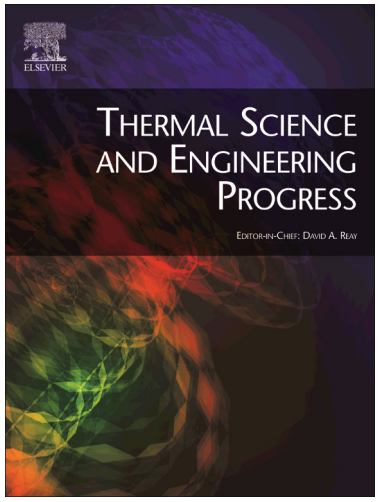

The melting of salt hydrate phase change material in an irregular metal foam for the application of traction transient cooling

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The melting of salt hydrate phase change material in an irregular metal foam for the application of traction transient cooling

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Abstract:

To cope with the increasing cooling loads in power electronics especially in traction, a new heat sink based on the irregular aluminium foam/salt hydrate phase change material composite was proposed for the integration into liquid cooling or heat pipe systems to provide transient cooling during the traction stationary phase. This heat sink would also be applicable to accommodate power surges or thermal buffering-related conditions. The melting point of the salt hydrate PCM was 46°C. The coolant water was heated up to 60°C, similar to the inlet condition in traction liquid cooling systems. The vacuum impregnation method used to create the composite resulted in a 96% impregnation ratio. The heat sink absorbed a thermal load up to 0.092 kWh with increasing charging temperature from 50 to 60°C (from ambient: 20°C) within an hour of heating and the PCM was fully melted. This was a combination of latent and sensible heat storage methods. The thermal capacity value matched closely with the theoretical calculation of 0.103 kWh (11% deviation). An hour of complete melting would match the stopping period of intercity trains at the terminus and the sink would be able to cool a group of 4 to 5 IGBTs, rated at 20W power dissipation for each IGBT, during this stopping period. The heat balance formulated was commendable due to the small mismatch (7% deviation) between the released and absorbed heat, from the coolant to the heat sink. Therefore, it could be used to further optimise the design with alternative PCMs, foam porosities, operational conditions, thermal masses, heat exchanger configurations and so on. The effective thermal conductivity (K_{eff}) for the composite was calculated as 10.8 W/m.K and the ratio of K_{eff}/K_{PCM} was 24, higher than many composites