Product development
A 21 and A22

Final report

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Content

1. Background

Nordisk Aluminat A/S became a partner in the EU Life project CMA+ in February 2010. We have produced calcium magnesium acetate (CMA) since 2001.

Two of the action point, which Nordisk Aluminat A/S is responsible for in the project, is to improve the CMA product with focus on slickness and de-icing.

Nordisk Aluminat A/S wrote a status report in December 2010. This is the final report regarding action point A21 “Product development with focus on slickness” and A22 “Product development with focus on de-icing”.

2. Product development with focus on slickness and de-icing

Nordisk Aluminat started the development of CMA (calcium magnesium acetate) in 1996 together with the Technical University in Odense (Ingeniørhøjskolen Odense Teknikum). The product was optimized to get the highest melting capacity and the lowest freezing point. Therefore the CMA used for this project can not obtain better de-icing properties.

It has not been possible to find any literature about how to minimize slickness on the road caused by CMA or other de-icers/dust-binders. The ratio between Ca and Mg might influence, but the ratio has been optimized according to de-icing properties, therefore we did not want to change that. We decided to improved the de-icing properties first and the see how it influent on the other properties.

When the CMA could not obtain better de-icing properties as a pure calcium magnesium acetate solution we had to add something else to create a better product. Therefore we decided to look for an other de-icer to mix with CMA to improve the product regarding de-icing effect and then afterwards measure friction on the road and dust binding properties to find out if this properties had increased or not.

Unfortunately it is not possible to find a substance which is good at every thing… Sodium chloride has the best melting capacity, but it is corrosive and harms the nature. Potassium formiate has a low freezing point, but the melting capacity is not as good as sodium chloride. Formiates and acetates do not harm the nature. All substance with calcium and magnesium is good for dust-binding because they are hydroscopic. Sodium and potassium is also hydroscopic, but the dust-binding properties are not known.

	Not so good properties	**Good properties**
De-icing	potassium acetate	sodium formiate
Dust-binding	?	magnesium + calcium
Friction	?	formiate ?
Environment	acetate sodium	formiate magnesium + calcium
Corrosion	chloride	acetate + formiate (with corrosion inhibitor)?

Fig. Properties of different kinds of de-icers.

We decided to add potassium formiate to CMA to produce a new and better de-icer.

3. Mix of CMA and KF

Potassium formiate (KF) is produced by chemical reaction with formic acid and potassium hydroxide. Water is added to get the required concentration. A corrosion inhibitor is also necessary.

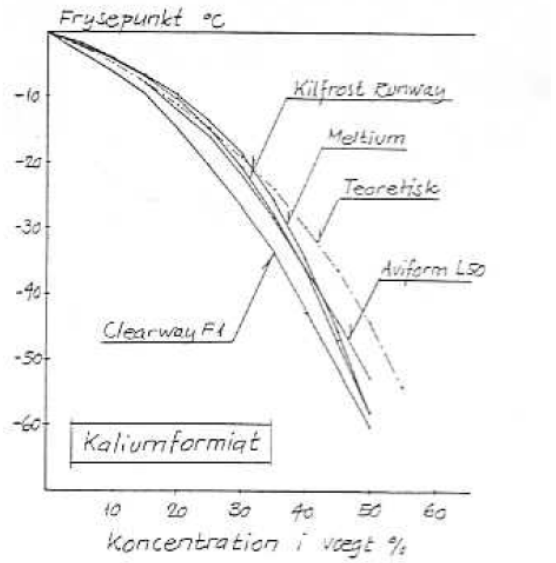
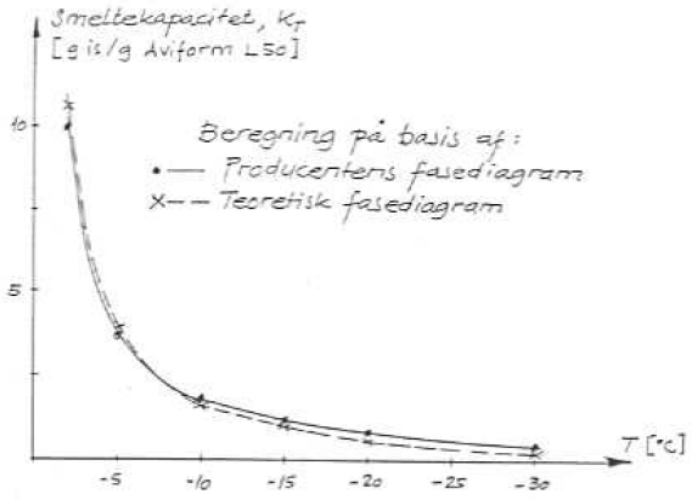


Fig. Freezing point for different potassium formiate (from the Danish report "Alternative de-icers", Carl Bro)



Melting capacity for Aviform (50 % potassium formiate)

First we looked at the other KF-products on the marked. Then we decided to produce a 50 w/w % potassium formiate. Tests were done in the lab and afterwards in a pilot plant (app. 1 ton). One full scale production has been made.

Picture: Tank for production of CMA and KF

Analysis of 50 % potassium formiate (50 % KF):

pH =	8.8 ± 0.5
Density =	1.3 kg/litre
Freezing point =	< - 50 °C

De-icing
The freezing point for the new product is between the freezing point for the pure CMA which is -19 °C and the pure KF which is -50 °C. The more KF we add – the lower freezing point we get.

