NEW STORAGE LATENT AND SENSIBLE CONCEPT FOR HIGH EFFICIENT CSP PLANTS

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ABSTRACT

The Newsol project intends to study the best heat transfer fluids to be used in concentrated power plants as one technical objective. Currently research has been focusing on inorganic molten salts which have a clear advantage, to be used as heat transfer fluid (HTF) and storage medium simultaneously. They can either be used on point focused (solar tower) or in a linear (parabolic trough type) focusing concentrating solar power plants. Molten salts can commercially replace the usual organic thermal oils offering several advantages:

- Higher (for now up to 600ºC) operating temperatures than thermal oil (up to 425°C for Helisol® 5A)
- No pressure build-up
- Non-toxicity
- Environmental friendliness and possibility to be re-used later on as fertilizers contributing to the circular economy
- Competitive costs and material availability in Solar rich regions like Chile

Solar Salt, a non-eutectic mixture of $NaNO_3$ and KNO_3, is the most widely used storage medium in concentrating solar power plants nowadays, with typical operating temperatures between 290°C and 560°C. Its lower temperature limit is driven by its melting point, including a safety margin, while the upper temperature limit is determined by the high temperature stability. Typically, Solar Salt is not used as heat transfer medium in line focusing CSP plants due to the enhanced risk of salt freezing in pipes and valves but may be used in point focusing CSP plants. Reducing its melting point is a viable option by substituting sodium and potassium with lithium and/or calcium cations.

Stability of two selected mixtures (Ca and Lithium ternary) has been tested. Among the molten salts the ternary nitrate salts appear to be most techno-economically promising as the melting temperature is comparatively low and the most common nitrate salts can be used as raw materials. Studies on the thermal stability limits performed in this report indicate, that Ca ternary molten salt is stable at 500°C and even 525°C under a synthetic gas atmosphere, as measured by the changes in nitrate, nitrite,

oxide and carbonate content. Therefore, the applicable, most conservative, temperature range is 200°C-525°C.

Li ternary molten salts show measurable changes regarding their composition, especially in terms of decomposition products like oxides and carbonates. It is however not possible to rule out an impact of salt creeping on the changes in molten salt chemistry. After testing accomplished for 300 h and 900 h, Lithium ternary mixture is considered to be stable up to 490 ºC, Nonetheless, a measurable, yet acceptable extent of decomposition is indicated by the formation of oxides and carbonates during isothermal exposure.

Nanoparticles can contribute to the enhancement on the cp of the base molten salt since it leads to a less quantity of material required for the same energy storage requirements. The optimal concentration of nanoparticles has been chosen to be 1wt% taking into account that the maximum enhancement on cp, that, is reached at this concentration.