Deicing Agents: Pros and Cons

Sooner or later it is going to get cold and result in freezing rain and/or snow. With that come the pleasant jobs associated with winter weather. Slick sidewalks and roads are hazardous. Removing compacted snow and ice with shovels or snow blowers is not always an easy task. Deicers can help by "undercutting," or loosening the snow or ice. Contrary to popular opinion, deicers primary function is not to completely melt snow and ice but can facilitate snow and ice removal by lowering the freezing point of water. Deicers melt down through the ice or snow to the hard surface, then spread out underneath. This undercuts and loosens the snow making shoveling and plowing more efficient. Products are available as either solids or liquids, but the majority of commonly used products are applied as a solid. Before a solid deicing chemical can do any melting, it must absorb moisture and create a brine solution. The concentration at which chemicals melt ice and create brine depends on the ratio of the chemical to the amount of water in the brine. Much like the proper use of pesticides, rate is critical to insure optimal results. More isn't always better when it comes to chemical concentration. If you increase the concentration of the product beyond what is recommended, the brine solution's effectiveness decreases substantially. Research has also shown that the shape of deicing particles affects the speed of their penetration through ice. Uniformly shaped spherical pellets of about 1/16" to 3/16" penetrate ice faster and more efficiently than other shapes. Irregularly shaped particles tend to melt randomly in all directions. Flakes melt as much horizontally as they do vertically. Deicing products are often marketed based on their freezing point and optimal concentration which is often in disagreement with what is recommended or used in practice. The discrepancy between freeze point and optimal concentration is indicative of creating a solution that will work in the broadest temperature range and optimizing the amount of moisture the deicer will absorb before it quits working. Ideally, deicing compounds should be effective, economical, and cause minimal damage to plants, structures and the environment..

A review of deicing compounds.

Sodium chloride (NaCl). This chemical, commonly referred to as rock salt, is the most prevalent deicing chemical, and in general, has the lowest price tag of all deicers. Rock salt first has been used as a road deicer since the 1940's. An estimated 10 to 14 million tons will be used yearly on roads in the United States and Canada. Sodium chloride, when mixed with water, works best at a 23.3 percent mixture, with an associated freeze point temperature of –5.8 ^{0}F. The practical working temperature of the product, however, ranges between 15 and 20 ^{0}F.

Magnesium chloride (MgCl). For MgCl the optimum solution for freeze point protection is 21.6 percent. The solution has a freeze point of –28 ^{0}F. MgCl is usually sold in a 30 percent concentration with an associated freeze point of 3 ^{0}F.

Calcium chloride (CaCl). CaCl is typically sold at a 30 percent concentration with a freeze point of –60 ^{0}F. The product's practical melting temperature, however, is typically considered to be approximately –10 ^{0}F. Available in flakes, pellets or liquid, CaCl produces an exothermic reaction, giving off heat. Because of this, it often performs better than many other deicing salts, especially at lower temperatures. Some highway departments spray liquid CaCl over rock salt to lower its melting temperature.

Potassium chloride (KCl). KCl is similar to or equivalent to K based fertilizer products. It is often promoted as beneficial to plants. KCl as a deicer that doesn't work unless temperatures are more than 25 ^{0}F. KCl as a stand alone product is relatively expensive and more oftern is seen as a part of a deicer blend with marketing promoting its benefit for plant health. At concentrations used for deicing and subsequent road splash and accumulation in

low areas, salt burn with KCl may occur.
Calcium magnesium acetate (CMA). Purchased as a solid and liquefied prior to use, Calcium magnesium acetate, commonly known as CMA, is typically used at a 25 percent concentration, which has a freeze point of 1 ^{0}F . At a 32 percent concentration, CMA has a freeze point of –18 ^{0}F. The practical working temperature of CMA is approxiamtely18 ^{0}F. CMA may be as much as 30 times the cost of rock salt. CMA use is primarily restricted to areas where damage to concrete surfaces, such as parking garages, cannot be tolerated.
Potassium acetate (KAc). An additional non-chloride product that has a 50 percent concentration with a freeze point of –76 ^{0}F . Because of cost (KAc is the most expensive of deicing products) use is restricted to high value locations such as airports.
Urea, ammonium sulfate, and other nitrogen salts. Nitrogen salts are rarely used as deicers because of the potential for nitrogen runoff and leaching into water sources. In many areas nitrogen salts are not approved for deicing because of these environmental concerns.
Corrosion-inhibiting salts. Many deicing salts are sold with added corrosion inhibitors. These materials may reduce corrosion, but not eliminate it entirely. No deicing salt, even if it contains a corrosion inhibitor, is entirely corrosion proof. Corrosion-inhibiting additives vary and their effects on plants and the environment are often unknown. Since many corrosion-inhibiting materials are combinations of one or more of the chloride salts mentioned above, some damage to vegetation could be expected when using these products.
Abrasives. Abrasives such as sand, cinders, and ash have relatively few impacts on the environment or plants. These materials do not melt ice but improve traction on slippery surfaces. The disadvantage of these materials is that they accumulate in the landscape, and may require frequent removal or create dust problems when they dry later in the year after the deicing season.
Enhanced radiation absorbers. Application of a dark colored material such as coal ash graphite or fertilizers such as Milorganite to a snow or ice surface increases radiation (sun energy) absorption and accelerates the rate of melting. These materials generally work slowly, may be tracked into buildings, and lose effectiveness as they are covered by new snow and ice.
Combination products. Various products are sold which contain combinations of one or more of the compounds previously mentioned. The label should indicate the percentage of different compounds in the product. Generally the combination product is going to perform most like the dominant compound in the mixture.

