Salt Brine, Salt Brine Blends And Application Technologies During The 2008 – 2009 Winter Maintenance Season Final Report

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16. Abstract

This report documents the evaluation of salt brine technology project. The primary objectives of this research initiative were to construct a salt brine facility, experiment with different combinations of salt brine and other ice melting additives, reduce the use of winter road sand while raising the level of service of state roads, and to determine if cost savings can be attributed to the use of salt brine and/or salt brine combinations. The original scope of work included deploying three Stratos spreaders to conduct the experiment on control and experimental test sections on Interstate 89 in Districts 5 and 8. Due to equipment complications, the experiment was modified and included different roadway sections of similar length and characteristics in both districts. Results have shown that the experimental section saved an average of 24% of material usage over the 2008-2009 winter season.

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Introduction

During the Fall and Winter of 2008-2009, the Northwest Maintenance Districts (D5-D8) embarked on a research project to test new theories and technologies involving the use of salt brine in winter road maintenance. Currently, Vermont spends over $15 million annually on winter road maintenance to improve traffic safety during winter months, and uses over 75,000 tons of salt and 21,000 tons of sand every year on winter snow and ice control for a total materials cost of almost 4 million dollars. Unlike spending millions of dollars to build a bridge with a fifty to seventy-five year life span, or paving a road with a fifteen to twenty year life span; money and materials spent on winter maintenance are gone at the end of the season. Vermont also pays enormous undocumented costs due to increased accidents in the winter, damage to the natural environment from salt and sand, and maintenance costs due to corresponding corrosion of our roads, bridges and vehicles.

The purpose of this research project is to determine if salt brine technology can provide safer winter roads at lower cost and less environmental damage than current methods – a very tall order. The research project has 4 initial project goals:

1. Construct a salt-brine making facility at the District 5 Chimney Corners Garage complex.
2. Experiment with different combinations of salt brine and additives to enhance the efficiency and cost-effectiveness of road salt in winter maintenance.
3. Reduce winter sand use and raise level of service on a portion of Interstate 89 through the use of salt brine, salt brine combinations, and European salt brine pattern spreaders.
4. Determine if cost savings can be attributed to the use of salt brine and/or salt brine combinations.

The catalyst for this research project was the generous award of $55,000 in Research, Development and Technology Funds from the Research Advisory Council (RAC) to purchase a salt brine maker. Districts 5 and 8 then set about the task of bringing this project to fruition.

Research Problem Statement

Sand has long been a staple of winter road maintenance, especially during durations of temperatures below 10°F. However, there is growing concern regarding negative effects of sand to public health and the environment. Airborne sand particles are major contributors to reduced winter air quality and can cause breathing difficulties. Sand particles absorb pollutants from the road and then are carried or blown into drainage paths where they plug ditches, cause turbidity and silting problems in streams and rivers, release pollutants into the water, and smother fish spawning beds and river/stream-bottom ecosystems. There is growing pressure from the Environmental Protection Agency (EPA) and other agencies to restrict or eliminate road sand in winter maintenance practices. Coastal states, namely Maine and Washington, have been severely restricted in their use of winter road sand for environmental reasons. These restrictions are expected to flow to other states. It is imperative that Vermont prepare for this possibility by exploring alternatives while balancing safety and the needs of the traveling public.

Road salt remains, now and for the foreseeable future, the most cost effective method of melting ice and snow from roadways. However, road salt comes with enormous costs to the environment and to society due to polluting wells and ground-water sources, increases in chloride content of streams and rivers, salt-induced vegetation die-off, and corrosion to roads, bridges and vehicles.

National trends show strong, steady increases in quantities of road salt and sand for the past 60 years. Vermont mirrors those trends. Costs of performing winter maintenance on highways have been rising dramatically in Vermont and throughout northern snow-belt states. Sand and salt costs are becoming a great concern to many northern states with many areas seeing cost increases of 25% in one year. In addition, some states, including Vermont, are experiencing difficulties in obtaining road sand as sources (pits, quarries) are depleted. During the winter season of 2007 – 2008, many northern-tier states experienced severe shortages of road salt due to high demand and inadequate supply.

It is vital to research and investigate new ways of performing winter road maintenance; ways that use road salt more effectively and efficiently while reducing the need for winter road sand.

