# Environmentally Safe Salt—Damp Salt

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*ABSTRACT*

*Damp salt usage is a modern, environmentally safe and economic technology to fight ice—more complete, safer and longer lasting.*

*In Germany this method to moisturize NaCl with a $CaCl_2$ solution on the screen dish, and bringing it out during the insertion, has been tested since 1972 and is now being used in many areas. The writer is responsible for carrying out the winter service in Rheinland-Pfalz and has led a working group that has supervised the testing for the research society of the Road & Traffic Department. Following the research phase, during which the necessary spreading equipment was also developed, the State Traffic Department in Bonn has now recommended this procedure for general usage.*

*Even though the State Traffic Department had beforehand a saving of salt in mind, a noticeable saving of NaCl was not achieved, because now the salt is also weather conforming (prophylactic), that is, it can now be brought out before the forming of ice and because travellers more and more, even in outlying areas, ask for ice control with this new technology. Additionally, "damp salt" (moistured), can also be used when, during lower temperatures, regular NaCl is not as readily effective.*

*The following will be stated during the paper:*

- *The reason for developing such a method*
- *The testing and the results explained*
- *The "damp salt" (moisturized) itself, its effectiveness and chemical analysis defined*
- *The manufacture of the solution explained*
- *"Damp salt" spreading equipment and their mechanics introduced*
- *The usage area outlined*
- *The advantages for traffic, roads and environment explained.*

## INTRODUCTION

For several years now in West Germany there has been animated discussion on the question of whether it is possible to replace road salt on a wide scale in order to eliminate damage to the environment. Pre-wetting salt is a method that has been tried in an effort to make salt more effective at low temperatures and to perhaps make it necessary to use less salt, thereby effecting a cost economy.

The results of tests show that the application of damp salt represents a modern, environmentally safe and economical technology in combatting icy conditions more accurately, more securely and on a more permanent basis.

## WHY HAS NEW TECHNOLOGY BECOME NECESSARY?

The fundamental question as to whether it is sufficient only to clear snow and ice from main thoroughfares in order to ensure the steady flow of motor traffic, or whether this can already be adequately achieved by the use of gritting material and snow chains, is answered by the publication "Official Standards of Snow and Ice Control" (Anforderungsniveau Winterdienst) published in Germany in 1979. This basically requires main thoroughfares to be passable between the hours of 6:00 a.m. and 10:00 p.m., while expressways are to be open to traffic 24 hours a day. According to German traffic law, it is additionally required that the Federal Department of Winter Road Service keep roads cleared and gritted "to the best of its ability."

The answer to the question—What causes damage to the environment?—naturally gives rise to conflict. To the specialist, who is concerned with economic maintenance of traffic of both private cars and trucks, the term "environmentally beneficial" does not merely refer to the protection of trees and water sources, but it also embraces a multitude of other acknowledged qualities of life, such as being able to reach one's place of work without accident and economic travelling (in terms of fuel consumption) on roads free of snow and ice (Öberg, 1981).

If one goes to the extreme of assuming that all main thoroughfares must be free from ice in winter, the only environmentally safe alternative to the use of sodium chloride as a thawing agent is the heating of road surfaces. Owing

to high energy costs, this, of course can only partially be put into operation or demanded.

As it is common practice in Western Europe for the winter service department to take steps to combat various slippery conditions, and because these nearly always occur first at particular points or sections of the roadway, it is understandable that, for economic reasons alone, attempts were made to find a means of minimizing the use of road salt.

Already the ineffective and very uneconomic method of road surface treatment, that of roughening the road surface with sand in granular or, fine gravel form, was replaced by salt spreading which was experimentally accompanied by using various mixed salts. There has been general approval for this latter method, whereby salt is discharged by various types of bulk spreaders, dependent on speed. Additionally, proportions 40 grammes/$m^2$ and 20 gm/$m^2$ were set on the bulk spreaders.

