Thermal Characterization of Binary Calcium-Lithium Chloride Salts for Thermal Energy Storage at High Temperature

ABSTRACT

Due to their excellent thermophysical properties and high stability, inorganic salts and Forsalt mixtures are considered promising thermal energy storage materials for applications operating at high temperatures. A mixture of binary salts, such as CaCl2 (58 wt.%)-LiCl (42 wt.%), was investigated in this work to understand their thermal properties and stability for use in TES systems. Thermophysical properties, such as onset melting and crystallization temperature, enthalpy of fusion, and crystallization enthalpy, were all investigated experimentally via the use of a simultaneous thermal analyzer. The experimental findings demonstrated a suitable onset melting temperature of 488 ◦C and a solidification temperature of 480 ◦C. The heat of fusion was observed as 206 J/g, whereas the heat of crystallization was recorded as 180 J/g. Thermal repeatability tests indicated little variations in melting temperature; however, fusion enthalpies changed significantly over the course of 30 heating-cooling cycles. Additionally, the results obtained from the thermogravimetric analysis showed relatively weak thermal stability with considerable mass changes. This might be caused by the salts decomposing at elevated temperatures. In order to validate this, a high-temperature in-situ X-ray diffraction technique was used to verify the thermal instability of the binary salt mixture with and without thermal cycling. The thermal decomposition of parent salts and the subsequent formation of new phases with the formation of voids were shown to be the cause of thermal instability. It is concluded that the binary mixture of chloride salt showed suitable thermal properties but relatively weak thermal stability, which may limit its use in practical applications.