Technology Review and Peer Review

A majority of states located within the snow-belt of the United States, including Vermont, utilize a standard winter maintenance practice known as "Deicing." Deicing operations consist of plowing and applying dry sand and/or salt to the pavement, and are commonly initiated only after snow has begun to accumulate on the pavement, sometimes at depths of an inch or more. Sand or salt is not applied prior to the storm because wind and traffic would just blow the costly material off the road, defeating its purpose. Also, dry salt cannot melt snow or ice; it first needs to mix with water (from the snow) to form a brine. Salt is used most effectively when temperatures are 20°F and rising, however, salt and sand/salt mixtures are often used down to 10°F but requires heavier and more frequent applications. Below 10°F, sand is used almost exclusively due to the fact that salt loses its efficiency and cost-effectiveness. For example, at 30°F, one pound of salt will melt approximately 46 pounds of ice. At 20°F, it takes 5 pounds of salt to melt the same 46 pounds of ice. At 10°F, 9 pounds of salt are required; and the trend continues as temperatures continue to drop.

Deicing is generally a straightforward procedure, and involves dropping a concentrated line of salt, known as a "furrow" or "bead", down the center of the road. As the salt mixes with water from accumulating snow, or snow melted by friction of vehicle tires or vehicle heat, it forms a brine and starts to spread across the road, melting snow and ice as it spreads. Unfortunately, the time required for this process to occur is often lengthy, leading to a compacted snow layer that is tightly bonded to the pavement surface. Standard deicing operations are time consuming, costly, and provide less safety, requiring large amounts of abrasives or salt to temporarily increase traction levels and break the bond of the compacted snow to the pavement so it can be more readily removed during plow operations.

Another technique for winter road maintenance developed over the past 10 to 15 years is known as “anti-icing.” Anti-icing is a systematic approach to preventing snow and ice from bonding to the pavement; requiring about one-fifth the amount of salt or other chemicals that is required to break the bond in deicing operations. A common practice is to spray the roads with a liquid ice-melting chemical such as calcium chloride or magnesium chloride prior to the storm to form a bond-breaking layer between the pavement and the falling snow or ice. Many of these ice-melting chemical solutions work much more effectively at colder temperatures than salt, some well below 0°F, but are quite costly. At over $1.00 per gallon, applied at the recommended rate of 50 gallons per lane mile, it would cost a District with 700 lane miles over $35,000 per application.

Anti-icing operations require accurate weather forecasting and timing of operations. If the roads are treated with anti-icing liquids prior to a predicted snow storm, but the storm arrives a few degrees warmer with rain instead of snow – the investment in anti-icing chemicals is washed off the road with no benefit. Alternatively, if temperatures unexpectedly rise during a snow event to say 30°F, some anti-icing chemicals will “slime” the road causing slippery and dangerous conditions. Due to the risks and high costs that are associated with anti-icing, Vermont had not yet embraced the technology despite the potential for salt and sand savings.

A relatively new technique for winter road maintenance involves the use of salt brine for melting snow and ice. Developed in Europe, salt brine is simply a mixture of 23% salt and 77% water (the carrying capacity of salt in a water solution) that is sprayed directly on the road as an anti-icing agent. Salt brine has the same melting characteristics of regular salt, but because it is already in brine form, it can begin to work immediately and, given its consistency, will not blow off the road. It is cost effective to produce, at approximately $0.10 per gallon, and other de-icing chemicals can be mixed into the salt brine to lower the effective melting temperature.

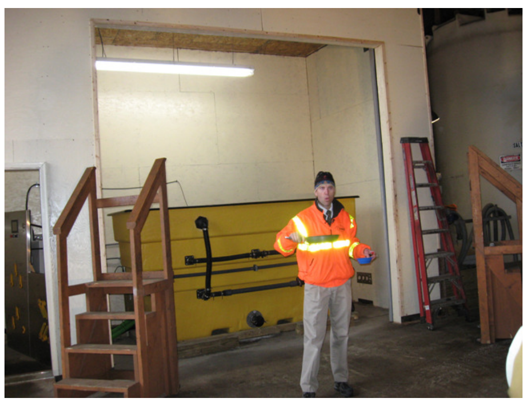
European countries have also developed the technology of mixing solid salt with liquid salt brine and spreading it in a pattern across the roadway. Coined “oatmeal”, the salt brine/solid salt mix can be used as a cost-effective anti-icing agent because the liquid brine coating “sticks” the solid salt to the road and reduces loss due to bounce or being blown off the road. The liquid begins to work immediately, and the solid particles act as “time-release” capsules providing a long lasting benefit. The “oatmeal” can also be used as an efficient and cost effective deicer. The European countries report significant savings in salt and sand, better road conditions, and lower costs for winter road maintenance.