It is true that this development involved training staff in the use of the devices as well as in meteorological observations. On the other hand, it must be remembered that even upon discharge, part of the thawing salt was dispersed by the wind and that because the thawing process begins when sufficient moisture from the air has concentrated around the grain of salt, a further portion of the salt was borne away by the traffic headwind to the side of the road. Since this method is still predominantly in use, this drawback has evidently been accepted.

Owing to environmental considerations, this method, needless to say, does not permit salt to be spread prophylactically. However, it is permissible, if necessary, to salt extremely hazardous places, such as brows of hills, bridges or forest lanes a short time before icy conditions set in, providing one is aware of this in good time.

## DEVELOPMENT OF THE NEW METHOD

Considerations as to which mixed salt could be used led back to earlier experiments where the finest particles of the thawing salt were bound together by moistening. However, no suitable spreading device was known.

The obvious solution would seem to be to bind the fine particles of the salt around the coarser ones by the application of moisture, so that these, now being heavier, will fall directly onto the road and not be blown away. Moreover, the added moisture will instigate the melting process immediately. There was no question of using water as a moistening agent, because temperatures in the Rhineland fall as low as −20°C (−5°F). Therefore, experiments were undertaken immediately using a calcium chloride solution, which does not freeze in supply pipes even at a very low temperature.

For this reason, it was a question of finding a method of discharging the salt in such a way, that it would not be blown to the side of the road and thus improve the even distribution over the road surface, and that the thawing process would commence as soon as possible after the salt hits the icy roadway. These efforts were reinforced in the Federal Republic of Germany by the Rhineland-Palatinate Transport Administration. It had been revealed during the construction of the 1-km-long highway bridge near Koblenz—which is 135m over the Mosel valley—that from time to time there is a hurricane-force wind blowing across the roadway and that for the remainder, the projecting roadways of the cross section of the bridge would be much more susceptible to frost than the adjoining roads on natural soil.

The known spreading devices, dependent on road speed, were tried out and it was established that the most practical way of proceeding was to moisten the salt on the spinner disc itself, near the axis of rotation, or a little above it. Thought was then devoted to developing the appropriate mechanical requirements, and with the help of suitable German manufacturers, this had soon reached the stage where it was ready for application.

On completion of the above mentioned highway bridge over the Mosel in 1972, the method was first tried out in this area and then in the whole of the Kaisersesch Highway (Autobahn) Maintenance Department over a stretch of 60 km and considerable experience was gained (Hahn and Bauer, 1981).

This use of salt was not without its critics—the car industry, for example, because of fears that this would lead to increased corrosion of vehicles. However, criticism did not have any serious effect on the tests, which continued in Rhineland-Palatinate after being justified by the lack of accidents on the highway bridge, as well as the reduction in the number of accidents on the open road.

However, since this method requires an increased initial outlay, e.g., in manufacturing the solution, in acquiring the equipment and in storage, it had to be examined in terms of its economic aspects and effects on the environment and vehicles. Proof was called for by the Federal Ministry for Transport, in particular, which provides Rhineland Palatinate with the means for the upkeep of the highways.

For this reason a committee within the Road Research Association was commissioned with this examination and a favorable result was achieved. (Forschungsgesellschaft für das Strassenwesen, 1979).

## TESTING THE PROCESS

Between 1976 and the spring of 1979, a study group of the Winter Service Working Committee of the Road Research Association (FGSV), Cologne, was present in a professional capacity at the testing of the process by several road maintenance departments and gave its evaluation on it. (Forschungsgesellschaft für das Strassenwesen, 1979). This group was led by the author.

In order to carry out comparable examinations, routes for testing and comparison were set up by three road and seven highway maintenance departments in the German Federal States of Bavaria, North Rhine-Westphalia, Rhineland-Palatinate, and Hessen.

Under certain weather and road conditions (hoar frost, fog precipitation or drizzle with slippery surfaces, water freezing over, acute danger of icy conditions arising from trends in temperature and humidity) damp salt was spread on the test routes. The remaining road maintenance operations were carried out in the conventional manner.

Dry salt was used on the routes to be compared; these were selected so as to be comparable to the test route in terms of topography, climate, traffic and type of road surface.

