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TRANSIENT BEHAVIOUR OF A FREEZING PCM IN A UNIFORMLY COOLED CIRCULAR CAVITY

Kyle Teather, Kamran Siddiqui
Department of Mechanical and Materials Engineering, Western University, London, Canada

ABSTRACT

Latent heat thermal energy storage systems, in which the storage media undergoes a change of phase, have advantages over equivalent sensible heat-based energy storage systems. The energy density associated with latent heat systems is greater, which allows for smaller volumes. The near-isothermal nature of phase change narrows the necessary range of operating temperatures compared to a sensible heat system. Furthermore, the availability of phase change materials (PCMs) over a wide range of melting temperatures allows system designers to tailor the system for many applications over a variety of temperature ranges. For example, paraffins are common for low-temperature operation, and molten salts can be used for high-temperature operation.

Despite the advantages, the complex nature of the phase change process inhibits the ability to design efficient solid-liquid systems, which is problematic as the low thermal conductivity of PCMS is a major barrier to make these types of storage competitive. Phase change in spherical geometry is of particular interest, as many of the most efficient methods to increase heat transfer to PCMs involve many spherical cavities within a material of relatively high conductivity. Many of the previous studies in the literature use the size and position of the solid-liquid interface to compare to a model of one-dimensional conduction. However, there is a lack of high-resolution experimental temperature data and little information on the flow behaviour in the liquid regime.

In this study, a circular section of PCM was cooled uniformly through the circumferential wall to induce freezing. The circular section serves to represent a cross-section of a sphere. Temperature data was collected using a high-resolution grid of thermocouples placed within the PCM, in conjunction with a novel technique using simultaneous thermal imaging. Tests were conducted at three magnitudes of applied cooling. Detailed results will be presented at the conference.

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