Neighboring states, namely Maine and New Hampshire, have experimented with this technology with varying degrees of success. New Hampshire has concentrated on spraying liquid salt brine as an anti-icing agent, moving almost completely away from other anti-icing solutions. Maine has done the same, but they are forging ahead into using more of the European "oatmeal" spreaders. Maine is also experimenting with brine additives and reports that a mixture containing 60% salt brine and 40% of a proprietary magnesium-chloride based product (Ice-B-Gone) had effective ice-melting performance down to negative 15°F. This is an unheard of performance for salt as a snow or ice melting agent.

The Vermont Experiment

Making Salt Brine

During late summer and early fall of 2008, District 5 forces spent approximately $65,000 of District funds to retro-fit an existing standard VTrans' salt shed building at the Chimney Corners Garage complex in Colchester, Vermont to house the brine making facility. The innovative retro-fit design shoe-horned a heated brine room and an unheated tank farm with capacity to hold six 5,000 gallon storage tanks with enough open floor space to allow loading the brine maker with a skid-steer and still retain over 500 tons of solid salt storage capacity. In theory, the salt savings from using salt brine should more than make up for the lost dry salt storage capacity.



The Chimney Corners Salt Brine Manufacturing Facility

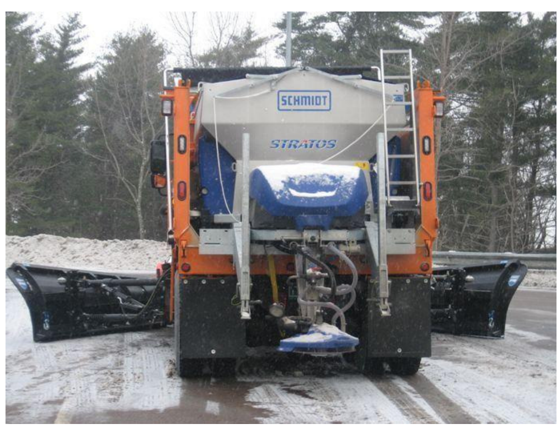
In the fall of 2008, using Research, Development and Technology Funds from the Research Advisory Council (RAC), VTrans District 5 purchased and installed a state of the art salt brine maker manufactured by Cargill, Incorporated. The brine maker can produce 5,000 gallons of salt brine per hour, is fully automated, has the capacity to automatically meter in additives, and records quantities in each storage tank in the tank farm. The brine maker was independently verified to accurately blend salt brine to the optimum concentration of 23% salt and 77% water.

The capacity and the location of the brine maker was designed to supply other VTrans Maintenance Districts and interested Town Highway Departments with salt brine in the future, and to allow convenient Interstate access for trucks coming to load brine. It is also interesting to note that the State of Maine built a 5-bay building which houses a brine maker of similar capacity and similar storage for a cost of $400,000 compared to a total of $118,000 spent by VTrans. In December, 2008, the VTrans salt brine facility went into full production mode and has operated without problems ever since. The first goal of the research project was accomplished.

Trucks and Equipment

Concurrently with the effort to bring the brine maker on-line, Districts 5 and 8 worked on obtaining equipment to spread the brine on Vermont roads. Working through a competitive bid process with VTrans Central Garage, Districts 5 and 8 obtained three STRATOS spreaders from Schmidt Corporation headquartered in the Netherlands (Holland). The STRATOS spreaders are a unique integrated design incorporating a central V-hopper for dry salt; two 350 gallon storage tanks for brine on each side of the V-hopper (blue tanks in the photographs); a low-friction, maintenance-free rubber conveyor belt system as opposed to standard VTrans metal bed chains; a high-capacity brine pump and mixing system that fully coats each salt particle with salt brine (to make "oatmeal"); and an electronic single joy-stick control system that allows the STRATOS to spread up to four lanes wide from a single truck. The Europeans have discovered that the optimum ratio for melting snow and ice with "oatmeal" is 70% solid salt and 30% liquid, so the system configuration is locked into that ratio.