## SCOPE OF APPLICATION

On the basis of the knowledge acquired in Rhineland-Palatinate, the following system, showing the process to be used in each case, was devised with the object of achieving as uniform a basis as possible within the framework of the experiment. This system has proved advantageous.

| Weather/Road Conditions | Type of Operation |
|---|---|
| snowfall, packed snow ($T < 0°C$) where $0°C = +32°F$ | clearing, salting (dry salt, 20gm/m$^2$) |
| very heavy snowfall ($T < 0°C$) | clearing, salting (dry salt up to 40 gm/m$^2$) |
| slush | |
| ($T > 0°C$, $T' \geq 0$) | clearing |
| ($T \geq 0°C$, $T' < 0$) | clearing, salting (dry salt) |
| hoar frost | damp salt (approx. 10 gm/m$^2$) |
| fog precipitation or drizzle followed by ice | damp salt (10-20 gm/m$^2$, according to thickness of ice) |
| water frozen over, ice | dry salt (NaCl, $CaCl_2$) damp salt, type and quantity of salt according to thickness of ice, temperature, humidity of air and availability of free surface humidity) |
| anticipated ice or hoar frost on dry road | damp salt (approx. 10 gm/m$^2$) |

Note: T = temperature
T' = temporal change in temperature

The aim of this experiment was, apart from obtaining general information, to establish facts with reference to economic viability and road safety in connection with the use of damp salt. To this end, a special plan of work was developed for the experiment which made an evaluation possible.

### *Results*

The study group of the Working Committee of the Road Research Association ascertained the following:

- the existing spreaders give an adequate intermixture and the finest particles of the salt accumulate at the coarse grain
- the salt is distributed homogeneously over the surface of the road
- as little as 10 gm/m$^2$ can be spread, the spreading width being up to 12m
- losses through dispersion can generally be avoided
- the salt adheres to the road and thus it is justifiable to salt as dictated by weather conditions
- thawing begins at once; this means much quicker than with the application of dry salt
- the remainder of the dissolved salt continues to adhere to the texture of the road, thus prolonging the effectiveness of the salting (long-term effect)
- the efficiency remains clearly below $-10°C$ ($+14°F$) (experience shows this to be as low as $-15°C$ ($+5°F$))
- the process is economically viable.

These characteristics of damp salt have led to the conclusion that road safety is increased and damage to the environment reduced, even when less salt is used.

During the relatively long testing period, the equipment for manufacturing the calcium chloride and the devices for spreading damp salt (bulk spreader with liquid additive systems) were also so fully developed that it was possible to consider the economic viability. In addition, the committee in its report has put forward prerequisites for application and given definitions.

## DEFINITION OF DAMP SALT

"Damp salt" is sodium chloride that will be moistened by a salt solution shortly before application (2.8kg NaCl + 1 liter solution). The moistened liquid must be so constituted, both in terms of type and quantity, that the resulting damp salt shows a marked improvement over dry salt with regard to adhesion, and thus exerts a more lasting influence on the road surface. This requirement is fulfilled by using a salt solution, which can be made up using either calcium chloride or sodium chloride.

**Usual Quantities**

| | | $CaCl_2$ (20‰) Brine Solution | | | |
|---|---|---|---|---|---|
| Level | NaCl gm/m$^2$ | cm$^3$/m$^3$ | gm/m$^2$ | NaCl : $CaCl_2$ | NaCl + $CaCl_2$ gm/m$^2$ |
| I | 6,8 | 2,4 | 2,846 | 2,833 : 1 | 9,646 ~ 1o |
| II | 13,6 | 4,8 | 5,692 | 2,833 : 1 | 19,292 ~ 2o |

(See Appendix 1).

## THE SPREADING PROCESS

The salt is dampened only while the vehicle is actually travelling along the stretch or road to be salted, i.e., immediately before being discharged onto the road surface. This

means that the dry NaCl and the calcium chloride solution are either mixed together between the conveyor system and the spinner disc or on the spinner disc itself. During mixing, the larger, coarser granules of the dry NaCl are fully moistened and the fine particles are dissolved. Depending on the speed, the pre-fixed amount is discharged, via the spinner disc (rotor), in the desired spreading width.

