CLEAR ROADS
research for winter highway maintenance

RESEARCH BRIEF

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AG-BASED DEICERS EFFECTIVE AT COLD TEMPERATURES

RESULTS SUMMARY

A literature review, practitioner survey and series of laboratory tests on agriculturally derived and complex chloride mineral deicers evaluated their performance and investigated the molecular processes involved. A best practices manual provides guidelines for material application, storage and handling.

PROJECT DETAILS

Project Title: Understanding the Effectiveness of Non-Chloride Liquid Agricultural By-Products and Solid Complex Chloride/ Mineral Products Used in Snow and Ice Control Operations

Project Number: CR13-02

Project Cost: $191,238

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In recent years, many new deicing and anti-icing agents based on agricultural byproducts and complex chloride mineral (CCM) blends have been introduced to the market. Agricultural byproducts, commonly from beets, corn, beer brewing or cheesemaking, generally contain or are added to chlorides. Manufacturers have claimed that these products offer benefits over road salt by itself and other more traditional deicers in their ability to reduce the freezing point of water, stick to the road surface, capture energy from sunlight or reduce corrosion of vehicles and infrastructure.

Need for Research

While the functionality of salt as a road deicing agent has been studied extensively, newer agriculturally derived and CCM products have not been as thoroughly evaluated. In particular, there is a need to understand the physical mechanisms behind their effectiveness—what happens on the molecular level to enhance deicing.

This project was designed to provide objective performance information and a best practices manual to guide Clear Roads members in determining appropriate, cost-effective applications and handling of agriculturally derived and CCM products.

Objectives and Methodology

The project included a literature review to identify currently available agricultural-based and CCM products, existing methods for evaluating deicer performance and studies of mechanisms by which deicers and anti-icers function. Researchers also surveyed winter maintenance practitioners about their experience with agriculturally derived deicers and CCMs.

Researchers then performed several innovative laboratory tests of 10 commercially available products: two CCMs, four agriculturally derived liquid products used as received, and four agricultural products mixed with salt brine as specified by the vendor. The tests made use of a snow chamber and traffic simulator to measure the impact of the deicers on friction, weakening of the ice bond to pavement, deicer absorbance of sunlight and deicer longevity on pavement.

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Innovative tests conducted as part of this project included compacting snow on a pavement sample, rolling a loaded tire over it 750 times and then measuring the shear force (right) necessary to plow snow from the surface.

Researchers also conducted a series of more traditional tests to evaluate properties such as ice melting capacity, corrosive effects, chloride concentration and eutectic curves, which show how the freezing point of a deicer solution changes with its concentration. Using the results of these tests and previous research from Clear Roads and other sources, researchers developed a best practices manual with guidelines for material application, storage, handling, loading and mixing.

Results

Highlights of the laboratory test results include the following:

- The tested agriculturally derived products that were blended with salt brine significantly reduced the freezing point of water compared to salt brine, but did not melt more ice than salt brine. They may, however, function as cryoprotectants that inhibit ice formation.
- The tested agriculturally derived products used as received from the manufacturer produced more ice melt than salt at all temperatures tested and reduced the freezing point of water much better than salt brine. This suggests that these products may be effective even at temperatures below 5°F.
- The tested CCMs did not significantly reduce the freezing point of water compared to salt, but they did melt more ice than salt at 15°F, suggesting that CCM products may offer better performance than road salt at temperatures between 10°F and 25°F.
- All of the agriculturally derived products tested stayed on pavement longer than salt brine alone, possibly due to their higher viscosity.
- Under ultraviolet light, darker agricultural-based products had a higher ice-melting capacity than lighter products at lower temperatures, although further testing is necessary to determine the precise level of sunlight intensity where product color has an impact.
- All products with an agriculturally derived component had lower corrosion scores than CCM products and salt brine.

Benefits and Further Research

The results support the potential benefits of agricultural-based deicing agents, suggesting that they be considered in appropriate situations where their additional cost is warranted. The results also suggest that manufacturer recommendations of appropriate mixing and application rates and effective temperature ranges for products should generally be followed. If agencies do deviate from these recommendations, they should do so for specific purposes, track whether their adjustments produce satisfactory results and share that information with other agencies.

This research project was the first major attempt to assess the performance of agriculturally derived and CCM deicers using a scientific approach. It produced a large amount of information that helps to illuminate the mechanisms of these deicing agents on a molecular level—a new focus of research that can be built upon in the future. In particular, it would be valuable to conduct the new friction, longevity-on-pavement and ultraviolet absorbance tests on a wider range of products.

"Thanks to this project, we've got some numbers now to back up qualitative observations agencies have made about the performance of ag-based deicers. Agencies can base further winter maintenance decisions on the technical information discovered."

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