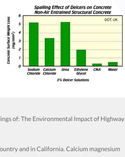
CALCIUM MAGNESIUM ACETATE (CMA)

TECHNICAL INFORMATION

List of technical information with a brief description following thereafter.



1. Amerhein, C. and Strong, J. E., The Effect of Deicing Salts on Trace Metal Mobility in Roadside Soils. In Proceedings of: The Environmental Impact of Highway Deicing, University of California, Davis, California, October 1989.

As an alternative to NaCl, calcium magnesium acetate (CMA) is gaining popularity in selected areas around the country and in California. Calcium magnesium acetate at a Ca/Mg ratio of 3:7 has been found to be the most effective deicer (Schenk, 1985) and is less toxic to fish, zooplankton, and phytoplankton and less corrosive than chloride salts (Horner, 1988).

The effect of calcium magnesium acetate on trace metal mobility in roadside soils should generally be beneficial. The acetate provides some pH buffering and the decomposition of acetate produces HCO3, which will increase the pH of the soil and decrease the solubility of trace metals coprecipitated with oxides, hydroxide, and carbonate. The Ca and Mg ions are beneficial to soil structure, maintaining the porosity and aggregate stability whereas Na tends to destroy soil structure. Mobilization of dispersed clays and organic matter occurs when adsorbed Na is high and the ionic strength is low. Thus, dilute solutions of NaCl and pure snowmelt are likely to mobilize metals through the process of organic matter solubilization and clay dispersion.

2. Connolly, J. P., Analysis of the Environmental Fate of ICE-B-CON® and its Impact on Receiving Water Dissolved Oxygen, HydroQual, Inc., Mahwah, New Jersey, April 1990.

The biodegradation kinetics in natural waters and soils of the acetate in a calcium magnesium acetate (CMA) formulation developed by Chevron Chemical Company and marketed under the trade name ICE-B-GON® were quantified from laboratory experiments. These kinetics were used to project the impact of this CMA on the dissolved oxygen of receiving waters. The laboratory experiments indicated that the degradation process may be quantified as a first-order reaction in which the degradation rate is a function of temperature and microbial activity. Model simulations indicated that significant load reduction can occur as a result of acetate degradation in soil as highway runoff passes over field prior to entering a receiving water. In an alternate scenario in which the CMA accumulates in the snowpack and does not begin to degrade immediately, the potential for a significant impact is increased.

3. Dobson, M.C., The Effects of Salt (NaCl) and Calcium Magnesium Acetate (CMA) on the Growth of Various European Tree Species, Preliminary Report, Forestry Research Division, Farnham, Surrey, United Kingdom, 1990.

A limited number of tree species have been screened for tolerance to CMA, and those that have been tested are not planted in significant numbers in Britain. This preliminary report outlines the results obtained to date from research, partly funded by BP, into the effects of NaCl and CMA on the growth of various European tree species. It contains data on parameters of tree growth and soil ion concentrations. The final report will contain additional data on foliar analysis and will include a full discussion of the results.

4. Horner, R. R., Environmental Monitoring and Evaluation of Calcium Magnesium Acetate (CMA), National Cooperative Highway Research Program Report 305, Transportation Research Board, National Research Council, April 1988.

This report contains findings from research to examine the environmental effects of calcium magnesium acetate (CMA) through laboratory and field experimentation. Previous research by others has suggested CMA as an alternative to the commonly used chloride-bearing highway deicers. With the completion of this study, state highway agencies considering the use of CMA now have access to information on its environmental effects. Specific guidance have been developed, and, in the few instances where research results are not definitive, field monitoring plans are suggested for use when circumstances dictate a conservative approach to the application of CMA.

5. Jones, P. H., et al., Environmental Impact of Road Salting, Institute of Environmental Studies, University of Toronto, July 1986.

