ACTION OF CALCIUM CHLORIDE ON ROADS

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It is a fairly common practice nowadays to spread calcium chloride over the roads as a means of preventing dust and it is often claimed that the calcium chloride will not wash out of the surface of the road. These two statements are difficult to reconcile. Calcium chloride is an extremely deliquescent salt and, therefore, condenses moisture from the air when the concentration is well below the normal dew-point. The formation of a film of solution prevents the formation of dust. The dissolved calcium chloride should, however, wash out of the soil. We can account for the alleged fact that calcium chloride does not wash out of the soil by assuming that the salt is adsorbed by the soil; but, the more strongly adsorbed the calcium chloride is, the less hygroscopic it will be and, therefore, the less effective in laying the dust. It seemed desirable to find out what the facts were.

Experiments were made with a pure sand and with the top dressing of a macadamized road which had been treated with calcium chloride during the summer. The sand was bought from the Carborundum Co. and is the sand used in making carborundum. Previous analysis in the Cornell laboratory had shown that this sand contains about 99.6 percent SiO_2. The sand was dried for an hour at 140° and was found to be fairly uniform in size, 20 percent passing a 60-mesh sieve, ninety percent passing a 40-mesh sieve, and 100 percent passing a 20-mesh one.

The fusing mixture, potassium nitrate and sodium carbonate, gave no test for chlorides, and the nitric acid (6N) was also free from chloride. To determine the chloride content of the sand before and after treatment with calcium chloride, approximately one gram of sand was mixed with eight grams of fusing mixture and the whole decomposed by heating with a blast lamp in a platinum crucible until quiet fusion was effected. The crucible was then cooled, a little water was added and the melt was detached by gentle heating. The contents of the crucible were poured into a porcelain dish, and treated with water and with nitric acid. The gelatinous precipitate was filtered off and the filtrate tested gravimetrically with silver nitrate. No chloride was obtained from the pure sand.

Thirty grams of calcium chloride and 40 cc water were added to 100 grams sand, the whole was stirred vigorously and allowed to stand for twenty-four hours, a pasty mass being formed with no supernatant liquid. Approximately ten-gram portions of the mass were placed in small beakers, 25 cc water added and the whole stirred vigorously. After settling, about 25 cc solution were decanted and the operation repeated until the wash water gave no test for chloride. The sixth wash water gave only a slight turbidity and the eighth was free from chloride.

To the third wash water 10 cc nitric acid were added and the solution made up to 100 cc. Silver nitrate was added drop by drop, the solution being shaken constantly. After complete precipitation the silver chloride was filtered through a Gooch crucible and the excess of silver nitrate washed out with dilute nitric acid. The crucible and precipitate were dried in an air bath at 110° for two hours and were left to cool in a desiccator. The third wash water from one of the small beakers contained about 30 milligrams $CaCl_2$. Practically all of the calcium chloride is, therefore, removed in the first two washings and all of it is removed in seven washings.

After the eighth washing the sand was tested for chloride by fusion, etc., as previously described. Duplicate experiments gave 5.5 milligrams $CaCl_2$ per gram of sand or 0.55 gram $CaCl_2$ per 100 grams sand.

These experiments show that calcium chloride is adsorbed but slightly by sand and that calcium chloride washes out of the sand very rapidly.

In another experiment 30 grams sand and 9 grams $CaCl_2$ were placed in a small beaker and allowed to stand in a desiccator over water for nineteen days. At the end of that time sufficient water had condensed in the beaker, and analyses were made as before. The third wash water contained about 10 milligrams $CaCl_2$, referred to approximately ten-gram portions. The sixth washing showed a slight turbidity, but the ninth gave no test for chloride. The amount of $CaCl_2$ retained by the sand after the ninth washing proved to be 145 milligrams per gram sand. This is much more than was obtained in the previous run. It is quite possible that this extra amount was adsorbed during the nineteen days in which the sand and calcium chloride were in contact; but the matter did not seem to warrant further experiments at this time.

A quantity of top dressing was taken from a macadam road between Sibley College and Franklin Hall in Ithaca. This road had been treated with calcium chloride during the summer. The earth was dried for several hours at 140°, was pulverized, and passed through a 100-mesh sieve. The chlorine content was determined as in the previous experiments and was calculated as calcium chloride so as to be on the safe side. The amount of $CaCl_2$, as thus tabulated, was 20 milligrams per gram $CaCl_2$. A mixture was made up of 100 grams earth, 30 grams $CaCl_2$, and 55 cc water. After standing twenty-four hours, the mixture was divided into approximately ten-gram lots and washed as before. The third wash water gave 180 milligrams $CaCl_2$ and the sixth, 6 milligrams $CaCl_2$. A slight cloudiness was obtained with the ninth and twelfth washings while the fourteenth gave no test. The chlorine content of the earth after the fourteenth washing was about 5 milligrams per gram earth.

It is thus clear that the top dressing does not adsorb calcium chloride appreciably differently from pure sand. The relatively high amount of calcium chloride in the original top dressing shows that the washing by the rain was not very thorough during the summer of 1911. While the calcium chloride does not wash out of the top dressing as fast as it does out of sand, this difference is probably due entirely to the greater fineness of the top dressing.

When stood over, water sand containing a little calcium chloride condenses more water than sand containing none. The original top dressing takes up more water and takes it up faster than top dressing which has been treated with calcium chloride, washed thoroughly and dried. The reason for this is that the original top dressing contains more calcium chloride than the other. Some experiments were made with a washed and air-dried top dressing using different strengths of sulphuric acid in the desiccator. With 75 percent H_2SO_4 the soil lost moisture; with 25 percent H_2SO_4 the soil took up water from the acid; with 50 percent H_2SO_4 some moisture was taken up from the acid but we were evidently not far from the equilibrium mixture. This is in harmony with the known vapor pressures of calcium chloride and of sulphuric acid. It did not seem worth while to make more accurate measurements, though this could easily be done if anybody so wished.

The general conclusions of this paper are:

1. The usefulness of calcium chloride in laying dust depends upon the presence of free calcium chloride in the soil.

2. Very little calcium chloride is adsorbed by the soil and consequently the salt can be washed out readily.

3. The time during which calcium chloride remains effective in laying the dust depends on the amount of rain and on the readiness with which the water drains off.

4. There is no basis for the claim, sometimes made, that two treatments with calcium chloride will keep a road in good shape all summer. On the other hand, calcium chloride does not wash out of a road as rapidly as one might at first expect.

This investigation was suggested by Professor Bancroft and has been carried on under his supervision.

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