Determination of Heat Capacities of Molten Salts for CSP Applications

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1. Introduction

Several binary and ternary nitrate and nitrite salt mixtures are considered as next generation heat transfer fluids (HTFs) for parabolic trough systems at operating temperatures up to 550 °C. Precise data on several physical parameters are required for designing such systems. Literature data on the heat capacities of relevant candidate materials vary significantly even in terms of the trend with increasing temperature.

The aim of this study was to determine the heat capacity at least up to 550 °C using Calvet-type differential scanning calorimetry (Calvet-DSC) and to determine and overcome the factors that hinder correct salt measurements.

2. Approach

Samples of molten salt were prepared from analytical grade salts. The powders were melted at 300 - 350 °C for up to 24 hours to allow for complete mixing and dehumidification. Cooling to ambient temperature was performed in dry atmosphere in a desiccator above silica gel with humidity indicator. The solidified material was grinded to powder with agate mortar and pestle in a glove box to control humidity and oxygen content.

Salt sample were filled into 130 µl gold-plated crucibles inside the glove box. The crucibles were closed inside the glove box and then sealed outside with a toggle press. Heat capacity was measured with the step method using a Calvet-type DSC (sensys evo, setaram).

3. Results

Solar salt with 60% sodium nitrate and 40% potassium nitrate was tested in nitrogen and oxygen atmosphere. While apparently rising heat capacity is found in nitrogen, a constant value of 1.54 J/(g*K) is found at least between 250 - 550 °C when the sample is prepared in oxygen (see Fig. 1).

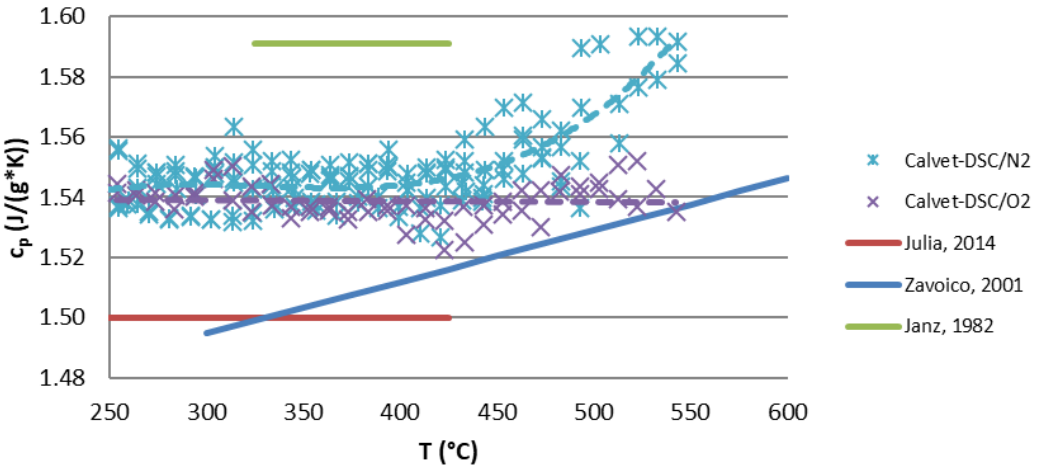

Fig. 1: Heat capacity of solar salt (60/40) according to Calvet-type DSC (step method) in nitrogen and oxygen vs. literature data

Analyses of the measured samples with ion chromatography confirm enhanced contents of nitrite in the sample prepared under nitrogen. The latter is formed due to the limited thermal stability of the nitrate salt at low oxygen partial pressure.

Hence, heat capacity measurement of solar salt in nitrogen is affected by salt degradation and apparently rising values are obtained. The values determined in oxygen represent the real heat capacity of molten solar salt. The study is currently ongoing in order to confirm the value up to 600 °C.

In the paper the details of the measurements and the findings will be presented and discussed. Moreover, findings for *Hitec* and *Hitec XL* salt mixture will be presented and the impact of typical impurities in technical salt grades on the measurement will be discussed.

4. References

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