Sustainable Technologies
EVALUATION PROGRAM

TECHNICAL BRIEF

Alternatives to Salt

What else melts snow and ice?

Given the high rate of urban development in the Greater Toronto Area, the amount of salt being applied each year is continuing to increase. In combination with plowing, the application of road salt has traditionally been the primary means to remove snow and ice across northeastern North America. This is due to salt's high degree of effectiveness, ease of use, and low initial cost (Sooklall, 2006). Only in recent years have the environmental impacts of the application of road salt been considered.

The impacts of salt are numerous, and include the corrosion of infrastructure and other metal structures such as railings and doorways; damage to vehicles; contamination of surface and groundwater; impacts to roadside vegetation; increased wildlife collision rates; and large amounts of product waste due to blowing or bouncing off roadways (Perchanok et al., 1991).

These impacts have led many road management agencies to test alternatives to traditional rock salt (NaCl). This technical brief discusses a number of these alternatives. Each of these products has pros and cons; it is up to each road management authority or parking lot manager to assess their needs and evaluate the materials to determine what is most appropriate for them. These decisions may be based on cost, application rates, lowest practical working temperature, potential environmental impact, and the potential for the material to damage infrastructure. Of note, sand and/or other abrasives are often used as a complement or alternative to road salt for the provision of traction. Sand is discussed in detail in the first Technical Bulletin in the series (www.LSRCA.on.ca/watershed-health/salt).

Plowing combined with salt application is how roads have typically been managed. With significant advances in winter maintenance technology and practice, many municipalities are starting to look at alternatives to save money and protect the environment.

Figure 1. Rock salt treated with a magnesium chloride coating

SO WHAT ARE THE ALTERNATIVES?

Alternatives to rock salt can generally be broken down into three categories: chloride deicers, acetate deicers, and agricultural by-products (organics). A number of these are discussed in this technical brief.

Chloride Deicers

These are the most commonly used for winter road maintenance. This brief looks at calcium chloride (CaCl), magnesium chloride (MgCl2), and pre-treated sodium chloride (NaCl) ("treated salt" e.g. Thawrox®), which are typically coated with $MgCl_2$ or CaCl and/or an organic corrosion inhibitor.

Benefits

- All are effective deicers with lower effective temperatures than the traditional chloride deicer, rock salt (NaCl);
- Requires lower application rates than rock salt → contribute less chloride to the environment;
- Treated salt is less corrosive to metals than untreated rock salt;
- Some treated salt products are coloured; residents and operators can be confident that a surface has been treated.

Drawbacks

- Contribute chloride to the environment;
- All are more expensive than rock salt (although the cost may be offset by the lower application rate).

Acetate Deicers

There are a number of types of acetate deicers, with calcium magnesium acetate (CMA) being the most commonly used for winter maintenance; other types are not readily available or are too expensive to consider for use on roads. There are now commercially available products that use rock salt as the base and are treated with acetate.

Benefits

- Residual effect – fewer applications are required than with rock salt in comparable conditions;
- Subsequent applications require lower application rates due to residual effect;
- Limited corrosion of metal;
- No chloride (unless a rock salt treated acetate product);
- Keeps snow light and dry, allowing for easier mechanical removal.

Drawbacks

- Expensive, requires higher application rate than traditional salt;
- Limited effective temperature range: -7°C is the lowest effective temperature, most effective above -5°C;
- Performs optimally when applied before precipitation;
- Less effective in light traffic;
- Poor performance in thick accumulations of snow and ice;
- Could potentially release acetate ions to groundwater, increases biological oxygen demand in surface water;
- Mining and production has environmental impacts.

Agricultural By-Products (Organics)

These products, which include beet juice, whey, and wheat-based starches, are refined from various agricultural feedstocks, and are typically added to chemical deicers. They are most often used in anti-icing activities, where a deicer is applied to the surface before the storm to prevent the ice from bonding to the pavement, or for pre-wetting, where the liquid is applied to the salt at the spinner to ensure that the salt stays where it is applied and to enhance its effectiveness, though there are some pre-treated products available.

Benefits

- Not corrosive;
- Generally increases the efficiency of traditional salt (e.g. lower effective temperature, less scatter);
- By-product of other processes – environmentally friendly;
- Contributes considerably less chloride to the environment.

Table 1. A summary of some of the pertinent information regarding commonly used deicers.

