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Comparing common de-icing products

1 Introduction

De-icers are substances that are used to melt ice and they work by changing the point at which water freezes i.e. while the normal freezing point of pure water is 0°C, water containing a deicer may freeze at a considerably lower temperature. Sodium Chloride or rock salt as it is commonly known is the most widely used chemical de-icer in the UK however different de-icers affect the freezing point differently. This is therefore an important consideration when choosing a deicer for regions where temperatures get particularly low. In addition to the freezing point, the speed at which water freezes is has to be considered, for example, a deicer which lowers the freezing point 10°C but takes ten minutes to achieve this result may not be as useful as one that lowers it only 5°C but does so instantaneously. Besides the important scientific considerations of deicing, the fact that it is used on such a large scale makes cost a very important consideration, while equally important will be consideration of the environmental consequences of the deicing chemical chosen.

This paper will provide an overview of the most widely used deicers and compare them based on the following parameters:

- Their Properties i.e. the point and speed at which they freeze water;
- The relative cost; and
- Their environmental impact;

2 De-icers

De-icers are categorised in terms of their active ingredient, for example, chloride or acetate. Chloride de-icers are the most commonly used in the UK while non-chloride de-icers [which are more expensive], like acetate are used in situations when corrosion of steel of steel is a more of a concern than cost, like for example, on bridges or in Airports. Table one compares the costs of commonly used chloride based de-icers to acetates. The increase in pound per tonne between the chloride and acetates is enormous but what is also apparent is that the cost difference between sodium and magnesium chloride (9 times) is also significant. In 2009-10 it is estimated that 2.2 million tonnes of salt were used in England,[1] based on the costs provided in table 2 this would have cost £55 million; if magnesium chloride had been used instead this cost, would rise to £396 million.

Table 1: Comparing the costs of de-icers

De-icer Chemical name	De-icer Market name	£/tonne	Cost in Pence (10 m^2/24h)	
			Anti-icing	De-icing
Sodium Chloride	Rock Salt	25	0.3	1.0
	Safecote treated rock salt	35	0.4	1.4
Magnesium Chloride	Ice Ban	180	4.5	9.0
Calcium Magnesium Acetate	CMA 40	600	12.0	24.0
Sodium Acetate	NAAC	1400	35.0	70.0

Source: Reeves, et al (2005)

Sodium Chloride v Magnesium Chloride

Sodium chloride is the most commonly used de-icer in the UK. Its predominant form is rock salt which is cheap and readily available. Sodium chloride can also be applied in solution as brine or pre-wetted to decrease the time it takes to activate while this can also make it adhere to the surface better. Sodium chloride is an effective de-icer down to -7°C and non-toxic to humans however it is harmful to vegetation and corrosive to steal, aluminium and concrete. Magnesium Chloride is more commonly used in the USA because it has a lower effective temperature (-15°C) however, it has the same corrosive properties as sodium chloride and is also damaging to vegetation.[2]

Magnesium chloride comes in liquid form as well as solid, however, liquids are most suitable for anti-icing as they do not penetrate already lying snow and ice as effectively as solids. In addition to this, liquids require spray equipment to apply the products, and while this reduces the risk of the salt blowing away, treated surfaces can potentially become slippery.[3] Based on this, Magnesium Chloride cannot be considered as a replacement for sodium chloride, in most UK regions.

[1] DfT (2010)"*The Resilience of England's Transport Systems in Winter*" [online] available from: http://nia1.me/5f

[2] Reeves, J. Evans, M., and Burtwell, M. (2005) *"Evaluation of frost, ice and snow precautions at stations".* Transport Research Laboratory for Rail Safety and Standards Board

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A different perspective: Canada

Given the degree of extreme winter weather experienced in Canada each year, much research is carried out into alternatives to traditional salting. However, rock salt (sodium chloride) remains the most used product[4] with Environment Canada estimating that on average, 5 million tonnes are used each year as de-icers. Due to concerns about the large quantities of chlorides being released into the environment, considerable research into alternatives has taken place. An example of this is calcium magnesium acetate (CMA) which while environmentally friendly, needs to be used in conjunction with ploughing to be effective. In addition, the cost of CMA is significantly higher than that of road salts as appears the case with all other products.

Rather than ban the use of road salt the Canadian Government, through the *Canadian Environmental Protection Act, 1999*, published a Code of Practice designed to help municipalities and other road authorities better manage their use of road salts as it remains the most viable option, based not least, on cost. The code of practice therefore identifies ways in which to reduce the harm caused to the environment while maintaining road safety. One of the recommendations for best practice include:[5] Expanding the use of 'pre-wetted' salt. Pre-wetting salt involves adding a small amount of liquid de-icier to road salt as it is placed on the road. Pre-wetted salt stays on the road better and works faster than dry salt. There is also potential here for the magnesium and sodium chlorides to be mixed changing the active temperature and reducing costs.

Summary

Chloride based de-icers; particularly sodium chloride (rock salt) remains the most widely used form of de-icer, in both the UK and North America. This can be replaced by Magnesium Chloride in areas where temperatures fall below -7°C although this is uncommon in most parts of the UK. Both these products have similar effects on the environment impacting mainly on vegetation, as they share the same active ingredient (chloride), however, magnesium chloride is significantly more expensive. It would appear based on this evidence that the widespread use of sodium chloride will continue although there is clearly a place for a policy regarding the use of Magnesium Chloride as a back up in times of extreme cold weather. It would also appear, based on the Canadian experience that the potential exists for mixing sodium chloride and magnesium chloride, thereby changing the active temperature, which may provide an economical solution.

[4] Transport Association of Canada (2003)" SYNTHESES OF BEST PRACTICES ROAD SALT MANAGEMENT" [online] available from: http://nia1.me/5g

[5] Ministry of Transportation Ontario (2010) "Road Salt Management" [online] available from: http://nia1.me/5h