*Manufacture of the Calcium Chloride Solution in the Factory Yard*

Due to the hygroscopicity of $CaCl_2$, the solution can be relatively easily manufactured. Freshwater and $CaCl_2$ in solid form (flakes) are placed together in a mixing tank, usually of 3 $m^3$, (e.g., 300 kg flakes together with 1000 litres $H_2O$ give a 20% solution), and mixed by means of a rotary pump. The solution can then be transferred either directly into the solution tank on the vehicle or into a larger storage container.

It is advisable to fill up a larger storage tank of this kind. This type of preparation plant, either semi- or fully automatic, is already offered by the industry.

To ensure that the spreader will be loaded as economically as possible, the preparation plant and storage tanks should actually be arranged in the shed used for the storage of salt or nearby.

Plastic was found to be practical for use in tank pipes and fittings, although galvanized steel pipes and cast iron diaphragm valves have also proved successful. Large storage containers are also an advantage, if the calcium chloride solution is delivered by tanker from a nearby chemical factory.

*Superstructure of the Spreading Vehicle*

The truck must not only be equipped with a bulk spreader with a liquid additive system and a salt container but also with the necessary salt water tank. With a salt/salt water ratio of 2.833:1, a 2000-liter salt water tank is required for a salt container with a capacity of 5 $m^3$ (net weight 6 t NaCl). This salt water tank is arranged either between the spreading salt container and the driver's cab, or beside the salt bunker, or even as an insert tank in the salt bunker.

*The Bulk Spreader*

The bulk spreaders with liquid additive systems, developed from dry salt spreaders, have been technically perfected. It is especially important to have a device which measures out the various amounts of salt with accuracy, when smaller spreading thicknesses are required. There are also additional additive systems, available as units, which can be subsequently fitted to the normal bulk spreader.

The salt water solution is brought into contact with the salt either by

- spraying through a nozzle above the spinner disc
- discharging the solution onto the spinner disc, so that the dry salt falls into the solution tank or
- distribution by means of a spray tube above the salt chute (supply).

The devices are operated from the truck cab by electronic remote control, which allows the change-over from damp to dry salt, or vice versa, to be effected without delay, as well as enabling the spreading thickness and width to be adjusted as desired.

The spinner disc is so protected that the otherwise usual crusting on the rear of the vehicle does not occur; therefore, the maintenance costs will be minimized.

## DISTRIBUTION PATTERN, SPREADING WIDTH AND RADIUS OF OPERATION

Moistening the coarse grains and binding the fine salt makes it possible to apply the thawing salt accurately to the roadway and consequently make considerably better use of it. There is also a considerable improvement in the homogenity of the distribution pattern, and as a result, in the utilization of the thawing salt.

In most cases, 10 gm/$m^2$ or thereabouts is sufficient to prevent or eliminate thin layers of ice.

It is possible to set a higher spreading width than has been usual so far (up to 12m). This means that on wider roads, there is no need for staggered spreading or traveling up and down the same stretch several times.

Right at the start of the large-scale experiment, there was proof that the amount of salt used would be lower

$CaCl_2$-Solution

| Brine Solution % | $H_2O$ l | $CaCl_2$ (77/88%) kg | $CaCl_2$ (Solution) l | Solution (Specific gravity) ge | Freezing point °C | $CaCl_2$ per 1000 l solution kg |
|---|---|---|---|---|---|---|
| 20 | 1000 | 344 | 1.133 | 1.186 | −18,0 | 303 |
| 25 | 1000 | 471 | 1.188 | 1.239 | −29,4 | 397 |
| 30 | 1000 | 627 | 1.256 | 1.295 | −46.0 | 499 |

than with the conventional spreading technique. Generally, i.e., with thin ice, it is advisable to spread the following amount of salt, which is now generally applicable for setting the spreading devices:

Level I (approx. 10 gm damp salt)
6.8 gm NaCl + 2.4 $cm^3$-20% − salt water
(6.8 gm NaCl + 0.86 gm $CaCl_2$ + 1.99 $cm^3$ $H_2O$ = 9.646 gm).

