



# MATES

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### PAVEMENT DEICERS - KEEPING MICHIGAN MOTORISTS ON THE GO!

Many of us can still remember years ago when traffic virtually came to a stop during winter storms. Imagine the paralysis that would occur if modern ice and snow removal methods were not used to keep roadways clear for today's high traffic volumes. Our reliance on trucks, busses, and cars to provide such necessities as food, fuel, and our jobs depend more than ever on unhindered travel at reasonably high speeds. Further, the courts have repeatedly declared that we must provide cleared pavements—winter and summer. For these reasons, MDOT is committed to actively seek better ice removal methods; both equipment and chemicals.

#### CMA "A Better Deicer?"

##### The Problem

Rock salt used to maintain Michigan's 'bare pavement policy' for winter road maintenance greatly increases the corrosion of almost all metals that are used in and around a highway environment. The salt-accelerated corrosion of bridges, guardrail, sign structures, and reinforcing steel in concrete (with resulting concrete deterioration) has led to ever increasing maintenance costs. As salt is washed from the roadways it infiltrates the underlying ground water. The possibility of gradually increasing chloride levels in the ground water has been the subject of continuing investigations. The resulting cost of both corrosion and environmental effects has been estimated to be from about \$180 to \$600/ton of rock salt used (6 to 20 times the cost of salt itself). The lower estimate comes from a Salt Institute report and the higher from a report by the U. S. Environmental Protection Agency.

##### A Possible Solution

The Federal Highway Administration (FHWA) sponsored research during the late 70's and early 80's that has identified calcium magnesium acetate (CMA) as the most promising replacement for salt. Unlike rock salt, CMA is a corrosion inhibitor (i.e., slows corrosion) and has a less serious effect on the environment in general. Unlike salt, which remains salt essentially forever, CMA gradually converts back to magnesium carbonate and calcium carbonate (the principal ingredients of dolomitic limestone—a relatively common Michigan mineral) and acetic acid—the components from which it was made. The dilute acetic acid is further broken down by bacterial action into environmentally safe substances.

For the last five to seven years, the FHWA and many of the states have conducted or sponsored research to evaluate various aspects of this potential salt substitute. Its deicing ability, corrosion performance, environmental acceptability, and improved manufacturing technology have been investigated. M&T's Structural Research Unit has been investigating the corrosion performance of CMA and CMA-salt mixtures, rock salt, distilled water, simulated acid rain, a rust inhibitor with rock salt, and a rust inhibitor with magnesium chloride. The corrosion studies have been performed using an artificial weathering chamber with an alternate wet-dry heated environment simulating a tropical marine beach exposure. This 'accelerated weathering' allows a faster evaluation of the relative corrosion differences between the various substances being tested than would be

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#### ROCK SALT "The Old Reliable"

##### Deicers Don't Just Deice!

The quest to find a new non-corrosive deicing material that can economically and functionally replace salt is laudable, and should be encouraged; but, care must be taken not to "throw out the baby with the bath." Along with its non-corrosive properties, any deicer must be evaluated for such characteristics as:

- 1) Preventing snow and ice from bonding to the pavement.
- 2) Dissolving slowly for a long-lasting deicing action.
- 3) Melting ice and snow at temperatures encountered in Michigan.
- 4) Allowing the pavement to dry off rapidly and uniformly at temperature ranges normally encountered when the material is used.
- 5) Non-caking or easily treatable to be non-caking so it can be stored and handled and spread uniformly onto the pavement.
- 6) Non-hazardous to handle.
- 7) Non-polluting during storage or after being applied.
- 8) Resists blowing off the pavement surface by either natural or traffic-induced winds.
- 9) Economical.

##### How Does Salt Measure Up?

At our current stage of technology, it appears that rock salt is still the material providing the optimum blend of these characteristics—not perfect, but the best currently available.

Rock salt (sodium chloride) is a particularly strong choice for the following reasons:

- 1) It forms a brine that coats snow particles to prevent packing and bonding of snow to the pavement.
- 2) Its particles dissolve slowly from their solid state, giving a continuing release of brine that coats the pavement and will react with additional snowfall.
- 3) It melts snow and ice easily at temperatures of 20 F and above.
- 4) Although being hygroscopic (it takes up and retains moisture) it still yields moisture readily enough to allow clear, wet pavement to dry off through evaporation when temperatures fall below 20 F.

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## .....CMA

possible with an atmospheric type exposure. The corrosion performances of the major structural metals used in and on Michigan's highways (primarily steel and aluminum) have been evaluated in these experiments. CMA produced only 1/3 to 1/10th the average corrosion experienced for the same materials in rock salt and was only slightly more corrosive than distilled water alone. Only the rust inhibitor-magnesium chloride combination performed better than CMA. This combination, however, is only slightly cheaper than pure CMA and presently lacks the extensive environmental evaluation that has been performed with CMA.

