Road Dust Control with Calcium Chloride

Dust is an inherent problem with unsurfaced and gravel surfaced roads. The problem ranges from a simple but costly nuisance to a definite health hazard. The dust from traffic on such roads carries several hundred feet into nearby homes, damaging clothing and household furnishings. When road dust covers nearby crops, it often kills or stunts several rows, due to the shading effect and clogging of the plant stoma (pores). In human health, dust is one of the most common causes of allergies and hay fever and may be a conveyor of diseases like tetanus.

A related problem is the degeneration of the road surface. It must be bladed periodically to keep it passable and also may require addition of new aggregate to roads every year or so.

To stabilize roadbeds and control dust, many materials are currently available. One that has been used for over 50 years in various parts of the United States is calcium chloride. This fact sheet presents up-to-date procedures on the use of calcium chloride.

GENERAL INFORMATION

Calcium chloride ($CaCl_2$) is classified as a salt. It is obtained commercially from natural brine deposits or as a byproduct of manufacturing sodium carbonate by Solvay Process. Calcium chloride is commercially processed as a clear liquid or as white flakes or pellets.

Three important properties make calcium chloride useful for a wide variety of applications. First is its deliquescence, the ability to become a liquid by absorbing moisture from the air. Second is its hygroscopicity, an extreme ability to absorb moisture without becoming a liquid. This ability to pull moisture from seemingly dry air maintains the road at a fairly uniform level of moisture. The valuable result is a binding effect on the particles and aggregate in the road base, thereby stabilizing the base and preventing dust. The third significant property of calcium chloride is that it is exothermic. This means that it releases heat as it dissolves. This property makes it a good deicer for snow and ice. However, this "heat of reaction" can raise its temperature hot enough to be a *safety hazard* to workers mixing flake or pellet calcium chloride in solution.

$CaCl_2$

Transportation Information Exchange

FACT SHEET
T-220

The Vermont Local Roads Program

St. Michael's College
Winooski
Vermont 05404

The three forms of calium chloride are:

1. Flake, or Type I—comes in 100 pound bags, with a 77 to 80% calcium chloride content and water of crystallization.
2. Pellet, or Type II—comes in 80 pound bags, with a 94 to 97% calcium chloride content and less than 1% water of crystallization.
3. Liquid—comes in railroad tank cars and tanker trucks with the chemical in 32, 35 and 38% concentration.

ROAD PREPARATION AND APPLICATION

Callcium chloride can be added to a road surface during or after blading and shaping, throughout the year. The best results are obtained during spring maintenance, when the road still has moisture from spring rains. This maintenance should consist of adding new aggregate and fines, if required, while blading and shaping the road surface into a proper crown. A straight-line crown of ½ inch per foot has been found to be most satisfactory. It is vital that the borrow ditches be shaped for good drainage, because standing water is the main cause of potholes and road base failures. Culverts also need to be cleaned and repaired.

To apply flake or pellet calcium chloride, ordinary lime drill spreaders, tailgate spreaders or spinner disc spreaders can be used. For liquid calcium chloride, tanker trucks with spray bars can be used. After using, all equipment should be cleaned of the calcium chloride residue to prevent corrosion.

The manufacturers' recommended application rates for flake calcium chloride and its equivalent in pellet and liquid form range from 1 to 1.5 pounds of flake per square yard for newly treated roads or .5 to 1 pounds per square yard for roads treated the previous season. These application rates conform to the 1.5 pounds of flake per square yard recommended by the 1976 Maintenance Manual of AASHTO (American Association of State Highway and Transportation Officials). Table I below provides the application rates for liquid, flake and pellet calcium chloride.

When applying flake or pellet calcium chloride, the road must be moist. After the calcium chloride has been spread, a water truck must soak the surface to dissolve all flakes or pellets. When reshaping the road, in addition to spreading calcium chloride, it may also be blade-mixed with new aggregate.

