Experimental investigations and data assessment for the system Na, K // Cl, NO_3

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ABSTRACT

Energy saving technologies in industry and power plants require the development of energy storage systems. In addition to electrical and electrochemical storage systems, thermal storage is an important part of modern energy saving technologies. The cascaded latent heat storage, where different salt systems are used as phase-change materials, is one of the simplest and probably the most effective way in implementation. Because of the thermodynamic, physical, chemical and economic aspects, multicomponent salt systems based on the cations Na^+, K^+ and anions Cl^-, NO_3^- are well applicable for designing a cascade thermal storage with small temperature steps and with the use of different compositions.

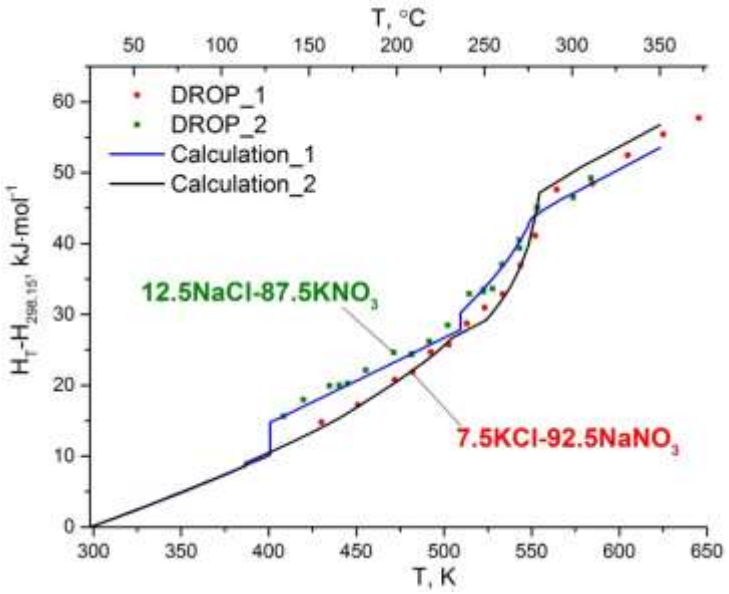

Figure 1: Enthalpy Increment

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This requires a precise knowledge of phase diagrams, enthalpies of phase transitions, enthalpy increments and information about the thermal stability. The realization of these storage system is possible to a limited extend due to insufficient data.

This work presents new experimental results of DTA and XRD analyses for the NaCl-KNO_3 and KCl-$NaNO_3$ systems. The phase diagrams of both pseudo-binary sections have been proposed.

The relative content of the compounds NaCl, KCl, $NaNO_3$, and KNO_3 has been determined by the use of XRD. The missing thermodynamic properties of the system NaCl-KCl have been measured by DSC and Drop calorimetry. The results have been used for the optimisation of the thermodynamic parameters of all available phases.

A self-consistent thermodynamic dataset for the salt system NaCl-KCl-$NaNO_3$-KNO_3 has been generated to reproduce all available experimental information on the corresponding binary salt sub-systems along with the present measured data on the phase relations of the pseudo-binary sections KCl-$NaNO_3$ and NaCl-KNO_3. A good agreement between the experimental data and calculated values has been achieved.

Based on these results, the two mixtures with the lowest melting points of the reciprocal system of 277 °C and 287 °C, respectively, i.e. 7.5KCl-92.5$NaNO_3$ and 12.5NaCl-87.5KNO_3, were selected for further investigation. To prove and compare the calculated thermodynamic properties of these mixtures, DROP measurements were carried out to determine the enthalpy increments (Fig. 1). These values show good agreement with our calculations.

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