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(54) **SOLUTION DE DEGLACAGE**
(54) **DEICING SOLUTION**

(57) A de-icing composition in the form of an aqueous solution which contains a film forming agent and a freezing point depressant. The film forming agent comprises a material selected from the group consisting of colloids, emulsions and mixtures thereof, and the freezing point depressant includes a suitable inorganic or organic material.

Abstract:

A de-icing composition in the form of an aqueous solution which contains a film forming agent and a freezing point depressant. The film forming agent comprises a material selected from the group consisting of colloids, emulsions and mixtures thereof, and the freezing point depressant includes a suitable inorganic or organic material.

DEICING SOLUTION

Background of the Invention

The current state of the art for coping with snow and ice on roads usually involves applying a deicer material such as a salt to the road surface. Sometimes antiskid materials such as sand or other aggregates such as gravel are added with or without a salt.

The use of salt and salt containing compositions having high concentrations of salt, cause an undesirable corrosive effect on vehicles, the road surface, and the environment with respect to the run off of water containing salt which contaminates the surrounding land and water.

Considering the above problems associated with the addition of salt formulations, there has been a continuing need for a deicing composition or formulation which can effectively melt snow and ice yet which reduces the corrosion and environmental contamination referred to above. In response to the above problems associated with the use of road salt, the prior art has looked to alternative formulations which are less corrosive and more environmentally friendly.

U.S. Patent 5,635,101 (Janke et al.) relates to a deicing composition containing a by-product of a wet milling process of shelled corn. Corn kernels are steeped or soaked in a hot solution containing small amounts of sulfurous acid. The corn kernels are separated from the steep water and steep water solubles are used in the production of a deicing composition.

U.S. Patent 4,676,918 (Toth et al.) relates to a deicing composition which comprises a mixture containing at least one component selected from a number of chlorides or urea and an admixture of waste concentrate of alcohol distilling that has a dry substance content of from 200 to 750 g/kg and from 10% to 80% by weight of water.

Both Janke et al. and Toth et al. materials are naturally occurring substances with hundreds (if not thousands) of components such as complex carbo-hydrates, starches, sugars, proteins etc. and are normally used with a salt. These materials essentially immobilize the salt by either forming a dry film, or at low temperatures, an adhesive, sticky layer due to the resulting large increase in viscosity.

The above de-icing solutions now being introduced in the field employ agricultural residues e.g., corn based distillers solubles, brewers condensed solubles and solubles from the corn wet milling industries steep water. These naturally occurring substances are extremely variable in composition, viscosity, film forming tendency, freezing temperature, pH etc., and consequently give varying performance when used in de-icing solutions. Depending upon the source and batch, these materials at low temperatures sometimes exhibit such resistance to flow that they cannot be effectively applied evenly to a road surface, rendering them virtually unsuitable for use.

To improve quality and performance, and to meet current mandated standards, there is an immediate need for synthetic, chemically modified and naturally occurring film formers, and carefully purified naturally occurring materials for freezing point depressants, which can be substituted for the currently used agricultural residues. Such a formulation would improve performance and reduce metal corrosion, spalling of concrete, toxicity and overcome environmental concerns.

It is therefore an object of the present invention to provide a deicing formulation which exhibits improved performance standards which overcomes the prior art problems described above.

It is a further object of the present invention to provide a deicing formulation which provide consistent physical and chemical properties and exhibit less corrosion.

It is another object of the present invention to provide an economical, highly effective deicing formulation.

Summary of the Invention

The present invention is based upon the discovery that the use of a combination of three key components in a deicing formulation overcomes the problems of the prior art described above. The three components comprise a

freezing point depressant, film former and water. These film formers are water soluble and water resoluble, and preferably comprise colloidal or emulsion materials dissolved in water. The freezing point depressants 'melt' the ice and snow and keep the resulting ice/snow/de-icer/ water layer liquid down to known (and defined) lower temperature limits, aiding removal and improving road safety. The film former immobilizes the freezing point depressant onto the road surface (preventing run-off), improves efficiency of ice melting, and can reduce metal corrosion down to acceptable levels. The freezing point depressants include conventional salts and selected organic materials used alone or in admixture.

Detailed Description of the Invention

The present invention relates to a deicing formulation which includes as its key components a freezing point depressant, a film former and water. The freezing point depressant may comprise any suitable inorganic or organic material and mixtures thereof. Suitable materials includes chlorides such as NaCl, $CaCl_2$, $MgCl_2$, and KCl. Also included are sodium acetate, potassium acetate, and calcium magnesium acetate. Suitable organic substances include urea and urea derivatives, glycerols, glycols, sugars (hexoses, saccharides), citric acid, lactic acid, primary alcohols, secondary alcohols, tertiary alcohols, glycol-ethers. Generally the freezing point depressant is present in the concentration of about 5 to 30 wt. % of the formulation depending upon the temperature demands dictated by the region in which the formulation is used.