The above quantity is to be doubled in the case of thicker layers of ice, namely, Level II (approx. 20 gm. damp salt)

These vehicles likewise have a greater range than was possible with the spreading process used up to now; at this point consideration is to be given to the following factors:

- smaller amount spread per $m^2$: level I with 10 gm/$m^2$ as compared to 20 gm dry salt
- greater spreading width: 10–12m instead of 6–7.5m, as has been the case up until now.
- limitations of truck-carrying capacity for NaCl because of the additional weight of the salt solution tank (restricted by permitted vehicle weight and license weight).

Previously a range of up to 40 km was possible, using 20 gm/$m^2$ and taking a spreading width of 7.5m, the carrying capacity being 6t, whereas, with the use of damp salt at Level I and a spreading width of 10m, 4.8 t NaCl and 1700 litres salt water solution, the reach can be anything up to 70 km.

## DURATION OF EFFECT AND MEASUREMENT OF REMAINING SALT

It has already been stated that damp salt adheres to the road surface and thawing begins immediately. The assertion can be made that the calcium chloride solution gives the damp salt a certain adhesive quality, resulting in a long-term effect. This can, however, be greatly reduced by the effects of weather, such as rainfall and traffic conditions, such as heavy traffic during the rush hour. By comparisons in the experiment, it was established that the duration of the effectiveness was markedly greater than with the use of dry sodium chloride solution, or with damp salt that had been moistened by a sodium chloride solution. The effectiveness was seen to last for 12 hours and more.

If salting is carried out after especially heavy rush hour traffic has eased off, as far as this is permitted by other conditions, the long-term effect is increased considerably. It must also be added that damp salt was still effective at low temperatures; observations were made at −15°C (+5°F).

## SPREADING IN ACCORDANCE WITH WEATHER CONDITIONS; MEASUREMENT OF REMAINING SALT

A device, which has been calibrated and works on the principle of the electrical resistance of a solution, has been developed, so that chloride remaining off the road surface can be detected (della Faille, 1981). True, research has still not been carried out to find the smallest possible quantity of salt necessary to prevent icy conditions developing, but should the district engineer establish, for example, that there is still 4 gm/$m^2$ on the brow of a hill that is exposed to icy conditions, he can assume that his next salting operation, prompted by falling temperatures or rising humidity, will reach this exposed place in time. Due to the favorable characteristics of damp salt (no loss through wind dispersion; adhesiveness), it has been proved over and over again that salting can be effective in accordance with weather conditions.

## METEOROLOGICAL OBSERVATION AND UNSUCCESSFUL SPREADING

There is simply no justification for prophylactic spreading of dry salt, and indeed this was only used in extreme cases, in particular, at known critical places. However, should careful meteorological observation show that temperatures are approaching 0°C and that, at the same time, the humidity has risen above 80%, it can be assumed with relative certainty that icy conditions will set in during the next half hour or so. Consequently, salting will be effected in response to the demands of this meteorological development. Prerequisites for making a correct prediction of a high percentage of all occurrences of icy conditions, with a high degree of probability are, of course, good training of personnel and careful meteorological observation, as well as a knowledge of the particular and typical microclimatic conditions in the area to be salted. High probability for a correct prognosis of the incidence of icy conditions can be achieved by keeping track not only of prognoses issued by the meteorological office, but also of one's own meteorological data and road conditions and their tendencies, and by having available information about the influence of the weather on road conditions. In order to be able to compile an accurate prognosis for the spreading operation, one requires some measurements of one's own, besides the meteorological prognosis, which for practical purposes is called up just before finishing work in the afternoon. Thus, the following parameters are of significance for the occurrence of icy conditions:

1. air temperature and its tendency
2. air humidity and its tendency
3. road surface temperature and its tendency
4. moisture on road (yes or no)

5. quantity of salt remaining on road
6. type and amount of precipitation
7. steam pressure variation to road
8. air movements
9. road surfacing and construction.