TABLE I

Equivalent Rates of Application (Specific formulas—see below)

Flake	*Pellet*	*Liquid (concentrations)*		
		38%	*35%*	*32%*
lbs./sq.yd.	lbs./sq.yds.		gal./sq.yd.	
0.5	0.41	0.09	0.10	0.11
0.75	0.61	1.13	0.15	0.16
1.00	0.82	0.17	0.19	0.22
1.25	1.02	0.22	0.24	0.27
1.50	1.23	0.26	0.29	0.33

During dry spells with low humidity, it may be necessary for a water truck to soak the road to continue the action of the calcium chloride.

Application rates for a given road can be calculated, using Table I with the folowing procedure.

Example: Several homeowners along a quarter mile of 20-foot wide gravel road have complained of dust problems. Since the road has never had calcium chloride added to it, the desired application rate is 1.5 pounds of flake per square yard or its equivalent in 32% liquid or pellet. The procedure:

1. Determine road area to be covered.

$$\text{Area yd.}^2 = \frac{\text{width (ft)} \times \text{length (ft)}}{9 \text{ ft.}^2 \text{ (1 yd.}^2\text{)}}$$

$$\text{Length} = .25 \text{ mile} \times 5{,}280 \text{ ft/mile} = 1{,}320 \text{ ft.}$$

$$\text{Thus: area} = \frac{20 \text{ ft.} \times 1{,}320 \text{ ft.}}{9} = 2{,}933 \text{ yd.}^2$$

FLAKES

2. Next determine quantity of flake needed for the desired application rate.

lbs. needed = area to be covered (obtained above) × desired application rate.

lbs. of flake = 2933 yd.^{2} × 1.5 lb/yd.^{2} = 4399.5 *lbs. needed.*

3. Determine the number of bags required.

$$\text{no. of bags} = \frac{\text{lbs. of flake (from No. 2 above)}}{\text{100 lb/bags (general information)}}$$

$$\text{no. of bags} = \frac{4399.5 \text{ lbs.}}{100 \text{ lb/bag}} = 44 \text{ bags needed}$$

PELLETS

2. Determine quantity of pellets needed at desired application rate.

lbs. of pellet = area to be covered (from No. 1) × desired application rate (Table I)

lbs. of pellets = 2,933 yd.^{2} × 1.23 lbs/yd.^{2} = 3607.6 lbs.

3. Determine the number of bags required.

$$\text{no. of bags} = \frac{\text{lbs. of pellet (from No. 2 above)}}{\text{80 lb/bags (general information)}}$$

$$\text{no. of bags} = \frac{\text{3607.6 lbs.}}{\text{80 lb/bag}} = \text{45 bags needed}$$

LIQUID

2. Determine quantity of 32% liquid needed at desired application rate.

gallons of liquid = 2933 yd.^{2} × .33 gal/yd.^{2} = 967.89 gallons

Therefore, it will take 44 bags of flake, 45 bags of pellet or about 1,000 gallons of 32% liquid to treat this section of road. Using this procedure, a good cost comparison between available products can be made.

STORAGE

Calcium chloride can be stored in buildings, hoppers, silos or covered piles. The type of storage facility will depend upon the amount of product to be stored and the length of time it is stored. Three requirements are necessary for safe storage:

1. The material must be kept dry and, especially in warm weather, protected from humidity.
2. Drainage should be away from the storage area to prevent any possible runoff contamination of nearby creeks or lakes.
3. In storage, the floors or pads at ground level should be of bituminous paving or treated concrete.

When simple stockpiles are used, the calcium chloride should have polyethylene or vinyl-coated nylon covering the entire pile. This cover must be held firmly in place by means of timbers, old tires, sand or other anchorage. If a building is used, the floors, walls, and ceiling must be as airtight as possible, to prevent moisture from getting into the calcium chloride. Doors which swing open may allow excessive air leakage. Hoppers or silos can be made of carbon steel but, in this case, moisture exclusion is of the utmost importance in preventing rust.

When overhead storage is used with a gravity feed system for flake calcium chloride, an angle of 45° from the horizontal is required for flow. For pellet calcium chloride, an angle of 35° from the horizontal is required for gravity flow.

