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Research papers

Numerical investigation and group method of data handling -based prediction on new flat plate solar collector integrated with nanoparticles enhanced phase change materials and tube rotation mechanism

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Highlights

- Efficiency of the system increases with the enhancement in Q and the rotation of the pipe.
- Using PCM improves thermal efficiency and energy saving.
- The system has the best thermal performance when water and PCM are in the outer and inner tubes.
- As Q increases, the amount of energy stored by PCM decreases.
- GMDH ANN can predict thermal efficiency well with R^2=0.97951.

Abstract

One of the weaknesses of the flat plate solar collector (FPSC) is that due to the poor thermal characteristics of the functioning fluid, a large part of the absorbed heat is wasted. A new design based on the phase change material (PCM), Fe_3O_4 nanoparticles, and tube rotation in the current research is suggested to compensate for this weakness. The finite volume method is utilized for mathematical solutions. The effect of PCM position, nanoparticle and its volume fraction, tube rotation, and working fluid flow rate on the warm exhibition of the FPSC was investigated, and the results were analyzed. The results show that the efficiency of the system increases with the enhancement in the flow rate and the rotation of the pipe. Using PCM improves thermal efficiency and energy saving. The system has the best thermal performance when water and PCM are in the outer and inner tubes, respectively. As the flow rate increases, the amount of energy stored by PCM decreases. When nanoparticle/water or nanoparticles-PCM is used, the proficiency of the framework enhances. In the water- Fe_3O_4nanoparticles (3%)/PCM mode, flow rate of 0.424 Lit/min, and rotation speed of 0.05 rad/s, the efficiency is the highest and is around 67.94%. Using the available data, the group method of data handling modeling neural network method has been able to predict thermal efficiency well with R^2=0.97951.