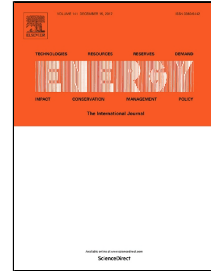


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Energy and Exergy Analysis of Nanofluid Based Photovoltaic Thermal System
Integrated with Phase Change Material

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1 **Energy and Exergy Analysis of Nanofluid Based Photovoltaic Thermal System** 2 **Integrated with Phase Change Material**

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6

7 **Abstract**

8 In this study, the effects of simultaneous use of ZnO/water nanofluid with 0.2 wt% as the coolant
9 as well as an organic paraffin wax as the phase change material (PCM) on the electrical and thermal
10 efficiencies of a photovoltaic thermal (PVT) system are experimentally investigated. For this
11 purpose, three different systems are studied and compared with each other: a conventional PV
12 module, a nanofluid based PVT, and a nanofluid based PVT/PCM. The experiments are performed
13 on selected days in August and September at the Ferdowsi University of Mashhad, Iran. The
14 measured data are analyzed from the energy and exergy viewpoints. Based on the results, using
15 the PCM in the nanofluid based PVT system enhances the output thermal power of the PVT system
16 by about 29.60%. The results also indicate that the nanofluid based PVT/PCM system compared
17 to the other two systems considered in this study (PV and nanofluid PVT) has the maximum output
18 overall exergy and overall exergy efficiency of 114.99 W/m² and 13.61%, respectively. In
19 addition, the relative reduction of the entropy generation of the nanofluid based PVT and
20 PVT/PCM systems compared to that of the conventional PV module are about 1.59% and 3.19%,
21 respectively.

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