PCM Screening: High Temperature Phase Change Materials

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In the frame of the PCM Screening project we are developing a new thermodynamic database, which includes the main components Na, K, Ca // NO_3, Cl, CO_3. This database should help us to identify new high temperature phase change materials, which can be used on the modern solar power plants. The PCMs should have phase transitions with a large enthalpy within the operating range of the thermal storage system. Multicomponent salt systems are considered as potential PCMs to design cascaded latent heat storage with small temperature steps between melting temperatures of a series of PCMs. This is possible by following different compositions along a univariant line in the liquidus surface of a multicomponent system. Such type of compositions has the potential covering a very wide temperature range from 100 ℃ to 900 ℃.

Calphad-type modelling and thermochemical analysis are used to provide a sufficiently reliable and consistent database. The analysis of available literature data for pure compounds and binary systems has shown a deficiency of reliable experimental data. For example, the thermodynamic properties of $Ca(NO_3)_2$ are contradictory. The phase diagram of the Na_2CO_3-K_2CO_3 system has been assessed before, but a final solution has not been found yet. In the case of the KNO_3-$Ca(NO_3)_2$ system, the available experimental data are not sufficient for a Calphad-type assessment. In all these cases, there are experimental or computational challenges, which need to be solved.

In this work the above mentioned salt systems were experimentally studied using the following complementary methods: differential thermal analysis coupled with thermogravimetry (DTA/TG), differential scanning calorimetry (DSC), high temperature X-ray diffraction (HTXRD) and Knudsen effusion mass spectrometry (KEMS). The combination of these methods with thermochemical modelling allows for solving the problems, which have not been considered in previous works.

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