The purpose of this report is to provide a comprehensive resource document concerning the environmental impacts of road salt. This document will be of use to MTC Regional Environmental Planners in assessing the impacts of road salting activities on ground and surface water quality, and terrestrial aquatic biota. Alternatives to the use of sodium chloride are not considered.

6. Leiser, A. T., Johns, S. A. Evaluation Of The Effects of Calcium Magnesium Acetate on Selected Plant Species, In Proceedings of: The Environmental Impact of Highway Deicing, Department of Environmental Horticulture, University of California, Davis, California, October 1990.

The two deicing agents (CMA and NaCl) were applied in solution to soils and by spray to plant tops to investigate the possible effects of CMA to roadside vegetation using NaCl as the control. Soil application rates were selected to bracket the rates of NaCl actually applied to highways so that soil concentrations would equal, and at the highest rate, exceed those attained in soils within 25 feet of the roadway. Spray application rates were selected in the range and to exceed the concentrations found in snowmelt actually sampled from highway surfaces. One plant of each species was included in each replicate as a non-treated control.

7. Pollock, S. J., Mitigating Highway Deicing Salt Contamination of Private Water Supplies in Massachusetts, In Proceedings of: The Environmental Impact of Highway Deicing, University of California, Davis, California, October 1989.

The purpose of this report is to document the effectiveness of two of the preventive and remedial actions that are used by MDPW to alleviate salt contamination of private water supplies. These actions are reducing salt on state highways and use of salt substitute, calcium magnesium acetate.

8. Washbrook, D. M., Investigation into the Effects of BP Clearway CMA on the Activated Sludge Process at Rye Meads Sewage Treatment Works, Thames Water, March 1989.

The results of this test have shown no detrimental effects on sewage treatment, and it is unlikely that any problems would be encountered if the use of Clearway CMA became widespread.

9. Winters, G. R., et al., Environmental Evaluation of Calcium Magnesium Acetate (CMA), Report No. FHWA/RD-84/094, California Department of Transportation, June 1985.

This report presents the results of a literature survey and a limited laboratory study on the environmental impacts of Calcium Magnesium Acetate (CMA). Laboratory tests were performed on fish, zooplankton, phytoplankton, common roadside plants and soils. No information was found on surface water quality, groundwater quality, or air quality. CMA is less toxic than NaCl to Rainbow trout, Fathead Minnows, and most plant species tested. CMA is not toxic enough to prevent it from being used as a deicer. Recommends additional studies to determine how CMA impacts natural systems.

10. Chollar, B. H. and Virmani, Y. P., Effects of Calcium Magnesium Acetate on Reinforced Steel Concrete, Federal Highway Administration, Public Roads Vol. 51, No. 4, March 1988.

Results indicated that the potential of the black steel rebars in slabs ponded with salt solutions started increasing numerically within the first 3 months of exposure, while that of rebars in slabs ponded with CMA solution did not increase at all during that time period. The CMA solutions did not cause any significant potential shift or corrosion after 4 years on/off ponding in an outdoor environment.

11. Locke, K. E. and Kenneley, K. K., Corrosion of Highway and Bridge Structural Metals by CMA, Federal Highway Administration Report FHWA/RD-86/064, June 1986.

This report describes a study of the corrosive tendencies of reagent grade calcium magnesium acetate (CMA) and a commercial grade CMA on metals used in bridge construction including reinforcing steel on concrete. The results of an electrochemical and exposure study indicate CMA is much less corrosive to the exposed metals than found with sodium chloride.

12. Man, M.C.M., Hazell, L.B., Smith, R.P., On-Line Measurement of Simulated Reinforcement Corrosion in Concrete Under Action of De-Icers, British Petroleum Research Center, London, U.K., October 1989.

It has been demonstrated that, compared to rock salt, acetate deicers are at least a factor of ten times less corrosive towards steel reinforcement in a model concrete. Changing from rock salt to acetate deicers should extend considerably the lifetime of steel reinforced concrete elevated highways and bridge structures, even those already damaged by previous use of rock salt.