The film former of the present invention comprises any suitable water soluble or water resoluble material, and preferably comprises colloidal and/or emulsion materials which are dissolved and/or dispersed in water. A group of suitable film formers for use in the present invention comprise:

- cellulosic derivatives e.g. sodium carboxy methyl cellulose, methyl cellulose, hydroxy ethyl cellulose, hydroxy propyl cellulose, hydroxy ethyl cellulose, hydroxy propyl methyl cellulose.
- polyvinyl alcohol and copolymers
- polyvinyl acetate and copolymer emulsions
- styrene - butadiene emulsions

- urea/formaldehyde and melamine/formaldehyde condensates
- polyacrylates and copolymer emulsions
- modified polysaccharides (ethylene oxide or propylene oxide)
- xanthan gums
- polyesters e.g. water soluble alkyds
- maleic anhydride modified resins and oils
- starches, starch ethers, dextrins
- alginates
- natural gums e.g. gum acacia, seaweed extracts
- caseins, zeins and derivatives.

The above materials can be used alone or in admixture

These film formers are selected to provide predictable performance and consistent properties from batch to batch which are presently not available with prior art formulations. They provide a predictable viscosity, film forming tendency, pH, and freezing point which allow them to be tailor made for particular applications which address the severity of weather conditions and type of road surface being treated. The organic film formers also act to depress the freezing point although they are not as efficient as inorganic salts.

A freezing point depressant melts the ice and snow keeping the resulting ice/snow/deicer/water layer liquid down to predetermined lower temperature limits, aids in clearing the road surface and provides for improved road safety conditions. The film former immobilizes the freezing point depressant onto the road surface thus preventing run-off. It is itself a freezing point depressant and so further improves the efficiency of ice melting and aids in the reduction of metal corrosion up to an acceptable level not attainable with present deicing formulations.

Table 1 below illustrates a typical operating range of formulations falling within the present invention along with typical pH and viscosity values.

Table 1	
	% by weight
Thickener/Colloid/emulsion (solids)	0.15 to 30
Salt and/or freezing point depressant	5 to 30
Water	40 to 90
pH	5 to 9
Viscosity	0.1 to 3 poises at 25°C (77°F)

An optional additive which may be used with the composition of the present invention includes a non-ionic and/or anionic surfactant in a concentration of about 0.2 to 2.0 wt %. The non-ionic surfactant should have a hydrophilic lipophilic balance (HLB) value of about 2 to 10. The surfactant functions to reduce the surface tension which enables penetration of the formulation into the snow/ice matrix and promotes wetting of the road surface under the snow/ice layer. Any surfactant which can accomplish the above objectives may be used. Suitable surfactants include:

The non-ionic surfactants typically comprise ethylene oxide condensates and include polyoxyethylene alcohols, phenols, acids and esters. Many products are available under the following designations:

Trade Names	Source
Plurafac, Pluronic, Chemal	B.A.S.F.
Ethonic	Ethyl Corp.
Igepal	GAF Corp.
Merpol	DuPont
Chemax, Ethofat	Akzo
Macol	PPG/Mazer

Anionic surfactants are usually sodium salts of various organic sulfonates and sulfates such as Na salts of alkyl aryl sulfonates, alkyl naphthalene sulfonate,

di-octyl sulfosuccinate, lauryl sulfate, saturated hydrocarbon sulfonate, dodecyl sulfonate, etc.

Many products are available under the following designations:

Trade Names	Source
Alkanol, Perrowet, Duponol	DuPont
Nekal, Igepon	GAF Chemicals
Karawet	Colloids Inc.
Stepanol	Stepan Co.
Astrowet	Alco Chem. Co.

The eutectic freezing point for a water solution containing three typical salts which can be used as the freezing point depressant are as listed in Table 2 below.

Table 2

Salt	% Concentration	Freezing Point Temperature °F
NaCl	23	- 6
$MgCl_2$	21.6	- 27
$CaCl_2$	29.5	- 60

As can be seen from the above, $CaCl_2$ will allow melting down to - 60°F but requires a high concentration to achieve this temperature. $MgCl_2$ will allow melting down to - 27°F with a lower concentration of 21.6%. Therefore, the selection of a particular salt will depend to a large extent upon the contemplated winter temperature range of use for a given geographical region.