Deicing Effects Beyond Melting Ice

Vegetation. Salt applied to surfaces may run off and enter soil, or be splashed by vehicles and snow plows onto the surface of vegetation adjacent to the treated area. In soil, salts reduce the availability of water to plants, and significantly increase water stress during spring and summer months. This effect has been referred to as *chemical drought*. Salts deposited directly on foliage may also burn and kill the affected parts, or the entire plant. This is commonly observed where salts from winter maintenance damage evergreen trees and shrubs adjacent to roadways. The sodium and chloride components in certain salts are especially damaging to vegetation.
Hardscape. Salts are corrosive and accelerate rusting of metal railings, grates, drains, and door frames, and underground utility lines if they are not properly protected. Salts may also cause scaling, or flaking of surface layers from concrete. Salt solutions enter void spaces in concrete and expand by 10 to 20% in volume when they freeze. The pressure exerted by this expansion fractures the surface of concrete. Porous brick, masonry, and natural stone are especially vulnerable to damage and should be avoided in areas where deicing salts are used. Concrete which is properly formulated for environments where freeze-thaw cycles are common resists

scaling caused by deicing salts. Corrosion resistant paints and sealers will also minimize the impact of deicing compounds on the hardscape, and are recommended for areas where deicing salts are used.

Indoor surfaces (floors and carpets). Residues from deicing chemicals are frequently tracked into buildings and deposited on floors and carpets. Salts degrade wax and other finishes, leaving a dull appearance on floors and requiring more frequent cleaning and maintenance of indoor surfaces. Sodium and potassium chloride salts are relatively easy to remove from floors and carpets. Calcium and magnesium chloride salts, however, leave a greasy film and require wet cleaning with detergents to remove the residue. Abrasive materials such as sand also mar the finish on floors and can be difficult to remove from carpets.

The environment. Salts move rapidly with water off surfaces and into the surrounding soil. If sufficient water is moving through the soil, components of the salt may leach to ground water. Salt may also run off and enter surface waters, potentially degrading quality and killing fish and other organisms. Certain salts have greater potential for environmental damage than others. For example, nitrogen salts have a high risk for surface and ground water pollution while organic salts (calcium magnesium acetate, CMA) have a high risk for surface water pollution.

Strategies for Deicing

It is clear that there are advantages and disadvantages to all deicer compounds and alternatives. Planning a combined chemical and mechanical approach to snow and ice control can often minimize the impacts of deicer compounds in the landscape. Consider the following:

- Use more mechanical removal. The more snow and ice present, the more deicing compound is needed for melting. Reduced amounts can be used if large accumulations of snow and ice are removed first. The cost of labor for physical removal may be offset by savings in reduced damage to the landscape.
- Use abrasive materials in conjunction with mechanical removal and/or chemical deicers. If possible, select abrasives that can be incorporated into the landscape to reduce the need for subsequent removal.
- Use deicing compounds with minimal effects on plants (Table 1). If possible, plant salt tolerant vegetation in areas receiving large amounts of deicing salt, or as a barrier between salt sensitive vegetation and the site of deicer application. Locate salt sensitive plants away from the site of deicer application and splash. Use hardscaping (gutters, barriers) to channel deicing solutions away from planting areas. When removing snow containing deicer residues, do not pile on or near salt sensitive plants. Irrigate once heavily in spring to leach accumulated salts from the root zone of plants.
- Use concrete formulations, sealants, and other treatments specifically designed to resist deicing compounds to reduce damage to hardscaping.
- Use deicing compounds that are easily cleaned from indoor floors and carpets (Table 1), or use these products immediately outside of building entrances. Place easily cleaned, durable multi-purpose carpeting and floor mats immediately outside and inside building entrances to capture as much deicing compound as possible.

Table 1 Select properties of common deicing agents (adapted from "Deicing agents for Utah landscapes, Cooperative Extension, Utah State University)

		Effect	On:	
Compound	**Hardscapes**	**Carpet/Floors**	**Vegetation**	**Environment**
NaCl	severe	slight	severe	moderate/severe
CaCl	severe	severe	moderate	slight
MgCl	severe	severe	moderate	slight
KCL	severe	slight	moderate	slight
Corrosion-inhibiting salts	slight/moderate	varies	varies	varies
CMA	slight	moderate	slight	slight/moderate
N salts	none/severe	moderate	slight	severe
Abrasives	slight	moderate	none	slight
Radiation Absorbers	slight	moderate	slight/none	slight