SAFETY AND DISPOSAL

Calcium chloride and its solutions present the same handling problems as other, similar salts. Contact of the solid material with the eyes will result in irritation or injury to the eye. A mild burn to the skin may be caused by prolonged contact. Reasonable handling, care and cleanliness, plus the use of safety goggles, should be enough to prevent injury. If gross contact with solid or solution does occur, the affected area should be washed thoroughly with clear water and medical attention obtained. Contaminated eyes should be flushed thoroughly with large amounts of water for at least 15 minutes, then medical attention should be obtained promptly.

Care must be taken when mixing flakes or pellets with water because calcium chloride gives off heat when dissolved (it is exothermic). Flake calcium chloride may cause a temperature rise of as much as 84°F when mixed in heavy concentration. Pellet calcium chloride can cause a temperature rise of up to 158°F under these same conditions. *Always use cool water* when dissolving calcium chloride, to prevent the possible boiling of the solution. In a closed tank, this temperature rise may cause a dangerous increase in pressure.

When disposing of calcium chloride and its solutions, care should be taken to prevent the product or brine from entering drinking water supplies or from being spread onto plants and shrubbery. In excess, it may kill or burn vegetation. Adding enough water to the brine may dilute its concentration to acceptable levels for ground surface disposal. Care should also be taken when cleaning out the mixing and processing equipment, for the same reasons.

CORROSION AND EQUIPMENT HAZARDS

After spreading and mixing with the roadway soil, the concentration level of calcium chloride will be relatively low. The calcium chloride will be held within the roadway and is not available for direct contact with vehicular traffic or the surrounding environment. For this reason, calcium chloride concentrations mixed in the road base are much, much lower than when the material is spread dry on the surface for use in snow and ice control. If recommended spreading, watering and mixing procedures are followed, no health or corrosion hazard will exist for nearby residents or anyone using the treated road. The only corrosion problem to be expected from the use of calcium chloride might be in rusting of the spreader equipment, if prompt cleaning is not done.

Aluminum and its alloys *must not* be used in spreading equipment, as they deteriorate rapidly upon exposure to calcium chloride. Explosion-proof equipment may also be desirable when large amounts of calcium chloride dust are present around electrical equipment. When applying calcium chloride for dust control or road stabilization, *do not* spread it over bridge decks. If workers spill calcium chloride on a paved surface, clean or wash this area as soon as possible to prevent creation of a slick spot. Calcium chloride should meet these standard specifications:

1. Calcium chloride shall meet the requirements of ASTM D98-77a or latest specifications.
2. Sampling and testing calcium chloride for roads and structural applications—ASTM 0345-74 or latest specifications.

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HANDLING CALCIUM CHLORIDE

Storage

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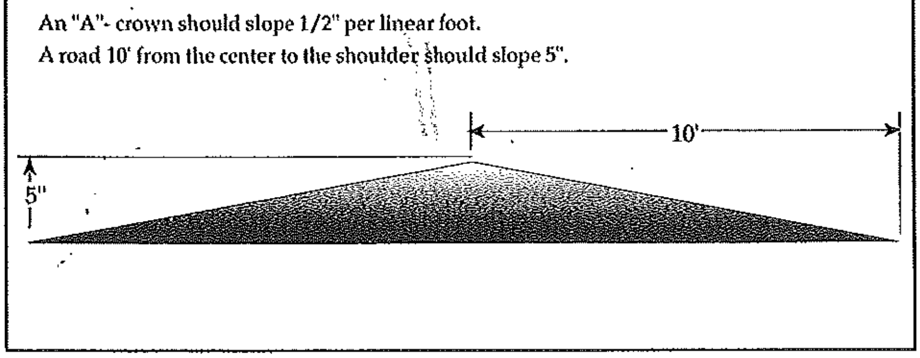
Adapted from South Dakota T[3] Special Bulletin Series 7: Road Dust Control with Calcium Chloride.

DUST BUSTED: HILLSBOROUGH COUNTY, FL LANDFILL ROAD

In April of this year, 1,200 gallons of 38% liquid calcium chloride were applied to approximately 1/8th of a mile of haul road at the landfill in Balm, Hillsborough County, FL.