Table 3 below dramatically illustrates the wide variance in freezing points for the concentration range of $MgCl_2$ from 0 to 30%. As can be seen from the table, concentrations over 22% do not result in a lowering of the freezing point. Other salts e.g., $CaCl_2$, act in the same way.

Table 3

% by Weight of $MgCl_2$	Specific Gravity	Freezing Point °F
0	1.000	+32
5	1.013	+26.4
10	1.086	+17.9
15	1.132	+4.0
20	1.180	-17.2
21	1.190	-23.0
22	1.200	-27.0
23	1.210	-20.0
24	1.220	-14
25	1.230	-10
26	1.241	-6
27	1.251	-3
28	1.262	-1
30	1.283	+3

The following examples (Table 4) represent specific embodiments of the present invention illustrating ten different colloid thickeners with freezing points varying from about 6.4 to -17.1°F (-16.4 to -27.3°C). Note that for the same concentrations of $MgCl_2$ the formulations of examples 1-10 exhibit a lower freezing point than an aqueous solution of $MgCl_2$ alone (Example 11).

TABLE 4

Ex. #	Colloid Thickener	Trade Name	Concen.of Thickener % by Weight *	Mg Chloride % by Wght *	Viscosity Ford Cup No. 4 (Sec.)	Freezing Point °C	Freezing Point °F
1	Carboxy Methyl Cellulose	Methocel A	1.0	15.0	17	-16.4	+2.5
2	Hydroy Ethyl Cellulose	Natrosol 250 HHR	0.33	15.0	18	-17.1	+1.2
3	Hydroxy Propyl Methyl Cellulose	Methocel K 15 M	0.40	12.45	16	-21.5	-6.7
4	Dextrin	-	5.04	15.0	12	-20.4	-4.7
5	Maltodextrin	Maltodextrin No. 5	5.04	15.0	13	-20.4	-4.7
6	Gum Arabic	-	3.60	15.0	11	-18.8	-1.8
7	Alginic Acid	Airvol 325	2.7	15.0	17	-14.2	+6.4
8	Molasses	-	18.8	14.9	13	-24.9	-12.8
9	Maltodextrin	Maltodextrin No. 15	9.1	15.0	11	-27.3	-17.1
10	Gum Tragacanth	Tragacanth 470	0.2	15.0	14	-19.6	-3.3
11	None Aqueous Magnesium Chloride Reference Solution	-	None	15.0	-	-15.9	+3.4

*Balance = Water

Certain chlorides such as NaCl cause an undesirable spalling of concrete where repeated freezing/thawing occurs. Another harmful effect of salts is the corrosion of steel reinforcing rods imbedded in the concrete which results in severe shear cracking eventually resulting in localized failure in road surfaces, bridge decks, parking lot and garage surfaces.

Other additives may optionally be used with the formulation of the present invention. These additives include without limitation, corrosion inhibitors; coloring agents which aid road crews in determining where they have sprayed and antifoaming compounds should foaming be a problem.

After selecting the desired film forming material for a given application, there are two additional variables to consider. One is the temperature range of use under consideration, and the second is the type of freezing depressant used. Formulations of the present invention may be tailored for specific temperature ranges such as:

20°F to 32°F

10°F to 20°F

0°F to 10°F

- 10°F to 0°F

Some applications dictate the use of NaCl, some $CaCl_2$, and some $MgCl_2$ and in some cases calcium magnesium acetate. For example, corrosion can be controlled by reducing or eliminating the chloride ion concentration, and replacing it with a non chloride depressant such as calcium magnesium acetate.

The present invention provides for deicing formulations which effectively melt snow and ice and which reduce corrosion and provide consistent performance specifications from batch to batch.

While the present invention has been particularly shown and described with reference to the preferred mode as illustrated in the drawing, it will be understood by one skilled in the art that various changes in detail may be effected therein without departing from the spirit and scope of the invention as defined by the claims.

CLAIMS:

1. A de-icing composition which comprises an aqueous solution which contains a film forming agent and a freezing point depressant.

2. The composition of claim 1. is in which film forming agent comprises a material selected from the group consisting of colloids, emulsions and mixtures thereof.

3. The composition of claim 2 in which the freezing point depressant comprises a salt.

4. The composition of claim 2 in which the freezing point depressant comprises a material selected from a group consisting of chlorides and acetates.

5. The composition of claim 2 in which the freezing point depressant comprises a material selected from the group consisting of urea, urea derivatives, , glycerols, glycols, sugars, citric acid, lactic acid, primary alcohols, secondary alcohols, tertiary alcohols, glycolethers and mixtures thereof.

