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 (CaCl₂) 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.
The three forms of calcium 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

Calcium 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 \( \frac{1}{2} \) 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 AASHO (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

<table>
<thead>
<tr>
<th>Equivalent Rates of Application (Specific formulas—see below)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Flake</strong></td>
</tr>
<tr>
<td>lbs./sq.yd.</td>
</tr>
<tr>
<td>0.5</td>
</tr>
<tr>
<td>0.75</td>
</tr>
<tr>
<td>1.00</td>
</tr>
<tr>
<td>1.25</td>
</tr>
<tr>
<td>1.50</td>
</tr>
</tbody>
</table>

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

   Length = .25 mile \( \times \) 5,280 ft/mile = 1,320 ft.

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

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

   \[
   \text{lbs. needed} = \text{area to be covered (obtained above)} \times \text{desired application rate}.
   \]

   lbs. of flake = 2933 yd.\(^2\) \times 1.5 lb/\text{yd.}^2 = 4399.5 lb. needed.

3. Determine the number of bags required.

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

   no. of bags = 4399.5 lbs. = 44 bags needed

FLAKES
PELLETS

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

\[
\text{lbs. of pellet} = \text{area to be covered (from No. 1)} \times \text{desired application rate (Table 1)}
\]

\[
\text{lbs. of pellets} = 2,933 \text{ yd.}^2 \times 1.23 \text{ lbs/yd.}^2 = 3607.6 \text{ lbs.}
\]

3. Determine the number of bags required.

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

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

LIQUID

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

\[
\text{gallons of liquid} = 2933 \text{ yd.}^2 \times .33 \text{ gal/yd.}^2 = 967.89 \text{ gallons}
\]

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.

REFERENCES

2. T. Allan Haliburton, Ph.D., P.E. Professor Oklahoma State University, Letter to Payne County Commissioner Karen Mullendore on corrosion of vehicles by calcium chloride.
3. Calcium Chloride Handbook, Dow Chemical U.S.A., Midland, Michigan
4. Materials for Stabilization, American Road Builders Association, Washington, DC
6. The Calcium Chloride Road, Solvay Process Division, Allied Chemical and Dye Corporation, New York, NY
7. William D. Lindholm, Highway Superintendent, Saunders County, Nebraska; telephone interview
10. State of Minnesota Department of Highways, Division of Materials and Research; Special Study No. 55, "Study of Calcium Chloride and Calcium Magnesium Chloride" (1939 to 1943)

Issued by the Transportation Information Exchange at St. Michael’s College, Winooski, Vermont 05401 (1983). Appreciation to the Center for Local Government Technology, Division of Engineering, Oklahoma State University, for permission to reprint this article written by Gary M. Brown, P.E. and T. Allan Haliburton, P.E., Ph.D.