In practice, it is sufficient to know the first 5 parameters.

It is possible to predict the likelihood of the occurrence of icy conditions caused by condensed or sublimed humidity even from thermo-hygrographs, which, for the sake of convenience, are set up in the agency as well as at one or more critical points. A second very common cause of ice is the so-called freezing over of moisture on the road surface. In order to recognize this situation in good time, the parameters—moisture on road and road temperature, including temperature tendency—must be measured or observed. Although it is possible to carry out this temperature measurement and establish whether or not there is moisture on the road using relatively simple aids, the process itself is very involved. In this case, the early warning devices for the occurrence of icy conditions that have been developed in recent years and give in addition an on-the-spot indication of the presence or absence of salt on the road, are of assistance. Even after a short time, the stage is reached where, because of the knowledge gained by observing the connection between the official weather forecasts and meteorological data obtained on one hand, and the incidence of certain icy conditions and possible unsuccessful saltings on the other, the probability of salting operations being initiated at the right time will be high. The term "spreading in accordance with weather conditions" is generally used to describe operations based on this principle. If an excess of unsuccessful or even unnecessary saltings can be avoided by careful meteoreological observation, spreading operations, because of the special characteristics of damp salt, are both possible and practical in cases where there is the possibility of icy conditions occurring.

(See Appendix 2).

## TRAFFIC SAFETY

From large-scale experiments as well as other observations, there are unfortunately not sufficient data available so that definite assertions can be made. It can, however, be stated that the damp salt method was first introduced where critical places, such as bridges or accident black spots, had to be dealt with. From the very definite results obtained, for example, in the highway triangle at Dernbach near Koblenz, it can be stated quite positively that a marked increase in traffic safety has been recorded.

During the winter 1976/77, it was revealed that a series of complaints had been made about the lack of braking power with double disc brakes. The use of the "new thawing agent" was considered as a possible cause for the reduced efficiency of the brakes. Despite the fact that this type of defect also occurred in Berlin, where calcium chloride had not been used and that for the rest, the use of sodium chloride and calcium chloride was not at all new, the large-scale experiments with damp salt were suspended, pending clarification of the situation regarding the effect of calcium chloride on brakes.

An investigation carried out by the Federal Institute of Transport (Bundesanstalt für Strassenwesen, 1977) produced the following results:

On exposure to water, thawing salt solutions or thawing salt, disc brakes temporarily lose some of their braking power. An unexpectedly high increase in braking distance (37-615%) resulted merely from splashing with water. In general, salt solutions bring about an additional increase in the braking distance. Of course, a greater difference in braking distance results from using the same salt solution on various brake liners than from treating the individual brake liners with different salt solutions.

With the brake liners examined, no significant difference was found between the effect of NaCl and that of mixed salt on the braking distance.

## ECONOMIC VIABILITY

A comparison of salting operations using 20 gm of dry salt and those using 10 gm damp salt shows a saving of approximately 35% in quantity and 20% in costs.

The additional costs for the preparation of damp salt, including the depreciation of the equipment and allowing for the cost of the bulk spreader with liquid additive system, amount to approximately DM 5.000.00 (2500 Can. $) in one road maintenance department. Set against this is a saving in vehicles and staff as a result of the greater range when damp salt is used. This is estimated to be at least DM 250.00 (125 Can. $) for one spreading operation on a stretch of road 225 km in length.

The proportion of spreading operations involving damp salt, as compared to the total number of operations, varies greatly from place to place and will work out at up to 50% in each case.

For this reason the figures, which were obtained in large-scale experiments in Germany and show notable savings, are not given. However, it can be generally stated that, in any case, the process is economically viable.

## SUMMARY

Due to the necessity of preventing dry salt from being blown from the road and to initiate the thawing process more quickly, development of the damp salt method has been taking place in the Highway Maintenance Department of Kaisersesch, near Koblenz, since about 1972.

Meanwhile, damp salt spreading has been introduced on a general scale in Germany and even used on airfields.

