above, with and without abrasives
- Brines (*byproduct of gas production*)
- Agricultural byproducts
- Other proprietary materials
- Abrasives

The first four materials listed above are naturally occurring salts, with rock salt and calcium chloride the two most extensively used materials in applications around facilities and rock salt most frequently used as a common road treatment. Urea, ammonium nitrate and ammonium sulfate are synthetic materials that are most commonly found in fertilizers.

With a proliferation of brands, there has also been a proliferation of products packaged without listing their chemical composition. While some brands fall into this category, others have labels listing content, but they make false or misleading claims about the ability of their product to perform. That has resulted in a good deal of confusion about the pluses and minuses of such products.

There are times when if the wrong material is used, the condition can actually be made worse. The chemical supplier should provide the chemical information about each compound they sell. It's important to know the composition of the de-icing product to know the temperature range, speed to liquefy into a solution to melt ice and snow, duration of melting action, and amount of material required.

Under the Surface: The Science Behind De-Icing Materials

De-icing materials react with snow and ice to form a layer of liquid solution that has a freezing point below 32°F (0°C). They prevent ice from forming or they melt ice that has already formed, and prevent buildup of snowpack. They work by attracting moisture to form a liquid de-icing brine to generate heat to melt the ice. The de-icing product needs to reach the pavement to become effective. For de-icing material to be most effective, it needs to go into solution quickly, which is generally within 15 to 20 minutes of application.

Once this de-icing solution/brine reaches the pavement, it can spread out on the ice or snow and break its bond with the pavement. The rate of melting depends on how fast the specific chemical reacts to the existing moisture. As the ice and snow are loosened, they are much easier to plow or shovel away. Ice melting products work best if applied proactively as an anti-icing operation before snow or ice accumulate (compared to reactive de-icing). Anti-icing can be used as the first in a series of strategies employed for a winter storm. By preventing the bonding of ice and snow to the road, fewer chemicals can be used and faster melting action will take place. Research has shown that timely applications of anti-icing materials can cut the cost of maintaining a safe road surface by 90% compared to traditional deicing.[1]

Agriculture byproducts (fertilizer, refined corn carbohydrate, beet juice, corn wet milling byproducts and more) work in a similar way, although they do not form a brine. They are soluble in water, with the solution that results acting by depressing the freezing point of snow and ice.

[1] The Salt Institute. *The Snowfighters Handbook – A Practical Guide for Snow and Ice Control,* 2013

Comparing Materials

Analyzing the performance of de-icing materials involves a number of factors, starting with the range of temperatures that can provide de-icing action in a reasonable time period (within 15 to 20 minutes of application). Other factors to consider are speed to go into solution, the amount of material required (as well as cost and availability), the duration of melting action, ease of handling, environmental and infrastructure impact, equipment requirements, and more. The following materials application guide provides an overview and comparison of various materials.

Materials Application Guide

Technical information about snow and ice control materials is provided for general information only. For more specific information, please contact your materials supplier.

