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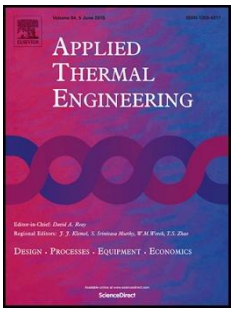

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Experimental Characterisation of Sub-Cooling in Hydrated Salt Phase Change Materials

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Highlights

- Hydrated calcium chloride-based salt materials were tested at various cooling rates
- These materials showed up to 10°C of sub-cooling at high cooling rates
- At low cooling rates salts remain liquid below their freezing points for >20 minutes

Abstract

Phase change materials (PCMs) allow storage of large amounts of energy within a narrow temperature range via their latent heat. This is useful for applications where the outside environment swings above and below the nominal temperature range, enabling the design of passively regulated thermal systems. This short communication presents an experimental characterisation of two proprietary hydrated calcium chloride-based salt materials designed for maintaining temperatures of 25-30°C for building/enclosure temperature stability. It was found that materials' thermal performance is critically influenced by their rate of cooling. Using a T-history method, the experiments revealed these salts undergo high specific enthalpy changes across a broad temperature range (e.g. up to 1MJ/kg, which is 5-10 times their latent heat), but that up to 10°C of sub-cooling and long nucleation times are possible, depending on their rate of cooling. This communication reveals that careful operation is needed to ensure that these materials achieve control within the desired temperature range.

Keywords: Phase change; Sub-cooling; Freezing; Hydrated Salts; PCM; Nucleation

1. Introduction

All thermally controlled environments rely, to some extent, on thermal mass to maintain consistent temperatures. The use of phase change materials (PCMs) in these applications is beneficial as it represents a compact form of thermal mass which, if designed properly, can maintain temperatures within a narrowly defined range. PCMs have been increasingly researched in recent years from both a materials science and an energy savings perspective [1]–[7]. There are many PCM formulations available today to meet a variety of freezing/melting points [1]–[5]. Commercially available PCMs are generally proprietary and little technical information is provided by manufacturers beyond their nominal thermal properties – including phase change temperature and enthalpy values. This is insufficient to determine their performance in an application. In this study, experimental results of two commercially available hydrated calcium chloride salt PCMs, trade-named PC25 and PC29 [8], [9], are reported for various cooling rates. These materials were chosen due to their ideal nominal phase change temperatures (25°C and 29°C), which could potentially be used to regulate living environments. This study uses the temperature history (T-history) method to characterise the properties of these materials and to determine how they would operate at various cooling rates.

2. Experimental Determination of PCM Material Properties

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