The Schmidt STRATOS spreader automatically adjusts feed rates for the number of lanes. For example, if the operator is spreading "oatmeal" at 200 pounds per mile on a single lane and then switches to two-lane coverage, the system automatically feeds 400 pounds per mile to the spinner and the spinner adjusts its speed and "aim" to cover the two selected lanes. So, in theory, the Schmidt STRATOS spreaders should save salt by replacing solid salt with salt brine, reduce salt loss due to bounce and wind by "sticking" the "oatmeal" to the road, and should be able to do the work of two or more traditional spreaders. In European practice, significant savings in salt have been documented and in some countries only 1 of every 3 or 4 winter maintenance trucks has a spreader; the other trucks just plow.



The Schmidt Stratos slide-in "V" hopper spreader

The STRATOS spreaders were fitted to three VTrans plow trucks and deployed into the field along Interstate 89 in Districts 5 and 8. The District 5 and 8 Salt Brine Research Team selected three test sections along I-89 interspersed with three comparable control sections. The test/control area stretched from St. Albans to Bolton and included three major winter maintenance problem areas: a band of high elevation and high snowfall in Fairfield; the high traffic counts (50,000 AADT) and high accident areas (Winooski River Bridge and Exit 14) in Burlington; and the cold pocket/high wind zone in Bolton Flats. The three Schmidt STRATOS trucks were outfitted with reversible front plow and double wings so they could plow either lane with a "sister" truck that would only plow the other lane. The STRATOS trucks were responsible for spreading material on both lanes. The control sections were maintained with two standard de-icing trucks where both plowed and spread material.

Initial Results

The early intent of the Research Team was to concentrate on Research Project Goals 1, 3 and 4: make brine, test brine and brine spreaders on I-89, and run cost comparisons with control sections using the conventional technology. It was decided that the research involving using additives in the brine mixture to allow salt and salt brine to work efficiently at lower temperatures (Goal 2) would wait until next winter season (2009-2010). However, December of 2008 and January 2009 produced a series of cold storms and cold temperatures. Early training runs with the STRATOS spreaders using salt brine showed that the technology did work, and worked well, even better than conventional methods. At temperatures below 10°F, salt spread by conventional means worked very slowly with relatively little melting action that was limited to the center of the road where the "furrow" or "bead" of salt was dropped. However, the STRATOS trucks spreading "oatmeal" started a much quicker, stronger melting action across the width of the lane. The lower temperatures, at some point, overwhelmed the melting action, causing re-freezing of the melted (now liquid) snow and ice and caused slippery and dangerous conditions. Therefore, the Research Team issued directions to the field operators that salt brine was to be used only at 15°F and rising. At that point in the initiative, the Research Team chose to launch investigations into using additives to enhance the performance of salt brine. Initial intent was to experiment with using Calcium Chloride ($CaCl_2$), a snow and ice melting chemical which was already extensively used and widely available at VTrans, as a salt brine additive. Unfortunately, a peer review revealed that $CaCl_2$ did not mix well with the salt brine. In fact, at high concentrations the $CaCl_2$ caused the salt to precipitate out of the salt brine. The peer review showed that the State of Maine was having some initial success with mixing a proprietary Magnesium Chloride based product, Ice-B-Gone. The Research Team decided to mix the Ice-B-Gone additive with the brine. On the first trial mix, a ratio of 70% salt brine and 30% Ice-B-Gone was used for testing at lower temperatures with using enhanced, or "hot" brine.

Complications

As the Research Team worked through the purchase process for the Ice-B-Gone additive, brought the last of the three STRATOS trucks on line, and acclimated the STRATOS operators to the new equipment, three unique features of the STRATOS spreaders arose as significant challenges to the Research Project.

First, many state agencies are currently experiencing a budget crisis. The last of the three STRATOS trucks arrived along with a directive from VTrans Executive Staff that there was a moratorium on Agency new vehicles and heavy equipment purchases until further notice, possibly even years to come. The STRATOS spreaders are expensive, adding approximately $35,000 to the cost of a conventional truck/spreader combination. Part of Goal 4, cost effectiveness, was to determine if the additional cost would be offset by projected salt savings, having one STRATOS spreader do the work of two (eliminate other spreaders), and projected longer service life and lower maintenance costs for the STRATOS spreaders. It was also the intent of the Research Team to expand the use of salt brine across both Districts and across the state if we could prove it cost effective. The moratorium on vehicles and heavy equipment essentially means the possibility of the project spreading to other Districts is nonexistent if the only means of using the salt brine technology is through using STRATOS spreaders.