Material	Description	EU Eutectic Temperature	EF Effective Temperature	Size/Liquid Concentration	How it is sold	Application Rates/ Concentration	Where it is used	Environmental Impact
Earth Blend Ice Melt www.greenicemelt.com 	Corrosion inhibited complex chloride (sodium chloride, potassium chloride, magnesium chloride) and magnesium chloride hexahydrate.	n/a	-25° F (-32° C)	Each crystal granule of ice melter is blended with liquid de-icer.	50 lb. bag 25 lb. bag 6 lb. bag	See manufacturer's recommendations	Most Green Ice Melt on the market today is safe if used as directed for concrete, around gardens, walkways, sidewalks, driveways and parking lots.	Green Earth Ice Melter™ has less bounce and scatter during application, reducing application rate, and consequently releasing fewer chlorides into the surrounding earth.
Calcium chloride ($CaCl_2$) www.calciumchloride.com 	A white deliquescent salt in its anhydrous state is used as a drying and dehumidifying agent, and when used in a hydrated state it is effective for controlling dust and ice on roads. Calcium chloride is hygroscopic (attracts moisture) and is exothermic (produces heat).	-60° F (-51° C)	-25° F (-32° C)	Available in pellet or flake form. Concentration by weight is 30%.*	In bags in most hardware stores, or online in 50 lb. bags	See manufacturer's recommendations	Highways and high traffic areas. Used as a mix and liquid application.	Corrodes vegetation
Rock Salt with Beet Juice 	A mixture of beet juice and salt that is kinder to concrete and metal.	n/a	20° F (-7° C)	As rock salt and halite crystals	Bulk; beet juice is added to current deicing material	475 lb/acre (215 kg)	Highways and roadways	Beet juice is a growing concern over roadside habitat degradation, wildlife kills, and water quality issues.
3/8" Chips 	Gravel type material usually acquired from quarries. Chips do not have melting characteristics but aid in traction.	n/a	n/a	3/8" - 1/2" (9.5 - 12.7 mm)	Bulk, by the ton	n/a	Secondary roads and roads with raised inclinations	n/a
Rock Salt treated with Super Blend 	Rock salt treated with multiple deicing chemicals (example shown has sodium chloride, calcium chloride, and beet juice). Blends are determined regionally.	Depends on blend	Depends on blend	Rock salt gradation (fine - coarse)	Bulk and blended on site	100 - 300 lbs/lane mile (45 - 136 kg/1.6 km)	Highways and roadways	Impact is lessened depending on blend ratio.
Clear Path Ice Melt www.clearpathicemelt.net 	High strength crystal comprised of sodium chloride and calcium chloride.	n/a	-15° F (-26° C)	See manufacturer	Bag, bulk	Refer to manufacturer's specifications	Everyday use and light traffic areas such as sidewalks and steps	Reduced effect on vegetation.
Merlin Melts Like Magic™ www.saferthansalticemelt.com 	Premium ice melt is uniquely formulated to outperform other ice melts. The product is a proprietary formulation of sodium chloride, urea, potassium chloride (a fertilizer) and calcium magnesium acetate (CMA).	See manufacturer	See manufacturer	See manufacturer	50 lb. bag	Consult manufacturer	Everyday use and light traffic areas such as sidewalks and steps	Claimed reduced impact by using less material.
Sodium chloride (NaCl, rock salt) www.saltinstitute.org 	An ionic crystalline chemical compound consisting of equal numbers of sodium and chlorine atoms.	-6° F (-21° C)	15° F (-9° C)	Fine, coarse Concentration by weight is 23%.*	Bag, bulk	Varies by gradation and regional preferences	Light and heavy duty traffic areas	Excessive use is harmful to vegetation.
Sand 	A loose granular material resulting from the disintegration of rocks and gravel.	n/a	n/a	Fine - coarse	Bag, bulk	Regional preference	Used as abrasive for traction control in icy conditions on secondary roads/rural areas	n/a
Magnesium chloride ($MgCl_2$) www.peterschemical.com/ magnesium-chloride/ 	Composed of magnesium and chlorine and is a typical ionic halide, being highly polar and soluble in water. Hydrated magnesium chloride can be extracted from brine or sea water.	-28° F (-33° C)	-15° F (-26° C)	Flake, pellets Concentration by weight is 22%.*	Bag, bulk	Varies by gradation and regional preferences	Light and heavy duty traffic areas	Used as recommended, it will not harm vegetation, however, magnesium chloride, by percentage, contains 17%-56% more chloride ions than other salt-type deicers.
Salt/Sand Mix 	Comprised of rock salt and sand; combination produces ice melting and abrasion.	-6° F (-21° C)	-15° F (-26° C)	Fine - coarse	Bag, bulk	Varies by gradation and regional preferences	Light and heavy duty traffic areas	Excessive use is harmful to vegetation.
Calcium Magnesium Acetate (CMA) 	A patented, granulated chemical from dolomitic lime and acetic acid.	-17° F (-27° C)	n/a	Concentration by weight is 32%.*	Bulk, cold patch bag	Varies	Roads and bridges	Biodegrades to carbon dioxide and water; low toxicity to aquatic species.
Potassium Acetate (CH_3COOK) 	Water soluable chemical present in most crude petroleums and some natural deposits.	-76° F (-60° C)	n/a	Concentration by weight is 49%.*	Bulk, pails	Varies	Airports	n/a
Urea ($CO(NH_2)_2$) 	A chemical found in most fertilizer formulas, it is 46% nitrogen, making it desirable for use by fertilizer manufacturers.	-10° F (-23° C)	n/a	Concentration by weight is 33%.*	Bulk, pails	Varies	Airports	High in nitrogen which can burn off vegetation; ideally used where chlorides are a problem.

* Percentage is calculated using the chemical's eutectic temperature.

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Calcium chloride and magnesium chloride are liquids in their natural states and have an affinity for returning to a liquid. When solid forms of these compounds come into contact with water, they release heat. Once calcium chloride and magnesium chloride touch ice or snow, they immediately pick up water to form a strong brine, emit heat to give added deicing effect, create more water and form more brine.

