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Experimental analysis of the behavior of OM37 phase change material during discharge stage

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Solidification of phase change materials (PCMs) in thermal energy storage (TES) systems, in general, constitute a challenging research area due to numerous intricacies involved in the process. In PCM based TES systems, the stability of these materials during the discharging stage is one of the main concerns. One of the major contributors to this key problem is the existence of undercooling (also referred to as subcooling or supercooling of the liquid) during the energy discharging stage (solidification of the PCM). It not only degrades the thermal performance of the TES system but also causes the system prone to failure due to repetitive thermal shocks. To capture the effect of undercooling on the system performance, an experimental investigation of discharging stage in a PCM based TES system is performed. The transient real-time temperature distribution within the cavity is measured by making the cavity instrumented with thermocouples. In addition, various solidification characteristics visualization and measurement in real-time (for example, solidification interface, mushy zone, etc.) are captured using High-Speed imaging. An interesting phenomenon of the formation of dendritic flakes and their detachment from the developing mushy zone is observed. The detached dendritic particles provide many nucleation sites for the initiation of the solidification in the domain. The insights from the current study of solidification process of OM37 PCM during the energy discharge stage delineated really important insights to avoid failure of TES systems.

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