Greg Walk, Supervisor of Waste Management, said he is pleased with the results. About 200 dump trucks travel the haul road daily and were kicking up a tremendous amount of dust. Now, once they reach the treated section, very little dust is kicked up. Walk plans to inform other chemical waste managers of the positive results.

If you'd like more information contact Greg Walk at P.O. Box 997, Lithia, FL., 33547.



Suggested Aggregate Mix

Designation Course	% Passing Sieve Surface Course	Base
1"	100	100
3/4"	85-100	70-100
3/8"	65-100	50-80
#4	55-85	32-65
#10	40-70	25-50
#40	25-45	15-30
#200	10-25	5-15

Applying Calcium Chloride

Calcium chloride is best applied in the spring, before the final shaping of the road. It should be applied while the road still is moist and dust appears. Roads which have been treated pre viously with calcium chloride many require reduced treatment, depending on the amount of carry-over from previous treatments, and the compaction of the surface.

Calcium chloride should be applied evenly over the road's surface to within one foot of either edge. The application should overlap the center of the road-- the crown-- which carries the most traffic.

During hot, dry periods, road surfaces should be lightly sprinkled with water before adding calcium chloride. This moisture permits rapid dissolution of anhydrous (pellet-form) calcium chloride, and creates capillary action to draw liquid calcium chloride deeper into the road's surface.

Road Surface Improvement

Constructing adequate drainage requires cleaning and shaping the ditches as well as maintenance of a proper crown. The best time to correct gradation problems is when the road bed is moist.

Insufficient fines or a lack of large aggregate will require the addition of limestone, gravel or crushed stone. These can be windrowed or mixed on the road. If the road is compact and smooth, but slippery when wet, adding stone, sand, pea gravel, stone chips or similar aggregate will improve traction. Recycled asphalt also can be used when sufficient fines are present. Add new aggregate in layers, blending with existing material. Then add calcium chloride.

Shaping the Road

To prepare road surfaces, scarify to a depth greater than existing potholes. Usually six inches in depth is sufficient. Scarifying loosens and blends existing materials to permit maximum penetration of calcium chloride. This step becomes particularly important when converting an oil-treated road to maximum stability with calcium chloride.

Blading and Shaping

A 20-foot-wide road should slope five inches from center to edge. It should have a straight crown line of 1/2-inch per foot. If an existing road is potholed, it may be necessary to scarify first to replace poor soil. An "A"-shaped crown prevents penetration of the road's surface by rain water.

Maintenance

The maintenance of calcium chloride roads usually requires only a light blading--preferably after rainfall. The grader should blade lightly from edges of the road toward the center-- and then feather the material back toward the edges.

It is a good practice to blade in short sections, so the area can be compacted before it dries out. Blading in dry conditions is not recommended, as it can loosen aggregate and dissipate calcium chloride.

Liquid Versus Dry

Both the liquid and dry forms of calcium chloride are on the market. Both are applicable for road use. The liquid is generally used as a 38% solution. The dry form is 94%-97% anhydrous pellet (Type I) and flake (Type II), having a 77% to 80% content. There are advantages to both liquid and dry.

In general, the advantage with the dry form is its availability in bags, which allows purchases of small quantities. The bags are easy to store and the dry material requires less specialized equipment to apply.

Liquid is best for larger projects, in that it costs less and is easier to handle and apply.

Adapted from an article by Brice Harwell, TETRA Chemicals.

Environmental FACTS *about calcium chloride*

Growing concern for the environment means that we need to closely examine the materials used in deicing and other road maintenance.

Calcium chloride works well not only for deicing but also for dust control/base stabilization and full-depth reclamation, says Bill Massa, General Chemical Corporation.

As its acceptance has grown, so have questions about how this substance works and how it impacts water quality and vegetation. This article answers questions road officials most frequently ask about calcium chloride.

How does calcium chloride work when mixed with aggregate?

Clays and other soil particles have a large negative surface charge. They act like little magnets and repel each other.

When water coats the particles, Massa says, it insulates them and reduces the force pushing them apart. Water also has a natural surface tension that acts to bind particles together.