It is rated as a valuable supplement to the conventional methods of snow and ice control.

This method can be used in all instances of icy conditions, either at Level I, whereby 6.8 gm NaCl + 2.4 $cm^3$ $CaCl_2$ solution (20%) is discharged or at Level II, whereby double this amount is discharged.

Because losses through wind dispersion are eliminated and the mixture possesses a certain adhesive quality on the road surface, it is possible to effect a preventive operation in accordance with weather conditions, should careful meteorological observation point to this being necessary. Moreover, the adhesion of the salt to the road means that the salting operation has a long-term effect.

A measuring device, which can determine quickly the amount of salt remaining on the road, has already been developed for the evaluation of this long-term effect and of the condition of the road, respectively. In addition, early warning devices for ice can be used to assess the condition of the road as well as to supplement meteorological observation, in order to reach a decision concerning damp salt spreading operations.

The industry has also already brought various products onto the market such as preparation plants, vehicles with salt solution tanks and bulk spreaders with liquid additive systems.

The process is economically viable.

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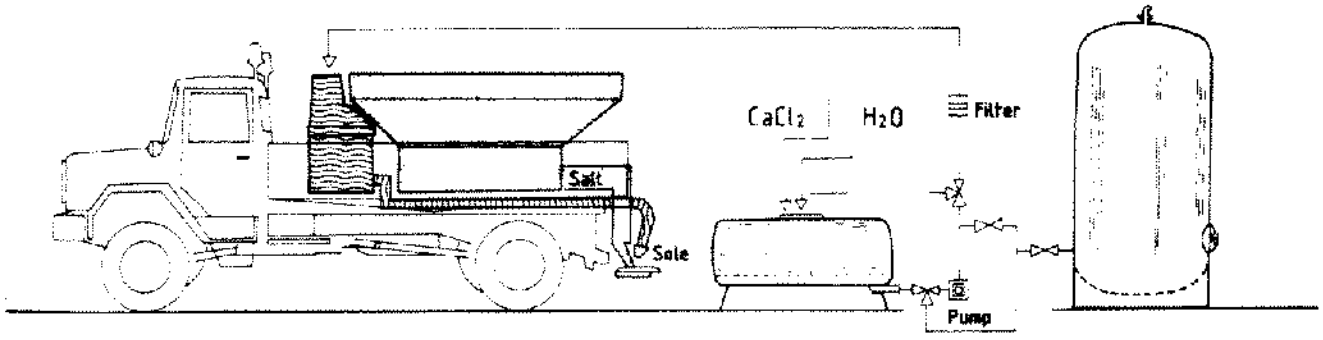
APPENDIX 1

## SKETCH OF A DAMP SALT PLANT



## APPENDIX 2

*Recommendations for use of damp salt*

| Weather, Road Conditions | Measures taken for control of winter conditions |
|---|---|
| 1. huar frost, frost (on dry road surfaces) | damp salt level I in acc. with weather conditions |
| 2. water (rozen over, ice | When possible before the wet road freezes (acc. to weather conditions) use dry salt NaCl (also damp salt, but thinning can occur). The amount of the salt respectively salt level is dependent on the thickness of the ice layer and the weather (free humidity, temperature) |
| 3. fog precipitation rain on undercooled roads frozen roads due to fog | if it can be determined that no salt remains, where possible, acc. to weather conditions use damp salt level I. |
| 4. drizzle or rain on undercooled roads: ice | where possible before setting in of precipitation (acc. to weather conditions) use damp salt level I. According to ice thickness a second salting with level I or II. |
| 5. snow fall (T = 0° to −7°C) (T = +32°F to *19°F) | clearing salting and clear width with dry salt NaCl—quantity according to amount of snowfall |
| 6. snow fall (T — 7°C (−19°F)) | clearing salting and clear width with NaCl and $CaCl_2$ flakes or damp salt level I or II according to amount of snowfall. |
| 7. Packed snow (becoming ice, particularly at lower temperatures) | damp salt level II or additional salting with dry salt NaCl and/or $CaCl_2$. |