Are You Using the Right Amount of Ice Control Chemical?

Here are new empirically derived guidelines for selecting ice control chemical application rates for a wide range of weather, site, and traffic conditions found in North America.

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The answer to this crucial question is based on the findings of NCHRP Project 6-13 (*Guidelines for Snow and Ice Control-Materials and Methods*), presented at the 6th International Symposium on Snow Removal and Ice Control Technology, June 7-9, 2004, Spokane, WA. The study produced a methodology, derived from field data, to prevent roadways from developing a bond between frozen precipitation and the road surface or improving pavement ice condition within a couple of hours of applying chemicals.

These guidelines apply to both state/provincial and local highway agencies. The guidelines were developed under NCHRP Project 6-13 by adding appropriate existing documentation to new data collected from field testing of selected strategies and tactics over three winters. A total of 24 highway agencies (13 state, one provincial, four county, and six city or town) participated, testing at 51 site locations. Three highway agencies were able to provide test data for the same location over all three winters.

Influencing Factors

The major factors to consider when choosing snow and ice control materials for treatment are the dilution potential chemical treatments will face and the performance characteristics of the materials. Some important terms follow.

ADJUSTED DILUTION POTENTIAL is a term that characterizes the rate that the chemical's effectiveness is eroded under operating condition. It takes into consideration precipitation, pavement conditions, pavement surface conditions, and operational conditions. For simplicity, adjusted dilution potential is divided into three levels: low, medium, and high.

PRECIPITATION DILUTION POTENTIAL is the contribution to adjusted dilution potential caused by the type and rate of precipitation of a winter weather event in progress. The higher the moisture content of the event per unit of time, the higher the precipitation dilution potential.

PAVEMENT CONDITIONS are the properties of the pavement itself that influence snow and ice control operations. The only pavement condition we will consider is pavement surface temperatures as it has a major effect on how ice control chemicals perform and ultimately, on the treatment decision itself. As pavement temperature declines below about 12°F, most ice control chemicals become inefficient in terms of the amount of ice melted per unit of chemical applied. Pavement temperature therefore drives the decision to plow only, plow and apply chemicals, or plow and apply abrasives, also depending on level of

It is important for plowing crews to remove as much excess snow, slush, or ice before chemicals are applied to the road surface.

service goals. Unpaved or gravels roads are unsuitable for chemical treatment.

PAVEMENT SURFACE CONDITIONS (in the wheel path area) describe any accumulations of snow and ice that may remain on the pavement at the time of treatment (after plowing). These include loose snow, packed snow, and ice. A critical surface condition is whether the snow or ice is already bonded to the pavement surface. Snow or ice remaining on the roadway surface after plowing will cause chemical treatments to dilute more quickly (in addition to the dilution caused by continuing precipitation). If the snow or ice is bonded to the pavement, considerably more chemical will need to be applied to achieve an unbonded condition.

The most important operational conditions influencing dilution potential are treatment cycle time and traffic. Longer treatment cycle times allow more precipitation to accumulate on the roadway between treatments. For equivalent effectiveness, more chemical must be applied for longer cycle times.

The two traffic characteristics thought to influence dilution potential are traffic volume and traffic speed. Higher speeds and higher volume will displace ice control chemicals from the roadway.

Table 1. Precipitation Dilution Potential and Its Adjustments

	Precipitation Rate			
Precipitation Type	**Light**	**Moderate**	**Heavy**	**Unknown**
1. Snow (powder)	Low	Low	Medium	Low
2. Snow (ordinary)	Low	Medium	High	Medium
3. Snow (wet/heavy)	Medium	High	High	High
4. Snow (unknown)	—	Medium	—	—
5. Rain	Low	Medium	High	Medium
6. Freezing rain	Low	Medium	High	Medium
7. Sleet	Low	Medium	High	Medium
8. Blowing snow	—	Medium	—	—
9. Snow with blowing snow		(Same as type of snow)		
10. Freezing rain with sleet	Low	Medium	High	Medium
11. None				
If wheel path area condition is:				
- Dry or damp		Not applicable		
- Wet		Low		
- Frost or black ice (thin ice)		Low		
- Slush or loose snow		Medium		
- Packed snow or thick ice		High		

Adjustments to Precipitation Dilution Potential

		Increase precipitation dilution potential above by number of levels
a)	Wheel path area condition when precipitation is present	
	Bare	0
	Frost or thin ice	0
	Slush, loose snow, packed snow, or thick ice	1
b)	Cycle time	
	0 - 1.5 hrs	0
	1.6 - 3.0 hrs	1
	Over 3.0 hrs	2
c)	Traffic volume at traffic speeds >35 mph	
	Less than 125 vehicles/hour	0
	More than 125 vehicles/hour	1

Step by Step

Winter maintenance field personnel should follow a step-by-step procedure to determine the most cost effective chemical application rate. Appropriate application rates for solid, prewetted solid, and liquid NaCl are based on pavement temperature range, adjusted dilution potential level, and the presence or absence of ice/pavement bond. These recommended application rates depend on weather and pavement conditions at the time of treatment and on how these conditions are expected to change before the next anticipated treatment.