Sodium chloride and potassium chloride are both solids in their natural state. When they come into contact with moisture, they will also go into solution to form a brine. The difference between calcium chloride and magnesium chloride — they must absorb heat from the environment to form a brine. Urea, ammonium nitrate and ammonium sulfate also go into a solution (though not a brine) when they contact moisture. They must also absorb heat before the solution can be formed.

Granulars vs. Liquids

In comparing solid versus liquid chemicals, the advantages and disadvantages will help determine how these materials can be most effectively used.

ADVANTAGES

Solids	Liquids
Generally cost less since they are mostly chemical (no free water)	Nearly instant melting action
Easier to handle and store	Not displaced by traffic
Slower dilution since they are close to 100 percent chemical state, for better retention	Residue can remain effective for hours or even days depending on conditions
Skid resistance advantages associated with larger particles of rock salt when first applied	Versatility—can be used directly on paved surfaces with no bounce and scatter; treat solid chemicals prior to application (pre-wet) to speed melting action

DISADVANTAGES

Solids	Liquids
Need moisture to go into solution	Higher transportation costs per unit of chemical
Solution process takes time, which generally results in slower melting action, particularly in colder weather	Not suitable for treating thick ice or snowpack
Not best for anti-icing or early de-icing due to bounce and scatter, and traffic displacement	Rain will wash the liquid chemical off the pavement
Material binds together and becomes clumpy, which makes it difficult to apply	Can cause slippery conditions if they run off the sloping ice surface
	Usually limited to higher pavement temperature ranges

What is Pre-wetted Salt?

Pre-wetted salt is salt that has been coated with a liquid solution prior to being spread. It is becoming more common as the advantages become clearer. Two primary benefits are less bounce and scatter because salt better sticks to the surface and can embed faster into an icy surface, and faster melting action (dry salt needs to form a brine to start the melting process). The more salt that stays on the road or other surface and starts melting faster means less total salt will be needed, which reduces costs and the environmental impact. There are typically three liquids used to pre-wet salt, with the first being liquid salt (sodium chloride). To enhance the melting action of salt at low temperatures, liquid calcium and magnesium chlorides are also used as pre-wetting agents.

Applying Ice Melt

In the municipal world of snow and ice fighting, ice melt is applied using a certain number of pounds per lane mile. There is sometimes the misperception that if a little is good, a lot must be better. But, that's not necessarily the case because it doesn't change the temperature range. The key is applying the right chemicals in the right amounts, whether it's a roadway, parking lot, driveway or sidewalk. And that requires knowing the composition of the materials being used.

Choosing the Right Spreader

With the correct ice melt material chosen, it's important to also use the correct equipment (spreaders and sprayers). There are multiple types and combinations of spreaders on the market. At the end of the day, the equipment is there to move the chemical from the truck bed to the ground. The chosen spreader system will be impacted by the type, size and quality of de-icing material used, as well as the size of the vehicle and the surface being treated. The more advanced the equipment is, the more precisely chemicals can be distributed based on factors such as pavement temperature, application temperature, pavement width, etc., and most effective using the least amount of materials.

Different materials will spread at different rates at the same setting, so spreaders must be calibrated with the material that will be used to achieve effective ice melting, cost-effective product use and the lowest possible introduction of ice melter into the environment. This is especially important where large quantities of deicers are applied from vehicles across large areas of pavement.

SPREADER TYPES

Receiver-Hitch Mount Spreaders

Commonly used by professionals driving full-sized pickup trucks. Capacities range from approximately 200 pounds (3 cu. ft.) to 800 pounds (12.3 cu. ft)*. Receiver-hitch mounted spreaders are best when used with dry, free-flowing material like rock salt and calcium chloride. Some tailgates offer a vibrator to help materials like cinder or gravel have a steady flow to the spinner.

**Based on 65 lbs. per cu. ft.*

Insert Hopper Spreaders for Dry Materials

Insert hopper spreaders are designed to fit in the bed of full-sized pickups, dump trucks, or flatbed trucks, and range in size from 6 to 10 ft. (1.8 m) long, and capacities up to 4.5 yd^3 (3.4 m^3). Made of durable polyethylene, carbon steel or stainless steel, insert hopper spreaders are ideal for applying salt, sand, salt/sand mix, or other granular materials to pavement for ice and snow control or traction.