Second, it was found that there was a significant operator learning curve and operator buy-in component that the Project needed to address. Conventional plow truck operators are used to looking in their truck mirrors and seeing a substantial line of salt on the centerline of the road behind their truck, and heavy grains of salt bouncing across the lanes. This reassures the operator that salt is flowing onto the roadway. The STRATOS spreaders spread the individual brine-coated grains of salt uniformly across the lanes. The STRATOS spinner moves at very high speeds, almost like an airplane propeller, in order to cast the salt grains great distances. Individual grains of salt, moving at high speed (compared to conventional), with little or no bounce, are very hard to see even in daylight. New STRATOS operators questioned if their equipment was working properly. Also, a conventional truck leaves a very high concentration of salt in a very narrow area (the furrow). Unlike the conventional method where operators see fast results in high concentration areas, the STRATOS spreaders do not have the initial fast visual melting action of a furrow because the "oatmeal" is spread uniformly across the road. Initial melting is not as quick due to lower concentration, however when the melting does start, the entire road starts to clear. The initial time lag in visual signs of melting was disconcerting for STRATOS operators which made it difficult for some to trust the equipment. The Research Team addressed some of the concerns by mounting lights behind the STRATOS trucks so operators could visually check that the equipment was working. Research Team members and supervisors learned to communicate more often with new STRATOS operators during the initial time lag on visible melting until the operators had built trust and confidence in the technology.

The third challenge was the most significant, and almost halted the project. Initially two of the three SRATOS trucks were delivered. After a few runs of initial testing and acclimating to the new trucks/STRATOS spreaders, a problem developed with one of the trucks. A power-takeoff shaft on the truck that ran the hydraulic pump for the spreader loosened and damaged the truck transmission. VTrans Central Garage immediately pulled the truck off the road and tagged it "out of service" until the problem could be identified and a solution negotiated with the truck supplier – which took almost the entire winter. The third truck was delivered late in the winter and developed mechanical issues as well. The STRATOS spreaders worked well, but mechanical issues with two of the three trucks prevented the Research Team from implementing the test strategy and accumulating a statistically significant data set using 3 test sections and 3 control sections.

<u>Course Alteration</u>

In January of 2009, the Research Team found itself with an abundant supply of brine, a supplemental tank of "hot" brine, only one operational truck equipped to use the brine, and a budget moratorium limiting expansion of the program. It was apparent to the Team that a change in operation needed to be made.

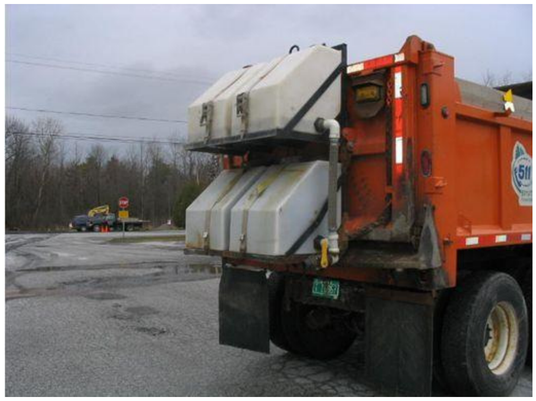
District 5 personnel at the Chimney Corners Garage designed and constructed their own anti-icing salt brine spray system. Using existing, borrowed and recycled equipment, the group installed a 1,200 gallon tank in the back of a plow truck and built a gravity-fed spray bar system with an on-off switch controlled from the truck cab. The spray rate was mechanically controlled by in-line baffles for an output of approximately 45 gallons per lane mile. A strip of fabric was installed on the back of the spray bar to "paint" the brine onto the road and reduce splash. The grand total cost was less than $1,500.

District 5's Tanker and Spray-bar system

No attempt was made to pursue numerical data or test/control sections on the District 5 spray bar system. Rather, the crew was instructed to try it out, experiment on their own, and bring back anecdotal performance evidence. True to form, the District 5 crew used the rig the remainder of the winter, trying different configurations, different additives, and even used the traditionally anti-icing tool to de-ice roads.