6. A de-icing composition comprising an aqueous solution which contain a film forming agent in the form of a colloid or emulsion or mixtures thereof, and a freezing point depressant in the form of a salt in which the constituents are present in the following concentration:

	Weight %
Thickener/Colloid/Emulsion	0.15 to 30
Salt	5 to 30
Water	40 to 90

7. A de-icing composition which comprises an aqueous solution which contains a film forming agent and a freezing point depressant in which the film forming agent comprises a material selected from the group consisting of colloids, emulsions and mixtures thereof, and where the freezing point depressant comprises a salt.

8. The composition of claim 7 in which the freezing point depressant comprises a material selected from a group consisting of chlorides and acetates.

9. The composition of claim 7 in which the freezing point depressant comprises a material selected from the group consisting of urea, urea derivatives, glycerols, glycols, sugars, citric acid, lactic acid, primary alcohols, secondary alcohols, tertiary alcohols, glycolethers and mixtures thereof.

10. A de-icing composition comprising an aqueous solution which contain a film forming agent in the form of a colloid or emulsion or mixtures thereof, and a freezing point depressant selected from the group consisting of chlorides and acetates in which the constituents are present in the following concentration:

	Weight %
Thickener/Colloid/Emulsion	0.15 to 30
Freezing Point Depressant	5 to 30
Water	Balance

11. The composition of claim 10 in which the film forming agent is at least one material selected from the group consisting of:

- cellulose derivatives;
- polyvinyl alcohol and copolymers;
- polyvinyl acetate and polymer emulsions;
- styrene- butadiene emulsions;
- urea/formaldehyde and melamine/formaldehyde condensates;
- polyacrylates and copolymer emulsions;
- modified polysaccharides (ethylene oxide or proylene oxide);
- xanthan gums;

- polyesters e.g. water soluble alkyds;
- maleic anhydride modified resins and oils;
- starches, starch ethers, dextrins;
- alginates;
- natural gums e.g. gum acacia, seaweed extracts; and
- caseins, zeins and derivatives.

12. A de-icing composition which comprises an aqueous solution which contains a film forming agent and a freezing point depressant in which the film forming agent comprises a material selected from the group consisting of colloids, emulsions and mixtures thereof, and where the freezing point depressant comprises a salt, said composition having a viscosity in the range of about 0.1 to 3 poises at 25°C.

13. The composition of claim 12 which further includes a non-ionic and/or anionic surfactant in a concentration of about 0.2 to 2.0 wt. %.

14. The composition of claim 12 in which the freezing point depressant comprises a material selected from the group consisting of urea, urea derivatives, glycerols, glycols, sugars, citric acid, lactic acid, primary alcohols, secondary alcohols, tertiary alcohols, glycolethers and mixtures thereof.

15. A de-icing composition comprising an aqueous solution which contain a film forming agent in the form of a colloid or emulsion or mixtures thereof, a surfactant and a freezing point depressant selected from the group consisting of chlorides and acetates in which the constituents are present in the following concentration:

	Weight %
Thickener/Colloid/Emulsion	0.15 to 30
Freezing Point Depressant	5 to 30
Surfactant	0.2 to 2
Water	Balance

16. A de-icing composition comprising an aqueous solution which contain a film forming agent in the form of a colloid or emulsion or mixtures thereof, and a freezing point depressant selected from the group consisting of chlorides and acetates in which the concentration of the constituents and properties are as follows:

Component	**Weight %**
Thickener/Colloid/Emulsion	0.15 to 30
Freezing Point Depressant	5 to 30
Water	Balance

Property	
Viscosity	0.1 to 3 poises (at 25°C)
pH	5 - 9

17. A method for inhibiting the accumulation of freezing precipitation on a surface which comprises applying an aqueous solution which contains a film forming agent and a freezing point depressant to said surface, wherein said solution has a viscosity of about 0.1 to 3 poises at 25°C.

18. The method of claim 17 in which the film forming agent contains a colloid or an emulsion and mixtures thereof.

19. The method of claim 18 in which the freezing point depressant includes a salt.

20. The method of claim 17 in which the surface comprises a roadway, bridge, parking garage or parking lot.

21. A method for inhibiting the accumulation of freezing precipitation on a surface which comprises applying to said surface an aqueous solution which

contains a film forming agent selected from the group consisting of a colloid or an emulsion and mixtures thereof, a surfactant and a freezing point depressant.

22. The method of claim 21 in which the freezing point depressant comprises a salt.

23. The method of claim 21 in which the surface comprises a roadway, bridge, parking garage or parking lot.