13. Nadezhdin, A., et al., The Effect of Deicing Chemicals on Reinforced Concrete, Domtar Inc., Senneville, Quebec, Canada, Domtar Chemicals Group, Sifto Salt Division, Mississauga, Ontario Canada, Report to Transportation Research Board, January 1988.

This paper addresses the role played by deicing chemicals in the deterioration of reinforced concrete. The use of rock salt as a deicing chemical has given rise in the last few years to important environmental concerns because of the potential damage to concrete pavements. Several newer and faster bench scale methods of study and materials evaluation are described and compared to the ASTM recommended techniques. The difference in freezing temperatures between concrete pore solution and an outside deicer solution is shown to be one of the important factors in the spalling process. The importance of an anisotropic character of freezing zone is also outlined.

14. Slick D.S., Effects of Calcium Magnesium Acetate (CMA) on Pavements and Motor Vehicles, Federal Highway Administration Report FHWA/RD-87/037, April 1987.

This report describes a study of the effects of reagent grade and commercial grades of calcium magnesium acetate (CMA) on all non-metallic materials used in highway and bridge construction and on all motor vehicle parts. The results of this study indicate CMA has much less effect on the non-metallic highway materials and motor vehicle parts than found with sodium chloride.

15. The Danish Corrosion Center, Effect of CMA on Corrosion Properties of Rebar in Concrete, Denmark Ministry of Transport, December 1990.

This study investigated the effect of CMA on corrosion of steel reinforcement in salt contaminated concrete. The results of the study show that the application of CMA to concrete already contaminated with chloride delays the onset of corrosion. This work, along with recent studies by the Michigan Department of Transportation, BP Chemicals Ltd. in the United Kingdom and the Federal Highway Administration, confirms the corrosion inhibiting properties of CMA in concrete.

16. Fleege, E., Salt Additives and Alternatives Corrosion Study, Minnesota, Department of Transportation, May 1991.

The Minnesota Department of Transportation has committed itself to the development of methods and techniques to reduce the negative aspects associated with deicing agents and still maintain current levels of service during the winter for the traveling public. This is being accomplished by either of two (2) methods; either to reduce the corrosiveness of the de-icing materials and/or to reduce the risk of group water contamination by reducing the amount of sodium chloride that is used as a de-icing agent.

17. Bacchus, A., Financial Implications of Salt vs. CMA as a Deicing Agent: Cost & Benefits Estimated by an MTO Expert Group, The Research and Development Branch, Ministry of Transportation of Ontario, December 1987.

It is salt which historically has been used to keep Ontario roads passable and safe in winter for commercial, commuter, and recreational traffic. Salt is very effective as a deicer and costs relatively little per ton, but it is known to have damaging effects on vehicles, reinforced concrete highway bridges, parking garages, groundwater, vegetation, and other private property. MTC continues to seek methods of reducing salt usage and to search for affordable alternative deicers that are more benign to the environment. Calcium Magnesium Acetate (CMA) has been identified as one of the most promising alternative deicers.

18. Hudson, Lawrence R., Calcium Magnesium Acetate (CMA) from Low-Grade Biomass, Paper, Presented at IGT Conference, Energy from Biomass and Wastes XI, Orlando, March 18, 1987.

Calcium Magnesium Acetate (CMA) is an alternative to salt for highway deicing. It was selected by the Federal Highway Administration (FHWA) as the long-term deicing material of choice based on several characteristics. Compared to salt, CMA is less corrosive, less damaging to concrete, and less harmful to plant and animal life.

19. Murray, D. M., Ernest, U.F. W. An Economic Analysis of the Environmental Impact of Highway Deicing Report No. EPA-600/2-76-105, Environmental Protection Agency, May 1976.

This study involves an analysis of the cost of damages that result from the use of salt (sodium chloride and calcium chloride) on highways to melt snow and ice. A large literature search and several surveys were carried out in order to determine the types and extent of damages that have occurred. This report contains over 320 references.

