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Thermophysical Characterization of Paraffin/Palmitic Acid Binary Eutectic Composite for Thermal Energy Harvesting

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Abstract

The twenty-first century is witnessing a quite rapid shift towards eco-friendly and green energy sources to reduce global warming. Solar energy is the cleanest, most abundant renewable energy source available and hence it is extensively utilized despite its uneven nature in distribution. The inconsistency in solar irradiation can be managed by incorporating latent heat energy storage materials within solar energy harvesting systems. Phase Change Materials (PCM) are the most extensively preferred material for thermal energy harvesting (TEH). The effective thermal management capability of the TEH system was greatly hampered by the low thermal conductivity of PCMs. The current work focuses on the development of an appropriate binary eutectic PCM for medium-temperature applications like thermal management of PV, PVT, CPVT systems, electronic devices, and even desalination. Organic PCMs, paraffin (melting point 58-60°C), and palmitic acid (melting point 61-62.5°C) were mixed in the ratio (60.3:39.7) to form a binary eutectic composite followed by its thermophysical characterization. Thermogravimetric analyzer (TGA) and Fourier Transform Infrared spectroscopy (FTIR) results ensured thermal and chemical stability of the synthesized binary eutectic PCM. The newly synthesized eutectic PCM clocked a thermal conductivity of 0.257 W/mK (11.26% increment compared to palmitic acid). Thus, a new economical, PW-PA-based binary eutectic PCM was fabricated. The enhanced thermophysical properties make the composite suitable for medium-temperature applications.

Keywords: Binary eutectic; Thermal conductivity; Thermal energy storage; Paraffin wax; Palmitic acid.