Plowing should be done before chemicals are applied to remove any excess snow, slush, or ice, hopefully leaving the pavement surface wet, slushy, or lightly snow covered when treated.

STEP 1. Determine the pavement temperature at the time of treatment and project the temperature trend after treatment. Using modeling techniques, you need to estimate or predict just what the pavement temperature will be in the near term (1 to 2 hours after treatment). It generally does not change much in a couple of hours, unless influenced by sunshine.

STEP 2. Establish the adjusted dilution potential for your intended chemical treatment by considering type and rate of precipitation, pavement surface conditions in the wheel path area, operational cycle time, and traffic speed and volume. Use Table 1 to determine precipitation dilution potential. As necessary, adjust the precipitation dilution potential for various wheel path area conditions, cycle time, and traffic speed and volume. Finally, using field observations or sensor data, determine if an ice/pavement bond condition exists.

When making adjustments to the precipitation dilution potential, an adjustment of "1" would change a low level to a medium level or a medium level to a high level. An adjustment of "2" would change a low level to a high level. The end result of adding various adjustments to the precipitation dilution potential is termed "adjusted dilution potential" The adjusted dilution potential level cannot exceed "high."

Some agencies have simplified this dilution potential guidance by considering only precipitation dilution potential and the presence or absence of a packed or bonded condition. They feel that their surface conditions, traffic volumes, and cycles times are constant.

STEP 3. Using the calculations and observations from Table 1 as inputs, go

Table 2. Application Rates for Solid, Prewetted Solid, and Liquid Sodium Chloride

Pavement Temperature (F)	Adjusted Dilution Potential	Ice Pavement Bond	Application Rate Solid[1] lb/L-M	Application Rate Liquid[2] gal/L-M
	Low	No	90[3]	40[3]
Yes	200	NR[4]		
Over 32	Medium	No	100[3]	44[3]
		Yes	225	NR[4]
	High	No	110[3]	48[3]
		Yes	250	NR[4]
	Low	No	130	57
		Yes	275	NR[4]
30 to 32	Medium	No	150	66
		Yes	300	NR[4]
	High	No	160	70
		Yes	325	NR[4]
	Low	No	170	74
		Yes	350	NR[4]
25 to 30	Medium	No	180	79
		Yes	375	NR[4]
	High	No	190	83
		Yes	400	NR[4]
	Low	No	200	87
		Yes	425	NR[4]
20 to 25	Medium	No	210	92
		Yes	450	NR[4]
	High	No	220	96
		Yes	475	NR
	Low	No	230	NR
		Yes	500	NR
15 to 20	Medium	No	240	NR
		Yes	525	NR
	High	No	250	NR
		Yes	550	NR
	Low	No	260	NR
		Yes	575	NR
10 to 15	Medium	No	270	NR
		Yes	600	NR
	High	No	280	NR
		Yes	625	NR
Below 10	A. If unbonded, try mechanical removal without chemical. B. If bonded, apply chemical at 700 lb/L-M. Plow when slush. Repeat as necessary. C. Apply abrasives as necessary.			

NR = Not recommended

Specific Notes:

1. Values for "solid" also apply to prewet solid and include the equivalent dry chemical weight in prewetting solutions.
2. Liquid values are shown for the 23-percent concentration solution.
3. In unbonded, try mechanical removal without applying chemicals. If pretreating, use this application rate.
4. If thin ice, liquids may be applied at the unbonded rates.

General Notes:

5. These application rates are starting points. Local experience should refine these recommendations.
6. Prewetting chemicals should allow application rates to be reduced by up to 20 percent depending on such primary factors as spread pattern and spreading speed.
7. Before applying any ice control chemical, the surface should be cleared of as much snow and ice as possible.

to Table 2 to determine the appropriate application rate for solid, prewetted solid, or liquid NaCl.

In summary, this methodology can be useful in developing and implementing salt management plans. The practice of applying the "right" amount of chemicals for weather and road conditions will most likely result in long term chemical savings when compared with using only a few application rates over the full spectrum of winter weather events. GE

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