Use of Chemical Dust Palliatives as a Best Available Control Measure for Controlling PM-10 Emissions from Paved Roads during Windstorms

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This report describes the final part of a study funded through a Transfer of Responsibilities Agreement by the Alaska Department of Transportation and Public Facilities, Project Number 53586, Project Name- "PM-10 Control Evaluation." The second of three items under Scope of Services in the TORA was to "evaluate the efficiency of using liquid magnesium chloride ($MgCl_2$) as a dust palliative on major paved roadways during PM-10 episodes."

Introduction

In September 2002, the State of Alaska submitted a Natural Events Action Plan (NEAP), prepared by the Municipality of Anchorage (MOA) to the Environmental Protection Agency for a PM-10 exceedance that occurred on March 18, 2001 during a wind storm.* The Anchorage NEAP committed to identify, study and implement practical mitigating measures as necessary. To this end, the MOA investigated the use of chemical dust palliatives for PM-10 control on paved roads during windstorms. This report describes the results of this investigation.

Background and Purpose

The purpose of this study was to determine whether magnesium chloride ($MgCl_2$) and/or potassium acetate (KAc) brines could be used to reduce PM-10 emissions during windstorms. These chemicals are commonly used for anti-icing and deicing on Anchorage roadways. $MgCl_2$ and KAc are hygroscopic, meaning they have a tendency to attract, absorb and retain moisture from the air. As a consequence, both can be used as dust palliatives.

Previous Anchorage studies demonstrated that $MgCl_2$ brine could provide significant reduction in ambient PM-10 concentrations. Ambient PM-10 measurements taken near a roadway where $MgCl_2$ was applied suggested that PM-10 concentration were lowered for at least three days following application.[1] Laboratory evaluations showed that the "dustiness index" of pulverized Anchorage traction sand was reduced by approximately 75% when the pulverized sand was dosed with $MgCl_2$ brine at rate used by MOA and ADOT&PF street maintenance crews on roadways.[2] These studies did not specifically address whether the application of chemical dust palliative like $MgCl_2$ would be effective during periods of high wind, however. The Anchorage NEAP committed to investigating best available control methods (BACM) for controlling PM-10 emissions during wind storms like the one experienced on March 18, 2001. The aim of this study was to provide the information necessary to determine whether $MgCl_2$ and/or KAc brine application should be recommended as BACM during wind storms.

Method

An area of unswept roadway at a MOA parking facility, identified as being reasonably representative of the silt loading conditions in the gutter pans of major Anchorage roadways, was used to conduct the test. In anticipation of the test, a portion of this parking area was cordoned off in February to prevent it from being swept of the traction sand applied there over the course of the preceding winter. The test area is shown in Figure 1.

The test attempted to simulate the time-of-year and environmental conditions that had prevailed on March 18, 2001 when Anchorage experienced the wind-related PM-10 exceedance that led to the NEAP. The test was conducted on March 4, 2003 after an extended

* The Anchorage NEAP is entitled *Natural Events Action Plan for Windblown Dust Events in Anchorage Alaska*, September 2002. A letter approving the Anchorage NEAP was sent by EPA to ADEC on May 5, 2003.

dry period.[†] The ambient temperature during the test was approximately 32 degrees F and relative humidity was 49%.

Figure 1. Dust control test area prior to palliative application

Three sections of silt laden pavement were separated by two strips of clean (pressure washed) pavement to give a clean break in the visual effect to be produced by a leaf blower wind test, as seen in Figure 3. A chemical sprayer was used to apply $MgCl_2$ to one section, KAc to another, and water to the third as a control. The $MgCl_2$ and KAc were mixed with water in accordance with supplier recommendations for an ambient temperature of 30 ºF In order to simulate the application rate typically used by the MOA and ADOT&PF road maintenance crews, an application rate of approximately 300 gallons per road mile was used for the $MgCl_2$ and KAc brines. This same application rate was also used to apply water control on the control section. A sample transect was sampled and weighed to determine total sediment load on the test section. A sieve test was performed on the sample to determine the percentage of fines (i.e. 74 μm or smaller) and silt loading in the test section.

The two treated areas and the control area were subjected to a simulated high wind using the leaf blower while six observers rated the palliative properties of the chemicals relative to each other and to the control section. The leaf blower was held at the same angle and identical one foot distance from each section in an effort to eliminate bias from one section to another. The air velocity of the leaf blower was measured to be 65 mph one foot from the nozzle. Test conditions are summarized in Table 1.

[†] Just three days subsequent to the March 4, 2003 test Anchorage experienced one of the most severe wind-related dust storms in the past two decades. Wind gusts exceeded 100 mph in some areas and 24-hour average PM-10 concentrations topped 500 $\mu g/m^3$, over three times the federal standard.

Table 1. Test Conditions for Simulated Windstorm

Silt fraction of material in each test section	7.5%
Silt loading in each test section	16 g/sq. ft.
Application rate	300 gallons per mile
Drying time after application	24 hours
Wind test date	March 4, 2003
Leaf blower nozzle air speed (measure one foot from nozzle)	65 mph
Leaf blower height above ground	1 foot
Relative Humidity	49%
Ambient temperature	32 ºF

The observers were instructed to rate the relative dust control on each test section. Video was used to record the tests in the field. The test was conducted single blind; observers were not told what had been applied to the three sections. Although Figure 3 shows that the $MgCl_2$-treated section was darker in appearance than the water-treated section in Figure 2 one hour after application, there was no obvious difference in appearance among the three sections 24 hours after application when the test conducted. The photograph in Figure 3 shows conditions similar to those witnessed during the dust tests.

Figure 2. Water-treated section after one hour

Figure 3. $MgCl_2$-treated section one hour after application (KAc section looked similar)

Figure 4. Wind test

Results and Conclusion

The six observers were unanimous in the opinion that section treated with $MgCl_2$ (Section 2) produced the least dust. All six observers felt that the KAc-treated section (Section 3) produced slightly more dust than magnesium chloride section. Observers were unanimous that significantly more dust came from the control section (Section 1) that was treated with water alone. This test suggests that the use of dust palliatives such as $MgCl_2$ or KAc can provide some control of PM-10 emissions during high wind events, and based on this result, it is recommended for inclusion as a best available control measure (BACM) during wind storms. A video record of this test, "Use of Magnesium Chloride Brine to Control PM-10 Emissions from Paved Roads during Windstorms, 2003" is available from the Environmental Quality Program of DHHS.

Epilogue

The day after this test, March 5, 2003, the MOA and ADOT&PF initiated city-wide $MgCl_2$ application because of high wind predictions by the National Weather Service. Even though PM-10 exceedances were measured on March 7, 12, and 13, the results of this study suggest that the $MgCl_2$ palliative application probably reduced the impact on residents. Indeed, observations by MOA staff suggested that roadways treated with the palliative seemed visibly less dusty than untreated roads. An additional $375,000 in federal funding for PM-10 control has been included in the current 2004-2006 Anchorage Transportation Improvement Program. A portion of this funding is intended for the application of $MgCl_2$ as a dust palliative during wind storms.

References

[1] Evaluation of Liquid Magnesium Chloride for Paved Roadway PM-10 Control in Anchorage, Air Quality Program, Department of Health and Human Services, October 1999.

[2] Evaluation of Magnesium Chloride Brine for Paved Roadway PM-10 Control in Anchorage, prepared by Midwest Research Institute for the Muncipality of Anchorage, February 15, 2001.