WINTERLIFE – EFFECTIVE, SUSTAINABLE AND NON-CORROSIVE DE-ICING AGENTS IN WINTER MAINTENANCE

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PURPOSE

Research on efficient de-icing agents

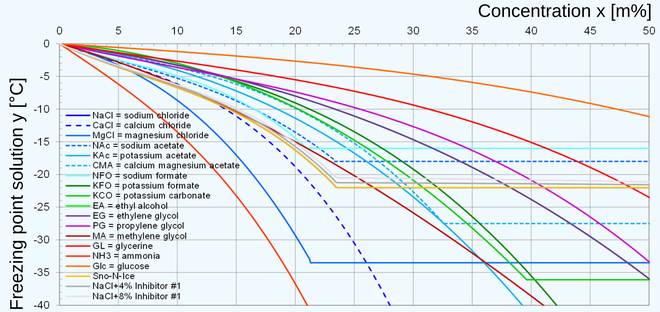
Deicing agents such as commonly used sodium chloride (NaCl) are highly corrosive, significantly reducing the service life of transport infrastructures. The research in WINTER-LIFE examines the extent to which less aggressive de-icing agents with an equivalent thawing effect can be used sparingly, economically and ecologically. The research approach and assessment is based on the criteria thawing performance, application rates & costs, corrosion & impact on humans, animals and plants. The decision criteria is based on additional costs for alternatives compared to the necessary increase in service life to offset these costs being compared to the likely improvements from corrosion testing.

METHODS & CRITERIA:

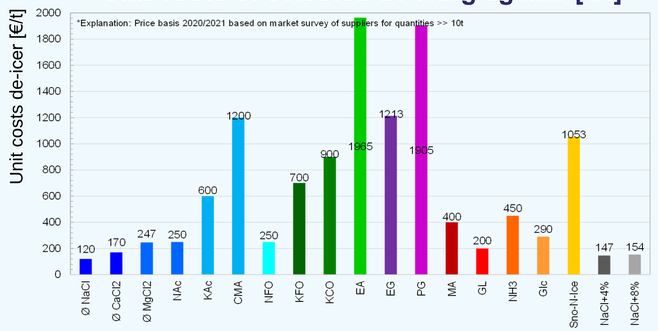
- **Freezing Curve:** The freezing curve provides insight into the freezing point of various de-icing agent concentrations until reaching a maximum (eutectic). A steeper freezing curve with a lower necessary concentration can therefore thaw a higher amount of ice with the same amount.
- **Thawing Capacity:** The thawing capacity is determined by thawing experiments providing the amount of thawed snow/ice for a given reference temperature and time of exposition. The thawing capacity decreases with lower temperatures and achieves a maximum after a long exposition according to the freezing curve.
- **Thawing agent demand:** Based on the freezing curves or thawing capacity the necessary of de-icing agent for thawing a defined reference mass of ice & snow can be determined being crucial for winter maintenance planning and application rates for comparable results.
- **Costs & efficiency:** Based on thawing capacity, purity and costs the costs for thawing a defined amount of snow/ice in a defined amount of time and temperature can be determined. The relative thawing costs provide insight into additional costs to achieve comparable results.
- **Corrosivity:** The corrosivity is based on corrosion tests and mass loss of steel, galvanized steel and copper for different deicers at the same conditions providing an insight into adverse effects for service life. Although the ageing of civil structures is complex corrosivity is considered key.
- **Life Cycle Costs:** As using alternative deicers usually leads to a substantial cost increase the necessary increase in service life for selected transport infrastructure is calculated to offset additional costs. With corrosivity, it is possible to estimate whether this increase in service life may be achieved with an alternative deicer under the condition of no significant negative ecological effects.

RESULTS:

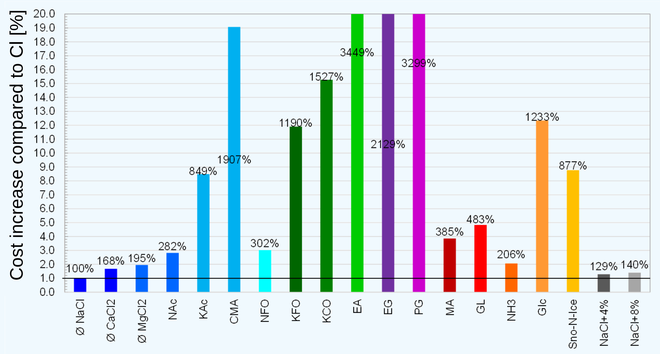
Freezing curves selected de-icing agents [°C, m%]



