Thermophysical properties of the composite ceramic-salt system (SiO_2/Na_2SO_4)

Reference: Thermophysical properties of the composite ceramic-salt system (SiO2/Na2SO4)
W. Notter, Th. Lechner, U. Gross and E. Hahne Thermochimica Acta, 218 (1993) 455-463.

Introduction: A composite ceramic-salt packed bed configuration is being developed for high-temperature thermal storage. The thermophysical properties of the more particular hybrid system SiO_2/ Na_2SO_4 have been investigated in the range from room temperature above the melting point of the salt, 884℃. The Na_2SO_4 fraction in the composite materials was varied between 20 and 50%. The following properties were measured: specific enthalpy, coefficient of thermal expansion and thermal diffusivity.

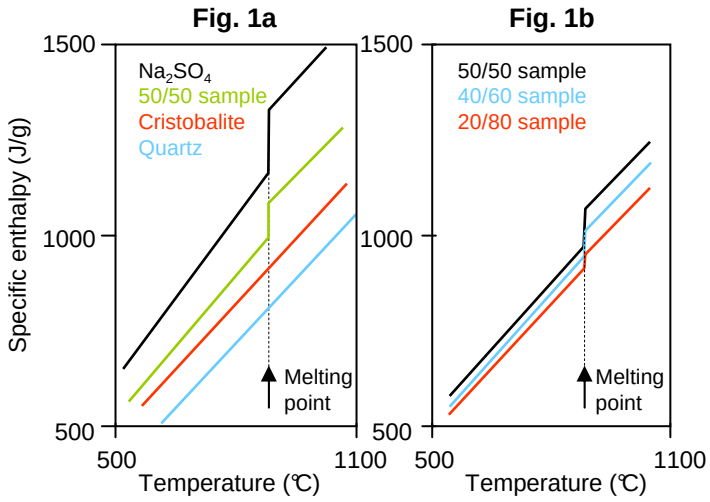

Fig. 1a: Specific enthalpy of a 50/50 sample in comparison with the pure materials
Fig. 1b: Specific enthalpy of 20/80, 40/60 and 50/50 samples

Experimental

The specific enthalpy of the above mentioned composite materials was measured with a drop calorimeter.

A sample (a cylinder of 5 mm in diameter and 5 mm long) tempered at room temperature is dropped into a heated measuring crucible which is completely enclosed by a thermoelectric pile. During the heating up of the sample the resulting heat flow is measured by the thermopile. The enthalpy difference between room temperature and the final sample temperature is determined by an integration of the measured heat flow. The measurements were carried out in an atmosphere of slowly flowing argon. The device has been checked with pure MgO.

Instrument :
High-Temperature Calorimeter Multi HTC 96 with "drop calorimetry"detector.

Results

The examined samples consist of mixtures of 20/80, 40/60 and 50/50 wt% Na_2SO_4 and different modifications of SiO_2.

The use of a drop calorimeter allows the determination of the absolute value of the specific enthalpy and the enthalpy change on transitions very exactly.

Fig. 1a shows measured specific enthalpy values of Na_2SO_4, the cristobalite and the quartz phase of SiO_2 and of a 50/50-sample. The measured values above and below the melting point are interpolated linearly.

An examination of the calorimetric measurements shows that a simple weight fraction mixture rule can be applied, which is reasonable since chemical reactions between SiO_2 and Na_2SO_4 are not expected. Assuming the cristobalite fraction to be 80 % of the ceramic matrix material, calculated enthalpy values fit the measurements of 20/80, 40/60 and 50/50 samples shown in Fig. 1b within the scatter of the data.

For more details ask for the publication B0852.