Effective Thermal Conductivity of Paraffin and Paraffin Composite with Copper Foam in the Phase Transition Region

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Paraffin is a potential phase change material (PCM) which has numbers of practical applications because of its ability for large latent heat storage. Since the drawback of low thermal conductivity hampers its application, copper foam is applied to enhance the thermal conductivity of the PCM. In the simulation analysis, the thermal conductivity of PCM in the mushy region is assumed to be linearly varying with temperature, which makes the simulation results different from the experimental results. Therefore, it is significant to obtain the effective thermal conductivity of phase change materials accurately, especially in the phase transition region. In this paper, an estimation of how the effective thermal conductivity of paraffin and paraffin composite with copper foam varies with temperature is discussed, covering the solid region, the phase transition region, and the liquid region. Based on the steady-state device designed previously, a one-dimensional heat transfer model is still used in this analysis. For model validation, both simulation and experiment on different regions are built. In the simulation analysis, the feasibility of the test model is verified. And in the experimental analysis, the specimen is divided into several layers by thermocouples and the effective thermal conductivity can be calculated separately. The phase transition state of the specimen is controlled by adjusting the heating temperature and the position of the solid-liquid interface can be observed visually. Depending on the experimental results, it is concluded that the effective thermal conductivity of paraffin and paraffin composite with copper foam varies with the liquid fraction, which presents a nonlinear relationship.