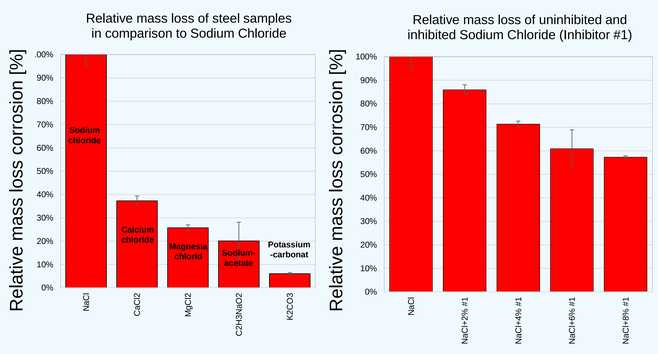
Unit costs of selected de-icing agents [€/t]



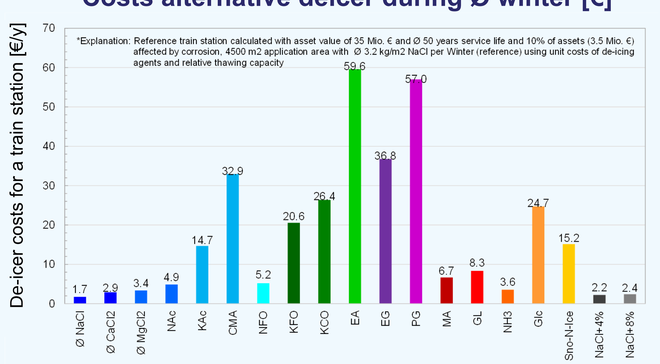
Cost increase alternatives compared to NaCl [%]



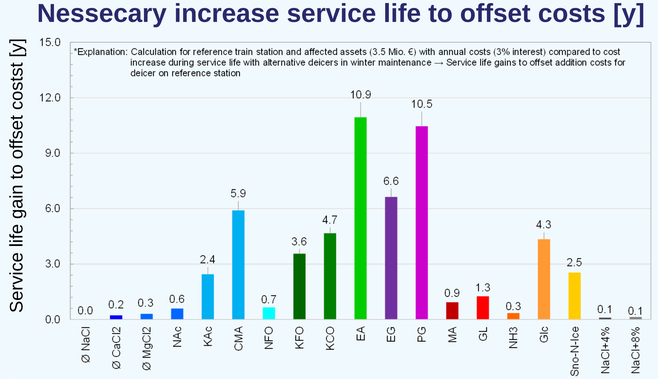
Corrosion mass loss compared to NaCl [%]



Costs alternative deicer during Ø winter [€]



Nessecary increase service life to offset costs [y]



CONCLUSIONS:

- **Multi-criteria:** The transport infrastructure owners and operators have to invest their resources efficiently, expediently, and economically, considering safety and sustainability.
- **Alternatives:** Available chemical elements and market products are based on different mixtures of principal de-icing agents, additives and contaminations and can be evaluated on this basis.
- **Sodium Chloride:** Based on extensive testing, and market analysis of all relevant alternatives no de-icing agent with a better cost-efficiency in winter maintenance alone compared to Sodium Chloride could be found.
- **Degradation:** With chloride-induced corrosion as one of the main factors in transport infrastructure degradation and loss of service life, just looking at the costs and efficiency in winter maintenance will fall short.
- **Corrosion tests:** The test procedures included standardized salt spray test (ÖNORM EN ISO 9227), salt immersion tests (ASTM G31-Testmethod) & alternate immersion tests (ÖNORM EN ISO 11130) with the best results
- **Reduction:** The result have shown significant reduction potential in corrosion effects compared to Sodium Chloride for alternative deicing agents as well as Sodium Chloride with different inhibitors.
- **Cost-increase:** Using alternative de-icers or products will always increase costs-in winter maintenance that may seem negligible in a given winter and a limited area of use but will add up to considerable sums in service life.
- **Service life:** However, if costly transport infrastructures (e.g. train stations, bridges, tunnels) are affected the additional costs can be offset by a marginal increase of service life being very likely for several alternatives.
- **Recommendation:** The highest efficiency is achieved by combining NaCl with suitable inhibitors (e.g. sugar derivatives) at a dosage of between 4-8 m% reducing corrosion from 10% to 60% compared to NaCl (100%). Prior to implementation additional tests on selected stations, inhibitors, concrete samples and for environmental consequences are recommended.

RESEARCH GRANTS & FUNDING:

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