District 8 staff chose a different approach. They set out to modify an existing VTrans plow truck and spreader to produce and spread "oatmeal". Two 100 gallon brine tanks were attached to the tailgate of the existing truck and plumbed together. A high-capacity, hydraulically-driven brine pump and a check valve nozzle system controlled liquid flow. The District-designed nozzle system evenly distributed the brine across the flow of salt cascading from the existing truck bed chain through a chute and onto the existing spinner. By the time the salt left the spinner, the particles were evenly coated with brine and dropped onto the road.

The District 8 retro-fit of an existing salt truck does not have the brine carrying capacity of the STRATOS spreader, and it cannot spread over multiple lanes. However, it does effectively produce the "oatmeal" mixture of brine and dry salt – at a grand total cost of $3,500.



District 8's First Generation Retro System

After a period of working the bugs out of the District 8 retro-fit system, the Research Team set up a test route and a control route of similar length, topography, elevation, and traffic. The two routes intersected each other to allow immediate visual comparisons between the two. At this point in the winter of 2008-2009, the end of February and the beginning of March, winter storms were tapering to an early end of winter. However, the Research Team was able to gather numbers to compare the District retro-fit brine truck using "hot" brine with a 70/30 ration of brine to Ice-B-Gone against a conventional plow truck over 5 storm events.

Results

District 8 Retro-Fit Brine System

(As noted earlier in this report, the Research Project was not able to collect a statistically significant data set for the Retro-fit Brine System, but the results are reported here as they point to several interesting trends.)

Experimental Section (VT 36), Retro-Fit Brine Truck, Route Length 14.1 miles								
Date	Type of event	Salt (tons)	Salt Brine (gal)	Gals/ton	Brine type	Sand (cy)	Air temp (^oF).	Lane-miles treated
2/22/09	Snow	8.5	350	41	70/30 IBG	0		99
2/23/09	Snow	4.5	100	22	70/30 IBG	0		41
2/24/09	Ice/pack	3.7	70	19	70/30 IBG	0	12	30
3/3/09	Ice/pack	8.0	200	25	70/30 IBG	0		80
3/9/09	Snow	2.5	10	4	70/30 IBG	0	30	25

Totals		27.2	730	26.8		0		275

Control Section (VT 108), Standard Truck, Route Length 14.9 miles								
Date	Type of event	Salt (tons)	Salt Brine (gal)	Gals/ton	Brine type	Sand (cy)	Air temp (^oF).	Lane-miles treated
2/22/09	Snow	18.7	N/A	N/A	N/A	0		160
2/23/09	Snow	10.0	N/A	N/A	N/A	2		63
2/24/09	Ice/pack	7.0	N/A	N/A	N/A	3	12	50
3/3/09	Ice/pack	4.0	N/A	N/A	N/A	0		32
3/9/09	Snow	2.0	N/A	N/A	N/A	0	30	8
Totals		41.7	N/A	N/A	N/A	5		313

During the 5 storm periods, 27.2 tons of dry salt, plus 0.9 tons of salt in the brine solution, totaling 28.1 tons was used on the 14.1 mile Experimental (Brine) route, averaging 1.99 tons of salt per mile of route. In the Control (Standard) 14.9 mile route, 41.7 tons of salt was used during the same time period, averaging 2.80 tons per mile of route.

Over the 5 storm period, the Experimental (Brine) Section used 13.6 tons less than the Control (Standard) Section, a savings of 0.81 tons (1620 pounds) for every mile of road – a total salt savings averaging 29% per mile of route.

The Control (Standard) Section used 5 cubic yards of sand to temporarily maintain traction due to slippery conditions because the standard salt de-icing application was not removing stubborn ice and pack. The Experimental (Brine) Section did not require any sand to maintain satisfactory traction.

The Experimental (Brine) Truck treated a total of 275 miles during the 5 day storm period – including 80 miles on 3/3/09 when a localized storm cell centered on the western portion of this route. The Control (Standard) Truck treated a total of 313 miles during the same period. During the 5 day storm period, the Experimental (Brine) Truck worked 7% fewer lane miles accounting for the difference in the lengths of the control and experimental sections, indicating the roads cleared quicker than the Control (Standard) Truck. If the data from the localized storm of 3/3/09 are removed from the analysis, the Experimental (Brine) truck treated 195 miles over the 4 storm period and the Control (Standard) truck treated 281 miles – a savings of 27% fewer miles for the Experimental (Brine) truck once again accounting for the difference in the lengths of the control and experimental sections.

