An effective and simple anti-corrosive additive to deicing salts

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1. INTRODUCTION

Rock salt (sodium chloride) is the main deicer to ensure winter road safety in Lithuania. It is known that sodium chloride, regardless of some negative factors, is the most available, economic and effective deicer. There is no alternative for the winter road maintenance as cost effective as sodium chloride. So, in the near future sodium chloride will remain the most popular deicing material, in spite of well-known damages caused by chlorides.

The purpose of this study is to reduce salt induced corrosion damage of motor vehicles, steel and steel reinforced concrete structures with the aid of some additives (corrosion inhibitors). Numerous chemical compounds were tested. After preliminary corrosion tests and taking into account some requirements for anti-corrosive additives to deicing salts (anti-corrosive effective, available, cheep and non-toxic to environment and human health), we selected diammonium phosphate, which is manufactured on a large scale as a fertiliser by JSC "Lifosa", Lithuania.

2. METHOD

2.1. Laboratory experiments

2.1.1. The steel plates were treated for 21 days in 20 % NaCl, 20% NaCl and 2,7% $CaCl_2$ mixture solutions with various amounts of diammonium phosphate (DAP) - 0,5; 2,0; 5,0; 10,0 wt % of the amount of NaCl. For comparison we also tested the best known anti-corrosive additive to deicers in Lithuania - superphosphate (SP), which is a mixture of calcium phosphates and sulphate (it is also used as a fertilizer). The plates were completely immersed in the solution in such a way that one plate could not come in contact with another. The solutions were not aerated.

2.1.2. The steel plates were held in prewetted salt (NaCl) for two months. Salt was prewetted with calcium chloride solution (control) and with the addition of diammonium phosphate (1,5, 3 wt % of the amount of sodium chloride).

2.2. Field experiments.

The steel plates were exposed (fixed to a pavement surface) on the road during three months (winter 1998\1999), spreading one road section with deicing salt with corrosion inhibitor (natrium chloride, prewetted with calcium chloride solution with addition 2 wt % dammonium phosphate of the total amount of salt), another section with the same amount of prewetted salt without inhibitor (control). Products of corrosion from all tested plates were removed with the aid of chemical reagents [1]. The rate of corrosion was appreciated and calculated gravimetrically via weight loss [2, 3].

3. RESULTS

Fig. 1, 2, 3 show the results of the afore mentioned the experiments. As we can see from fig. 1 (laboratory test 2.1.1.), the addition only of 0,5 wt% diamonium phosphate to the salt solution decreases the steel corrosion to 43-49% of its former value, the addition of 2 wt % reduces the corrosion rate by 84%. 5 wt% of inhibitor almost stops the corrosive process (90 - 92%).But when we compare DAP and SP , we can see that 5 wt% of SP gives the same **anticcorosive** effect as 0,5 % DAP.

We can see a similar picture, when we study the anticorrosive effect of DAPnot in solution but in prewetted deicing salt (fig.2).

The results of field trials can be seen in fig.3. It shows that this inhibitor (diammonium phosphate) also works in field conditions, when we spread deicing salt on the road to assure the traffic safety. Of course, the results of field tests are less than laboratory test results. As we can see from laboratory tests, the addition of 2 wt% DAP to deicing salts decreases steel corrosion about 85% (2.1.1.) or 70% (2.1.2). It was found that the same amount of DAP in field test reduces the corrosion rate by approximately 37%.

4. CONCLUSIONS

Laboratory and field test results presented in this study showed good corrosion inhibiting properties

of diammonium phosphate in quantities 2-3 wt% in deicing salt. Also, taking into account that proposed anticorrosive additive is available, cheap, non-toxic to environment and human health, we can recommended it at present for a rather effective protection against salt induced steel corrosion.

We must emphasise that this study only as preliminary and further research is necessary.

REFERENCES

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2. Test methods for rapid evaluation of corrosive effects. GOST 9.308 - 85 .

3. Raczev H. Corrosion information book, Moscow, (1982) 9-69.

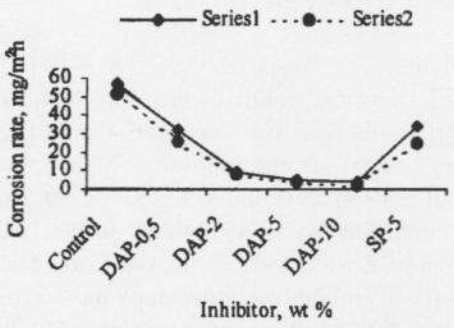

Fig 1. Relationship of steel plates corrosion rate to inhibitors amount (DAP - diammonium phosphate, SP - superpfosphate). Series 1 - 20% NaCl solution, series 2 - 20% NaCl + 2,7 wt % $CaCl_2$

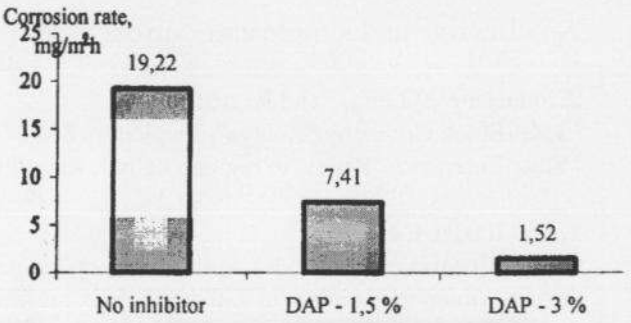

Fig.2. Inhibition effect of DAP in prewetted salt.

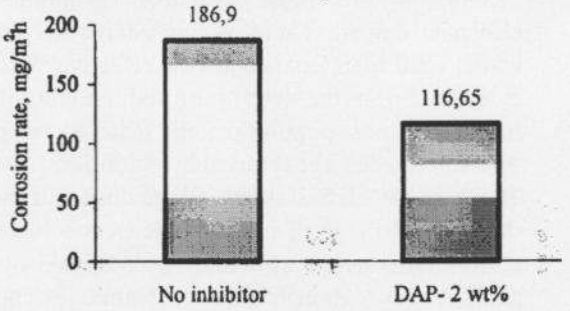

Fig.3. Inhibition effect of DAP. Field test.