We have not jet decided the ratio between CMA and KF. The first test is for a mixture of 90 w/w % CMA and 10 w/w % KF. The freezing point only decrease with 2 °C to approximate -21 °C.

Dust-binding
VTI in Sweden (partner in the CMA+ project) has also tested the dust-binding properties of the mixture of 90 w/w % CMA and 10 w/w % KF. In there report "Road Simulator Tests, Evaluation of new dust binder application method" from the 21.12.2010 they wrote: The mixing of CMA and potassium formate seems to prolong the duration of the effect. This is only one experiment and also the first using CMA from Nordisk Aluminat. More tests are needed to confirm that the prolonged effect can be attributed to the formate admixture.

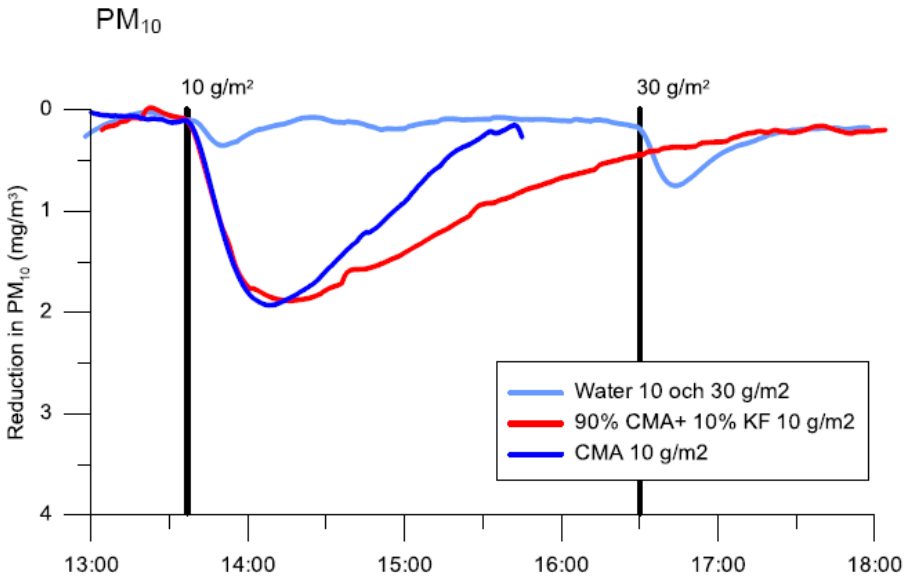


Fig. Time series of the reduction in concentration in the road simulator during 3 different tests; 10 g/m2 CMA, 10 and 30 g/m2 water and 10 g/m2 CMA with 10 % potassium formate. N.B.: The curves are shifted to start at the same level and time / *VTI*

The first results look like KF can give the new product some better dust-binding properties. We would like to do some more tests to be sure that KF has a prolonged effect. We would also like to use different concentrations of KF (10 %, 25 % and 50 % KF in CMA) in order to find the right mix.

Slickness
ÖAMTC in Austria has tested CMA in order to find out how much product is it safe to use on the road. In Austria you are alloyed to use 10 g 25 % CMA/m^2. In March 2011 ÖAMTC has tested the new product.

We tested tree different mixtures plus pure CMA and pure KF:

Test	Concentration (KF/CMA)	Deterioration in friction rating
1	100 % CMA	App. 20 %
2	10 % KF + 90 % CMA	App. 18 %
3	25 % KF + 75 % CMA	App. 16 %
4	50 % KF + 50 % CMA	App. 12 %
5	100 % KF	App. 17 %

Fig. Summary from the report "Fahrversuch FSZ Kärnten, 1.-4. März 2011"

It looks like KF can improve the friction rating. All measurements were done just after application. The friction rate became significant better after some time. The temperature is an important factor for how fast is goes. All the results are descript in the report from ÖAMTC "Fahrversuch FSZ Kärnten, 1.-4. März 2011".

Environment

Impact on the environment is not a part of this project – but it is still an important factor when you want to improve a product. We have a lot of data regarding CMA because our product has licence to the Nordic eco-label called "Svanen" (the swan). One of the KF-products, Aviform L50, also has this eco-label (only these two products have the label).

The City of Copenhagen has, in corporation with the University of Copenhagen, "Forest & Landscape", a project going on regarding KF. Until now they have find out that too much KF in the soil can be a problem – just like NaCl, because K or Na "takes the place" from the other ions in the soil. Lars Bo Pedersen from "Forest & Landscape" thinks that a new product with a mix of CMA and KF is much better for the environment. We hope that he or the City of Copenhagen gets an opportunity to test the impact on the environment.

Corrosion

Corrosion properties are also not a part of this project – but sill very important. Wuppertal Institute has made a LCA on CMA as a part of CMA+. They have compared corrosion caused by chloride, acetate and formiate as a part of LCA. The report is not finish jet.

4. Conclusions

All the tests done so fare have shown that our CMA-product can be improved by adding KF. The only negative thing abort KF is the production price! The cost of KF is almost four times as much as the cost of CMA.

Even with CMA it is difficult to compete with road salt (NaCl) because it is very cheap. An increase in price will only make it more difficult.

We hope that it is possible to do some full scale tests next winter with different mixtures of CMA and KF to determine if there is a big different in “real life”.

Even though we have made one full scale production we do not have store capacity for the new raw materials and new product(s) at the moment. It means that it will take some time to get the production started.

/TKO, Nordisk Aluminat A/S, Denmark