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

Vikram Soni, Research Scholar, Dept. of Mechanical Engineering, Indian Institute of Technology Kanpur (IITK), Kanpur, India.

Arvind Kumar, Asst. Professor, Dept. of Mechanical Engineering, Indian Institute of Technology Kanpur (IITK), Kanpur, India.

Abstract

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.

Recent Publications

1. Soni, V, Kumar, A, and Jain, VK (2018) Performance evaluation of nano-enhanced phase change materials during discharge stage in waste heat recovery, Renewable Energy 127:587-60.
2. Soni, V, Kumar, A, and Jain, VK (2018) Modelling of PCM melting: Analysis of discrepancy between numerical and experimental results and energy storage performance, Energy 150:190-204.
3. Shah, A., Kumar, A., Ramkumar, J. (2018) Study of the transient thermo-fluidic behavior of melt pool in laser spot welding: validation and analysis of melting and solidification, Journal of Materials Processing Technology 256: 109-120.
4. Shukla, R.K., Patel, V., Kumar, A. (2018) Modeling of rapid solidification with undercooling effect during droplet flattening on a substrate in coating formation, Journal of Thermal Spray Technology 27:269–287.
5. Mahato, A., Kumar, A. (2016) Modelling transport phenomena of ice slurry in an ice forming unit International, Journal of Refrigeration 69:205-222.



Biography

Dr. Arvind Kumar is an Assistant Professor in the Department of Mechanical Engineering at IIT Kanpur. His research work focuses on solid-liquid phase change (melting/solidification) involving theoretical work, computational heat transfer and fluid flow modeling (CFD) and experiments. His research typically is in the interdisciplinary area of fluid, thermal and manufacturing sciences. In the past, Dr. Kumar has worked in academic-industry R&D environments where he has performed applied and industry-centric research. Currently, his group focuses on casting, welding, additive manufacturing, coating, and energy storage, where the work involves developing through the process, CFD models, and experiments. The issues of transport phenomena, multiphase convection, and solidification heat transfer are studied with an aim towards the development of improved and new manufacturing and materials processes. His group is also involved in the areas of additive manufacturing technologies, thermal spray surface coating technologies, and phase change based energy storage technologies.

Email: arvindkr@iitk.ac.in

Notes/Comments:

NA