While this research has shown that CMA has suitable deicing and corrosion properties, it still has a major drawback—its price, currently projected at \$370/ton for large purchases. Nearly twice as much CMA as rock salt, by weight, is required for equivalent deicing action. Therefore, the relative cost of CMA to salt approaches 30 times Michigan's current cost of rock salt (\$22/ton). The relative cost goes even higher when one considers the increased storage and handling cost for the greater volumes of CMA required. Thus, the economics appear to limit the use of pure CMA to a select number of corrosion-sensitive structures or areas exceeding allowed chloride ion concentrations.

Our Soils Research Unit in cooperation with the Maintenance Division, has been field evaluating CMA's ability to deice highway pavements. Discussion of this phase of the work will be covered in a later MATES article.

### Another Possible Solution

Our corrosion work with mixtures of CMA and salt suggests that there may be another alternative. CMA and salt mixtures have been found to retain much of the corrosion protection provided by CMA alone. Current data indicate one part CMA to two parts salt results in a mixture that has almost as good corrosion performance as CMA by itself. This mixture would cost less than seven times the cost of salt by itself at current prices. While this represents a more economically reasonable alternative, the price may go even lower.

At least one research organization is reporting that if allowed to have some salt (less than 5 percent) in the final product, they believe that within several years they can produce CMA for as little as \$140 to \$240/ton. This equates to a mix (one part CMA to two parts salt) price of only three to four and one-half times the cost of salt by itself. At these price levels, the economics favor using a CMA-salt mixture.

The initial short-term higher cost could be more than offset by long-term gains in reduced maintenance and increased life of structures and vehicles. Even conservative estimates project possible savings of roughly 20 to 30 million dollars per year for Michigan alone. Savings nationwide in the hundreds of millions per year are conceivable. While such a measure might be only temporary in some areas of the country since part of the incentive towards a salt substitute is the possible environmental effect, this does not appear to be a problem for Michigan. Ground water studies performed adjacent to major Michigan highways periodically since 1971 do not show increasing levels of chloride contamination of ground water or current levels that are of any health concern.

Additional experimental work is needed to clarify the effects of CMA on the corrosion of steel in salt contaminated concrete. Existing results are not yet conclusive, and this issue must be resolved satisfactorily prior to extensive use of CMA throughout the country. In view of this, and the potential savings if CMA-salt can be used, the Structural Research Unit currently is planning further research to aid in clarifying the situation.

-Ronnie McCrum

## .....Rock Salt

- 5) It can be easily treated to resist caking, thus it can be stored and then handled with spreading equipment that can meter and place it uniformly on the pavement.
- 6) It costs only \$22 to \$40/ton, depending upon haul distance.
- 7) It is non-hazardous to handle.
- 8) It is relatively resistant to being blown off the pavement before its work is done.

### Rock Salt vs. Storm

To illustrate the value of these properties, let us describe a typical winter snowstorm and the highway maintenance actions it generates. Most winter storms in Michigan begin with temperatures ranging from 20 to 35 F. As the cold front approaches, a snowfall of 4 to 6 in. may be forecast over the next six to ten hours. Most of the snowfall will be early in this period, and diminish as the cold front passes overhead. Air temperatures will then begin to drop rapidly to below 20 F as winds switch to the northwest. These winds cause intermittent snow flurry activity and drifting of snow onto the roadway for several hours after the cold front passes.

Maintenance crews have a strategy prepared for handling winter storms. Their greatest concern is a build-up of an ice or snow pack on the pavement. The snow pack will remain for days once it is completely formed and bonded to the pavement, and cannot be removed even with several applications of salt. Such snow packs are the main cause of winter highway blockage by vehicles gone out of control.

Salt is the key material in preventing this situation. The snow plow operator first plows off all loose snow from the pavement and places a strip of rock salt down the center or at the pavement crown at a rate of 300 to 400 lb/mile. The salt quickly forms a brine which coats unmelted snow particles and prevents packing and bonding to the pavement. Salt particles dissolve slowly over a period of up to three hours; when the truck operator returns he finds 2 to 3 in. of slushy snow that can easily be plowed off the pavement. If the storm continues and temperatures are still in the 20's another strip of salt is placed in the center of the pavement to handle the new snow that is expected to fall. With the ice melting temperature range of salt, pavements are kept wet and generally clear of snow or ice down to 20 F.

When the temperature is at 20 F and dropping, maintenance operation strategies change. The cold front has passed and the winds are in the northwest, with snow flurries and drifting snow likely. It is time to dry up the pavement by plowing off all loose snow and ice and sanding any remaining frozen spots. Salting is stopped for it keeps the pavement wet by forming more brine from any newly fallen snow that occurs from flurries and drifting. Once the brine has dissipated, the diluted residue will dry off, leaving a clear dry pavement by the time the temperature drops to 15 F. The hygroscopic property of salt is highly desirable for safety purposes, for the entire roadway becomes both clear and dry at approximately the same time. Flurries and drifting snow usually blow over the pavement without wetting or sticking.

Despite its problems, salt remains our most valuable ally in carrying out our charge to provide clear, safe pavements!

-Marty O'Toole



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