Solar Salt – Progress of pushing an old storage material to higher temperatures

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Thermal Energy Storage (TES) based on molten nitrate salts has a chance of being a key player in nowadays energy transition. The use of Solar Salt (60 – 40 wt% $NaNO_3$-KNO_3) has proven successful even for TES in the gigawatthour-scale in the area of concentrating solar power (CSP) plants. Although modern steam power plants achieve the highest efficiencies at steam temperatures greater than 600 °C, state-of-the-art molten salt storage has so far only been used in CSP plants with steam temperatures lower than 560 °C. The reason for this is the limited thermal stability of the salt under atmospheric conditions. This thermal stability (temperature limit) of Solar Salt has been investigated at different scales with different methods and there is a consensus that, using state of the art storage methods, this limit is at around 565 °C. We demonstrated on a lab-scale level without corrosion aspects, that the thermal stability of conventional Solar Salt can be pushed to temperatures of > 620 °C, when the storage system including the gas system is sealed. We hypothesized that the stabilizing factor is determined by the quantity of reactive gas species relevant to keep the molten salt and gas atmosphere in equilibrium (mainly O_2 and NO_x which will accumulate in the gas phase)[1]

Figure 1 Autosampling system used for sample extraction during long-term experiments with Solar Salt at high temperatures.

The necessary data was generated using highly specialized and home-engineered test rigs, such as the ones shown in Figure 1. It allows for excellent chemical control utilizing inert ceramic interior materials and automated sample extraction, even from pressurized systems. Furthermore, side effects such as salt evaporation and creeping are minimized, thereby reducing the number of side effects on the measured equilibrium compositions, even at temperatures up to 650 °C. This presentation will summarize the current status and latest results on Solar Salt at and above 600 °C regarding thermal stability and thermodynamic data. We will also highlight the tremendous impact of reactive gases in reducing the corrosion of structural materials in contact with Solar Salt even at up to 620 °C.

References

[1] A. Bonk, M. Braun, V.A. Sötz, T. Bauer, *Applied Energy*, **2020**, 262, 114535.