Efficiency enhancement of a solar dish collector operating with a novel soybean oil-based-MXene nanofluid and different cavity receivers

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ABSTRACT

The objective of the present research work is to investigate a novel high-efficiency nanofluid in a solar dish concentrator by using the numerical model developed. The working fluids examined consisted of soybean oil-based MXene nanofluid of different concentrations (i.e. 0.025, 0.075 and 0.125 wt%) and pure soybean oil. The studied nanofluids yielded excellent thermal properties such as high thermal conductivity and heat capacity, which were two particular factors rendering them excellent candidates for solar thermal applications. The solar dish collector was evaluated for three different cavity receivers including cubical, hemispherical and cylindrical shapes. Then, thermal analysis was performed with a developed numerical model in steady-state conditions, which was validated by using experimental results. Meanwhile, the thermal properties of the oil-based nanofluid were described after the experiments. The analysis was parametric in nature, thereby studying the system performance on a daily basis. According to the analysis, the hemispherical cavity receiver led to maximum thermal efficiency with the nanofluid used. In particular, the daily mean thermal efficiency with nanofluid of 82.66% and the mean equivalent efficiency of 82.46% were achieved, while the mean enhancement was 0.6%. However, the enhancements were higher with the use of other cavities due to the higher thermal losses shown in such cases. Moreover, the equivalent efficiency proved that the increased pumping work due to the use of nanofluid could not overcome the thermal enhancement, thereby improving the overall performance of the solar collector.

KEYWORDS

Solar dish; Novel nanofluid; MXene; Efficiency enhancement; Parametric study

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