A dry road is less cohesive than a wet one and loses fines more readily under the pounding of passing cars and trucks. A commonly used rule of thumb is that one car traveling over a mile of untreated dirt road will throw off a ton of gravel/year. Roads that retain water last longer. Calcium chloride helps keep water in roads in two ways.

First, as calcium chloride penetrates a road surface, it reduces the negative charge on the particles. This decreases the repelling force between particles and the thickness of the water coating. A thinner coating allows particles to move closer together.

And second, the surface tension of a calcium chloride solution is far greater than that of plain water. The higher surface tension and the thinner film coating the particles substantially increase the attraction between soil particles. As the binding ability of the road fines increases, so does road stability. Calcium chloride in reclaimed aggregate and base soils produces a material well suited for use as a road base or wearable surface for an unpaved road.

Does calcium chloride migrate once it is added to soil?

Calcium chloride tends to stay where it is placed. Studies indicate that calcium chloride migration is minimal and that lateral migration is low.

Samples from a road in Maine found that a majority of the calcium chloride per square yard remained in the road base after 24 yrs. A recent study in Ontario, Canada, conducted by Trow Geotechnical Ltd., indicated excellent retention of calcium chloride. Ninety-five percent of the material was present six months after application.

What type of calcium chloride migration is most likely to occur?

Most migration occurs vertically in soil, depending upon rainfall, evaporation, temperature, and humidity. As rain soaks into soil, it carries calcium chloride downward. Evaporation of water from the road surface has the opposite effect due to capillary action. Although calcium chloride rises and falls with weather conditions, little is lost from the road. Calcium chloride generally stays in place in road stabilization and dust control work.

One study showed that higher water tables carried calcium chloride from the road. With this in mind, calcium chloride should not be placed in roads where drainage is poor.

How large a contributor are deicers to water pollution?

A study on dust suppressants prepared for the Environment Ontario Waste Management Branch of the municipal government of Toronto found no adverse effects on water or plants from the use of calcium chloride as a dust suppressant, Massa says. The effect of salt on ground water is believed to be minimal, but difficult to assess because of the many sources of chlorides.

More than 4 million t. of salt, both sodium chloride and calcium chloride, are carried in rain and snow each year. Sewage treatment and industry also contribute to chloride levels.

What effect does calcium chloride have on a reservoir?

Studies in Maine and Wisconsin by the Highway Research Board in Washington, D. C., examined the effect of deicing chemicals on highways. These confirmed that chloride concentrations in rivers and streams are well within acceptable limits, Massa says. The great water volume they contain dilutes chloride concentration to acceptable levels.

Many states have instituted reduced salt zones in the vicinity of reservoirs. Calcium chloride is frequently used in these areas due to its performance and tendency not to migrate.

Water pollution from deicers is primarily limited to shallow wells near roads and small ponds and streams that get direct runoff from roadways. A study conducted in Maine found chloride concentration related directly to distance from a road.

What about calcium chloride in drinking water?

The American Medical Association limit for sodium chloride in drinking water is 250 mg/liter. The limit for calcium chloride is the same. It is interesting to note that the 250-mg level was set by the U.S. Public Health Service based primarily on taste rather than health.

Is chloride harmful in drinking water?

Humans have drunk water containing as much as 2000 mg of chloride without adverse effects, Massa says. People can taste sodium chloride and calcium chloride in concentrations from 70 to 900 mg and 15 to 350 mg, respectively.

How does calcium chloride affect vegetation?

As with water sources, the effect of salts

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on roadside vegetation is related to distance. Trees along highways deiced with salts are less vigorous than along unsalted highways. Salt injury is more apparent near the road and on the side receiving salt-laden runoff.

Plant biologists are not exactly sure how salt injures plants. Nor do they know the amount and exposure needed to harm them or what are the symptoms of salt-caused injury. Most blame plant damage on ion accumulation that enters through the roots. Salt spray may also damage plant tissue.

Different trees are affected differently. A study of sugar maples showed that trees within 30 ft. of highway were moderately to severely affected. Those more than 30 ft. away were almost always healthy. It was also found that calcium was less toxic than sodium chloride to roadside vegetation, Massa reports.