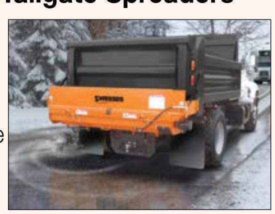
Insert Hopper Spreaders for Dry & Liquid Materials

For the most efficient applications, spreaders that combine the application of dry and wet materials are the choice. Typical configurations are a center hopper of poly or steel with one or more liquid tanks mounted alongside or behind the hopper. Combination spreaders apply anti-ice liquids and dry materials, or pre-wet dry materials with a de-ice liquid before applying. Three types of applications from one machine saves time and money!

Insert Liquid-only Spreader

Liquid spreaders are used to pretreat areas that need to remain open during winter storms. Applying anti-ice liquid prevents snow and ice from sticking to the pavement, resulting in less material and manpower usage when the storm arrives. Available with liquid capacity of 200 – 2,000 gal (757 - 7,571 L), and with advanced electronic control systems, liquid spreaders precisely apply desired amounts to the surface.

Under Tailgate/Replaceable Tailgate Spreaders



Under tailgate spreaders are designed to mount below dump body tailgates, but not interfere with normal dumping operations when not in use. Replaceable tailgate spreaders replace the existing dump body tailgate during de-icing operations. Free-flowing dry materials travel through the spreader trough onto the spinner, and are applied to the pavement. All under and replaceable tailgate spreaders accept pre-wet units.

Other Considerations—Storage and the Environment

Storage and environmental impact are two additional factors to consider when choosing the type and quantity of ice melt material to purchase. Liquids are stored in tanks while solid ice melt material needs to be stored in a dry place away from liquids, and where it won't be exposed to the elements because it is often hygroscopic, meaning it absorbs water. The amount of available dry space may help determine the quantity to purchase. Along with storage considerations comes the handling of chemicals, so they don't become a safety hazard. It's critical to know the chemicals being stored and used. The best sources of information are labels and the MSDS—Material Safety Data Sheet. If needed, the use of the proper personal protective equipment will then ensure safe handling.

Ice Melt and the Environment

The environmental impact of ice melters is another important consideration. Multiple studies have concluded that the benefits of ice melters—given the alternative of hazardous conditions—outweigh potential disadvantages. That's not to say environmental concerns should be overlooked. Studies have also shown that when safe and sustainable snow fighting practices are implemented, the impact of anti-icing and de-icing materials on the environment and on vegetation is manageable.

In the amounts of recommended quantities for grounds maintenance, the threat to grass, trees and shrubs is minimal. The Institute for Safety Analysis concluded in its major study, *Benefits and Costs in the Use of Salt to De-Ice Highways*, that: "There is no evidence that road salting produces permanent ecological effects. What salinity build-ups occur are due almost entirely to improper storage rather than application."

As for the effect on concrete, the only materials that will attack concrete are ammonium sulfate and ammonium nitrate. The other materials do affect the freezing point of water, which can increase the number of freeze-thaw cycles and potentially damage concrete. Damage can be minimized through the careful use of ice melters and the timely removal of slush and residual deicer from concrete surfaces.

Snow and ice on pavement surfaces can create dangerous, slippery conditions. Plowing and the use of ice melting compounds will help keep those surfaces clear to ensure public safety and mobility. Because there are a variety of materials on the market and more than 100 brands of ice melters, it's important to properly evaluate any chemical under consideration based on a number of factors. Most importantly, is knowing the chemicals used in an ice melt blend and understanding their effectiveness.

ICE & SNOW FIGHTING TERMS

Anti-icing—applying a de-icer chemical (a liquid or a solid) to a surface before the storm starts in an effort to prevent ice from forming and bonding to the pavement surface or to enhance plowing efforts. Also referred to as *pretreating* a site.

Concentration—percentage by weight of the chemical in solution.

De-icing—applying a de-icer chemical to an accumulation of ice or snow to melt it and weaken its bond to the pavement surface.

Effective Temperature—the lowest temperature at which an ice melter is cost effective to use for practical purposes, or at which the results justify the cost.

Endothermic—requires heat when going into solution.

Eutectic Temperature—the lowest temperature where a solution will melt ice.

Exothermic—gives off heat when going into solution.

Hygroscopic—the ability of a substance to attract and hold water molecules from the surrounding environment.

Pre-wet—the application of a liquid de-icer to a solid de-icer product (e.g. rock salt) to further enhance the performance of the de-icer.

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Acknowledgement—

Thank you to the Salt Institute, Cargill Salt and Aebi Schmidt Holding AG for providing much of the background information for this guide to de-icing.

Form #3-596 0916