6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11-15 June 2018, Glasgow, UK

Experimental and numerical study on the melting behaviour of a phase change material in buoyancy driven flows

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Keywords: *Melting, Porosity-Enthalpy method, Volume of fluid, OpenFOAM*

In the present work, a thorough experimental and numerical study is performed to understand the melting behaviour of phase change materials (PCMs) in buoyancy driven flows. Paraffin (Rubitherm® RT35) is used as PCM which occupies 90% of the capsule volume and the rest is occupied by air. In the experimental trials, one of the side walls is heated to a constant temperature above the liquidus temperature of PCM and all other walls are insulated. The influence of different temperatures at the heated wall on the transport of melt-fraction is investigated by monitoring the melt-front at different time intervals. The experimental results are compared with the numerical model which is developed in OpenFOAM® framework. The paraffin-air multiphase system is solved using a volume of fluid (VOF) approach with phase-fraction based interface capturing. The fixed grid mathematical model based on enthalpy-porosity is employed to capture the transport of melt-fraction. A new treatment to enthalpy equation overcomes the necessity to iteratively solve for the coupled enthalpy and melt-fraction fields, thereby reducing the computational cost. The melt-front captured by the numerical model for different time intervals are compared with the experimental results and are found to be in excellent agreement.