At $57.00 per ton for salt, and $0.40 per gallon for the 70% salt brine/30% Ice-B-Gone blend, the total cost of materials used on the Experimental (Brine) Section over the 5 day storm period was 27.2 tons x $57.00 per ton + 730 gallons x $0.40 per gallon = $1,842. At $10.00 per cubic yard for sand, the total cost of materials used on the Control (Standard) Section was 41.7 tons x $57.00 per ton + 5 cy x $10.00 per cy = $2,427. The Experimental Section showed a 24% cost savings over the Control Section.

The drivers of both the Experimental truck and the Control truck, and the traveling public all noticed – and commented – on how the Experimental (Brine) Section cleaned up quicker and better than the Control (Standard) Section. The Experimental driver reported seeing melting action begin within minutes of applying the "oatmeal" solution. In several storms, the driver of the Control truck had to make multiple trips to deal with stubborn ice and snow pack while the Experimental Section was already bare and the Experimental driver did not have to come back out. At one point in the test, the driver of the Control truck became concerned, stating that the Experimental (Brine) truck "was making me look bad."

District 5 Truck-Mounted Anti-Icing Spray Bar

As noted above, there was no attempt to obtain numerical data for this portion of the research project. However, District staff were asked to record their experimentation and observations and are summarized below.

Storm #1 and Storm #2: "air temperature 12° F with road temperature around the same. Pre-application (anti-icing) with straight salt brine … not much difference during the storm … clean-up slight(ly) … easier … if road and air temperatures are below 20° F this is not the application to go with."

Storm #3: "After the storm the roads on US 7 and the Circ Highway (no anti-icing applied) were caked with approximately 1 ½ inches of packed snow that would not come off regardless of how much salt and scraping was performed. We filled the truck with approximately 1,000 gallons of salt brine and 100 gallons of Ice-B-Gone. After applying the mixture to the trouble areas, five minutes went by and the results of the mixture were evident. The driver let the mixture work on the road for approximately 45 minutes. When he returned after battling the road for hours he reported that all he had to do was drop his hardware (plow and wing) and scrape off the remnants that the mixture had left behind."

Storm #4: "Pre-application (anti-icing) … same mixture (1,000 gallons salt brine, 100 gallons Ice-B-Gone) … results during the storm were noticeable … results of the clean-up after the storm were huge. The clean-up took half the time … less pack … cleaned up to wet roads in record time. It has been determined that this is the best application to go with, although if the temperature drops below zero … larger quantity of Ice-B-Gone. All drivers using the product have raved about the results in both storm maintenance and clean-up."

Storm #5: “Pre-application on the interstate in the worst areas … (known for) majority of accidents during a storm … After this road was pre-treated with the same mixture as noted in the previous storm the results were huge … During the storm there was no noticeable build-up (of snow) and there were zero accidents … zero vehicles off the road.”

STRATOS Pattern Spreaders

As described above, mechanical issues with the trucks prevented the Research Project from obtaining enough data to draw any conclusions. From the limited operational runs, the drivers reported that although the sophistication of the new technology had a learning curve, the spreader controls were very easy to operate and the results were promising. One driver using the STRATOS spreader in an anti-icing mode, applying “oatmeal” prior to a storm, reported that the treatment safely handled a small storm during the night and prevented calling out additional personnel or equipment. Another operator used the STRATOS for an anti-icing treatment late one afternoon and the next morning reported that the pre-treated section was the only portion of Interstate that was not icy. Drivers were able to spread “oatmeal” on multiple lanes in one pass and reported that when melting action started, the entire road would open up.

Conclusions

Goal 1

The Research Project constructed and continues to successfully operate a salt brine maker at the District 5 Chimney Corners Garage Complex. The design and construction of the salt brine facility was very cost effective (30% of the cost of a similar capacity brine facility in Maine), and operationally efficient. Operational costs (including District labor and heavy equipment) to make salt brine were $0.20 per gallon in the first year as compared to other commercially produced melting chemicals purchased by VTrans at $1.00 to $1.24 per gallon.