Deicer	Cost Estimate (low $ to high $$$$)	Typical Application Rates (average range)	Lowest Practical Working Temperature (°C)
NaCl (Rock Salt)	$	~130 kg/2 lane km, depending on conditions (range 70-220 kg/2-lane km in Lake Simcoe watershed)	-9
MgCl2 (Liquid Brine)	$$	Liquid anti-icing: 35-59 L/2-lane km	-15
CaCl2 (Liquid Brine)	$$$	Liquid anti-icing: 35-59 L/2-lane km	-29
Treated Rock Salt	$$	72-130 kg/2-lane km	-17
Calcium Magnesium Acetate	$$$$	219-292 kg/2-lane km (for first application, lower for subsequent due to residual effect)	-7
Agricultural By-Products	Cost varies	Varies; often used to pre-wet rock salt – less salt is required, lowest effective temperature is reduced	-17 to -23

Drawbacks

- May contribute to oxygen depletion and/or eutrophication in water bodies. Some toxicity to freshwater mussels has been noted, but needs further study;
- Degradation by soil microorganisms could lead to anaerobic conditions in soil;
- Possible issues with colour or odour.

MUNICIPAL EXPERIENCE: USE OF ALTERNATIVES IN THE LAKE SIMCOE WATERSHED

A number of municipalities have tried different materials to supplement or improve their winter maintenance programs. In a survey of Lake Simcoe watershed municipalities regarding their practices for the 2016-2017 season, seven of the 13 municipalities who responded had incorporated treated salt into their practices, for at least some conditions. The Town of Aurora switched from using straight rock salt to Thawrox, which has allowed them to reduce their application rates from 170 kg/lane km to 100 kg/lane km. Despite the increased cost to purchase these materials, the reduction in total use has more than offset the increased cost, and the environmental impact has been substantially reduced.

Several municipalities have tried agricultural by-products (i.e. beet juice), with mixed results; only one consistently uses it as part of their mix, and only at low temperatures (e.g. below -12°C). One municipality conducted a test of CMA at their operations centre, but found that beyond the prohibitively high cost, its chemical and physical characteristics made it unsuitable for use as part of regular winter maintenance activities. They found that although there was a residual effect that went well beyond that of regular salt, and it appeared to melt ice more quickly than salt in the same temperature and ice conditions, it needs to be applied before the snow falls in order to quickly melt the snow (which is often not possible or practical), and takes a long time to work if it is applied during a snow event.

The majority of Lake Simcoe municipalities continue to rely on a combination of salt, treated salt, brine, and/or sand for the majority of their winter maintenance activities, as they find these to be most effective. Most continue to evaluate new materials and practices as they arise, and are open to making changes if they make sense for their jurisdiction without jeopardizing public safety or causing a prohibitively large increase to maintenance budgets.

Figure 2. Salt over applied in a parking lot

Figure 3. Truck spreading beet juice (agriculture by-product)

CONCLUSIONS

All of the alternatives to traditional rock salt have drawbacks, including higher prices, specific application requirements, lack of effectiveness, and associated environmental issues. Municipalities must evaluate the available materials based on their needs. They should also evaluate how they use the materials they select (e.g. anti-icing, pre-wetting, etc.) to ensure their effectiveness. Pilot studies undertaken by municipalities in the Lake Simcoe watershed have arrived at some conclusions about several of these alternatives, including:

- Many municipalities have found treated salt to be worth the extra investment, due to its increased effectiveness at lower temperatures and lower application rate.
- Pre-wetting of rock salt with brine or an agricultural by-product as it is applied can help it stick to the road and reduce waste.
- The effectiveness of agricultural by-products is still under some evaluation. While some major cities, including Toronto, use it under certain conditions, several Lake Simcoe watershed municipalities have tested it and found it not to be effective.

It is also important to ensure that other best practices are incorporated into each road management authority's everyday practices. These include calibrating equipment, ensuring that the proper application rate is being used, and properly documenting and tracking the road conditions and treatments used.

Figure 4. Salt truck and snow plow

Figure 5. Truck applying brine to the road

This communication has been prepared by the Sustainable Technologies Evaluation Program. Funding support for this study was provided by the Ministry of Environment, Conservation and Parks (MECP) with additional support from municipalities located in the Lake Simcoe Watershed. The contents of this report does not necessarily represent the policies of the supporting agencies and the funding does not indicate an endorsement of the contents.

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