20. Nottingham, D., et al., Costs to the Public Due to the Use of Corrosive Deicing Chemicals and a Comparison to Alternate Winter Road Maintenance Procedures, Report No. AK-RD-84-14. Alaska Department of Transportation and Public Facilities, December 1983.

This paper represents a pragmatic attempt to quantify salt related damage to vehicles and bridges in the Anchorage area and to examine possible means of reducing the use of salt. Total program cost, as used in this report, includes direct and initial costs and indirect costs of loss of vehicle value and damage to bridge decks. The major avenues examined for reducing the total costs of the present Anchorage deicing program are: utilize heated storage buildings and stockpiling sand and replace salt with non-corrosive deicing chemicals. These options were selected based on simplicity, feasibility for the study area, and production of results similar to current maintenance procedures.

21. Vitaliano, D. F., An Economic Assessment of the Social Costs of Highway Salting and the Efficiency of Substituting a New Deicing Material, Rensselaer Polytechnic Institute, Economics Department, Troy, New York, February 1991.

The use of salt for deicing roads results in costs estimated at more than $800 per ton, including the costs of repair and maintenance of roads and bridges, vehicle corrosion costs, and loss of aesthetic value through roadside tree damage. Additionally, there are probable health costs related to elevated sodium levels in drinking water. The new Surface Transportation Act of 1991 appears to replace the previous federal funding policy that was biased against the use of calcium magnesium acetate (CMA) with a new subsidy for its purchase that may lead to inefficient overuse.

22. Transportation Research Board Special Report #235 Comparing Salt and Calcium Magnesium Acetate," 1991.

The damaging and corrosive effects of road salt on cars and highways, as well as its impacts on terrestrial and aquatic ecosystems, have prompted investigations on a variety of alternative deicing compounds. These studies have revealed that calcium magnesium acetate (CMA) may prove to be a good alternative to sodium chloride. Before CMA can be used on a large economic scale, however, investigations of its effects on various aquatic and terrestrial roadside environments are needed. In this investigation, samples were taken from each of the ten lakes and were then incubated in situ with various concentrations of CMA to determine if there are any effects on natural lake phytoplankton growth. Within the scope of this investigation, CMA seems to have no or relatively small effect on phytoplankton biomass.

23. Elliott, H. A. and Linn, J. H., Effect of Calcium Magnesium Acetate on Heavy Metal Mobility in Soils, Agriculture Engineering Department, Pennsylvania State University, Journal of Environmental Quality 16(3), 1987.

Calcium Magnesium Acetate (CMA) is a promising replacement for traditional roadway deicing salts. CMA was studied to assess its impact on the mobility of metals in contaminated soils. Under the experimental conditions, acetate complexation played a minor role in metal mobilization. Highway deicing with CMA may temporarily increase translocation of metals in strongly buffered acid roadside soils. Input of acetate ions and an increase in exchangeable bases with sustained CMA use should render northeastern USA soils less vulnerable to acidification, thereby inhibiting conditions that promote metal solubilization.

24. Goldman, C. R., Environmental Effect of Calcium Magnesium Acetate on Natural Phytoplankton Populations in Ten Sierra Nevada and Klamath Mountain Lakes, In Proceedings of: The Environmental Impact of Highway Deicing, University of California, Davis, California, October 1989.

Sodium chloride, or common road salt, is by far the most popular chemical deicer, because it is reliable, inexpensive, and easy to handle, store and apply. Over the years, however, the widespread use of salt has been linked with many indirect costs, including damage to motor vehicles, infrastructure, and the environment. Recognizing these drawbacks, in 1990 the Federal Highway Administration identified calcium magnesium acetate (CMA) as a possible replacement for salt. Results have been promising, but the most significant impediment to its use has been its price, which is more than 20 times that of salt.