Goal 2

The Research Project was able to experiment with several combinations of salt brine and additives to enhance the efficiency and cost-effectiveness of road salt in winter maintenance. Through field observations the Research Team recommends that straight salt brine is efficient and cost-effective when road temperatures are 15°F or more. From 15°F down to 5°F, the Research Team recommends a blend of 70% salt brine and 30% Ice-B-Gone. The potential exists for brine blends below 5°F, but weather conditions did not allow field trials.

Goal 3

The Research Project was able to demonstrate that winter sand could be reduced and even eliminated except for the very coldest weather conditions (5°F and below) through the use of salt brine and salt brine combinations. However, due to mechanical and equipment challenges the Research Team was not able to run long term tests on Interstate 89 with the European salt brine pattern spreaders.

Goal 4

Although the data sets were not as extensive as the Research Team initially sought, the Research Project was able to produce salt savings of approximately 30% and materials cost savings of approximately 24% during the first year of experimentation. If such a cost savings could be projected State-wide, the potential savings would be almost $1 million annually. The Research Team agrees that there is potential for more salt and cost savings as staff become more experienced with the technology.

Although not one of the original Research Project Goals, the Research Team found that employee/operator buy-in was a key component to the project, and that the operators are very astute at determining if a tool or product works or not. The operators of the District 5 spray bar system, the District 8 retro-fit brine truck and the STRATOS "V" hopper system are full believers in brine technologies. Although many were skeptical in the beginning, once they started using the brine and blends, and were able to provide a higher level of service with the use of significantly less sand and salt at a lower cost across their routes, they started believing in the technology. The operators were approached several times in the local stores by residents, school bus drivers and mail delivery personnel, who all commented on how quickly the roads were cleaning up and wondering what we were doing different. It did not take long before everyone involved had enthusiasm for the implementation of these technologies. By the end of the winter even people that were not easily convinced were convinced and the maintenance areas that did not yet have brine technology wanted them.

Another important element to emerge from the Research Project, although not one of the original Project Goals, was the development of the District designed spray bar systems and the retro-fit brine system. The future expansion of the salt brine experiment is severely limited by the high cost of the STRATOS spreaders and the budget driven moratorium on purchasing new equipment. The District designed systems adapting existing equipment at very low costs, and were proven to be very effective even if they do not have quite the capability and performance of the more advanced STRATOS system.

In conclusion, through the use of salt brine, brine blends and brine technology, the Research Project was able to produce safer, better winter roads at lower cost, less salt and less sand.

Next Steps

Districts 5 and 8 will continue the experiment in salt brine, but at a different scale. Instead of focusing and collecting data on small test sections, the Districts will be expanding salt brine technology and brine capability into more VTrans garages and VTrans trucks. In the first year the Research Project proved salt brine can work on a small scale; in the second year the Research Team will attempt to show salt, sand and cost savings on all roads maintained by certain garages over the course of a winter. If the savings are proven, then the goal will be to move the technology Statewide and equip entire Districts with the salt brine technology.

In the next year, with more brine equipment in use, personnel training will become a much bigger task. The goal will be to acclimatize more operators to the new technology and controls, and get them to turn up the brine usage and the solid salt usage down.

The results of the first year of the Research Project have already influenced how Districts 5 and 8 will use winter sand. Because salt brine can reduce sand use to a fraction of previous amounts, Districts 5 and 8 will not be purchasing winter sand this year (a cost savings). In fact, the Districts are combining existing sand sheds: emptying out one sand shed and transporting the sand to fill the sand at a neighboring District Garage. Hence, one sand shed will service two garages and the now empty sand shed will be filled with salt. The additional salt storage capacity will be added at no additional infrastructure cost (another cost savings). After consolidation, any remaining winter sand will be sold to interested towns at our cost, a revenue gain since the sand was paid for in a previous budget year.

The Research Team will continue to experiment with different brine blends and also conduct field experiments to determine if salt brine additives can act as corrosion inhibitors to the effects of salt.

The Research Team will also continue to refine District-designed salt brine equipment, specifically working to add the capacity to hold more brine to existing trucks and equipment.

Many local towns have shown interest in purchasing and using salt brine on their roads. Town municipalities typically have a tanker system designed to spray liquid chloride over the gravel-surfaced roads to prevent dust and could utilize these systems during the winter months to spread salt brine. During the winter of 2009-2010, salt brine will be available to municipalities from the District 5 Chimney Corners brine maker facility on a trial basis and the Research Team hopes to benefit from Town experience and experiments with salt brine.