Salt may be falsely blamed for plant injury from gasoline and diesel engine emissions. The Environmental Health Service reports that gases such as ozone, nitrogen dioxide, ethylene, and chlorine account for the most widespread injury to plant life, destroying plant chlorophyll, disrupting photosynthesis, and reducing the plant's food production.

What can I do?

Many factors determine how road salt affects plants. These include amount of salt applied, how soon plowing occurs after application, soil quality and drainage, slope, how much snow melt runs off before the ground thaws, and the type of trees present. The type of salt also is important. Experiments show that sodium chloride is at least five to 10 times more toxic to elm and white pine than calcium chloride, Massa says.

Design plantings to minimize the effects of deicing salts. Place the most salt-tolerant and persistent turf species adjacent to the road and plant deciduous and evergreen trees as far from the roadway as possible. Plant trees sensitive to salt, such as maples, hemlock, birch, and some pines, 30 or more feet from a highway.

Where snowplow and vehicular splash is present, select the most spray-tolerant species. Also, do not plant salt sensitive trees and plants on slopes below the roadway. And, finally, place shallow diversion ditches between the road and woody plantings.

What should I do to best use salt?

There are some ways to limit salt-caused pollution or vegetation damage. One is to use deicers that cause less environmental damage than salt, or materials that reduce the amount of salt used. For example, calcium chloride melts more ice in less time than sodium chloride, especially at lower temperatures, according to Massa. Also, it goes into solution more rapidly than sodium chloride, so less is wasted during plowing. Both of these benefits mean that less salt is needed to maintain bare pavement, which minimizes salt-caused pollution and damage to plants.

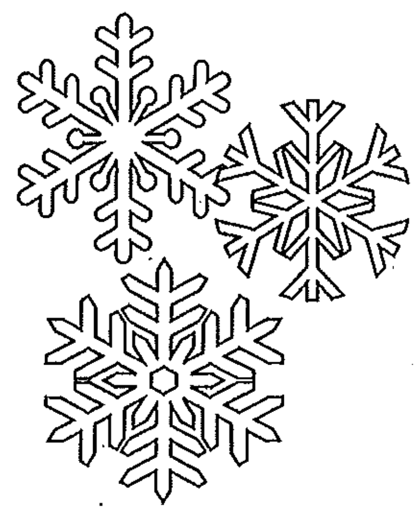
Another strategy is to pre-wet sodium chloride with liquid calcium chloride, which increases salt efficiency, improves the application pattern and reduces salt loss and the frequency of salt application. ❒

Write 6101 on reader service card.

The relative salt tolerance of trees and ornamentals

Low salt tolerance (0-2,000-ppm chloride)	Moderate salt tolerance (2,000-5,000-ppm chloride)	Good salt tolerance (5,000-6,000-ppm chloride
Filbert	Birch	Mulberry
Compact boxwood	Aspen	Apricot
Sugar maple	Cottonwood	White oak
Red maple	Hard maple	Red oak
Lombardy poplar	Beech	Hawthorne
Speckled alder	White spruce	Tamarix
Sycamore maple	Balsam fir	Squaw bush
Larch	Douglas fir	Russian olive
Black alder	Blue spruce	Scotch elm
Italian poplar	Texas pivet	White poplar
European beech	Xylosma	Osier willow
European hornbeam	Pittosporum	Honey locust
Rose	Pyracantha	Black locust
Pineapple guava	European black currant	Gray poplar
Viburnum	Siberian crab	Silver poplar
Arctic blue willow	Boxelder maple	English oak
Spirea	Japanese honeysuckle	White acasia
Multiflora rose	Green ash	Bottlebrush
Winged euonymus	Ponderosa pine	Oleander
Barberry	Golden willow	Common matrimony vine
Little leaf linden	Lantona	
Black walnut	Spreading juniper	
	Arbor vitae	
	Silver buffalo berry	

Source: ***Facts You Should Know About Effects of Deicing Salt on the Environment,*** **a review of a recent publication by the National Cooperative Highway Research Program, published as a supplement to the** ***Reporter*** **of the American Public Works Association. Reprinted by the Salt Institute.**



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