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Study of the Phase Transitions in the Binary System NPG-TRIS for Thermal Energy Storage Applications

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Abstract

Neopentylglycol (NPG) and tris(hydroxymethyl)aminomethane (TRIS) are promising phase change materials (PCMs) for thermal energy storage (TES) applications. These molecules undergo reversible solid-solid phase transitions that are characterized by high enthalpy changes. This work investigates the NPG-TRIS binary system as a way to extend the use of both compounds in TES, looking for mixtures that cover transition temperatures different from those of pure compounds. The phase diagram of NPG-TRIS system has been established by thermal analysis. It reveals the existence of two eutectoids and one peritectic invariants, whose main properties as PCMs (transition temperature, enthalpy of phase transition, specific heat and density) have been determined. Of all transitions, only the eutectoid at 392 K shows sufficiently high enthalpy of solid-solid phase transition (150–227 J/g) and transition temperature significantly different from that of the solid-state transitions of pure compounds (NPG: 313 K; TRIS: 407 K). Special attention has also been paid to the analysis of metastability issues that could limit the usability of NPG, TRIS and their mixtures as PCMs. It is proven that the addition of small amounts of expanded graphite microparticles contributes to reduce the subcooling phenomena that characterizes NPG and TRIS and solve the reversibility problems observed in NPG/TRIS mixtures.

Keywords: phase change material; thermal energy storage; latent heat storage; neopentyl glycol; TRIS; plastic crystals; globular polyols; subcooling