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Editorial

Advances Photovoltaic Thermal (PVT) Systems

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Editorial

The dependence of human on technologies and augmented living ideals lead to increased energy needs. Hence, given that the energy demand should be satisfied, the fossil fuel consumption is increasing, thereby resulting in numerous climate and environmental issues. The energy demand is continuously increasing annually; thus, renewable technologies have gained considerable interest. A substantial change in global perceptions about renewable energy since 2004 has shown its potential. Renewable energies have been improving, and many technologies are at par with conventional energy generation technologies. Many studies on energy demands have been conducted, and they have demonstrated how demands contribute to the society, surroundings and economy of a country. Furthermore, an issue involving high solar absorption that will increase solar PV panel temperature and consequently decrease the energy generation efficiency of the PV panel.

This problem results in the improvement of solar energy technology, in which the photovoltaic thermal (PVT) solar panel is introduced; this system is advantageous because it can produce hot water and electricity simultaneously because the system's operation is at low temperature. The PVT system resolves the electrical deficiency of the PV system because heat from the panel is extracted. Studies on PVT system have been anticipated many researchers who intend to study its contributions in generating electrical and heat energies. Previous studies focused on various climatic, design and operational restrictions of PVT system's performances. Further theoretical approaches, such as the use of nanofluids as coolants, have been performed; a theoretical model was developed to evaluate the system's performance, and a new configuration of the PVT system, which includes the collector tube and working fluid, was numerically studied.

A theoretical study conducted by Tyagi used aluminium/water nanofluids on direct-absorption solar collector, and its performance was compared with that of conventional flat-plate solar collector. The studied system involves an enclosed space of fluid channel, and the bottom surface is ideally isolated. The system is also equipped with a transparent glass, and a small amount of solar irradiance is lost by scattering or transmission through the glass cover. A research on direct absorption solar collector by utilising nanofluids made from different nanoparticles, such as carbon nanotubes, graphite and silver, was performed by Otanicar They observed 5% improvement in collector efficiency by utilising nanofluids as coolants. The use of nanofluids reduces reflectance because it acts as volumetric-based absorption medium. Hence, the heat absorbance is increased which is highly paralleled to surface-based absorption. In addition, the thermal performance of a densely packed photovoltaic cells cooled by Al_2O_3/water nanofluid-based cooling system was evaluated by Xu, Lee proposed a theoretical study on the feasibility of using plasmonic nanoparticles suspended in water of direct-absorption solar collector to improve broad-band solar thermal absorption. Khanjari also presented a theoretical study on the performance of PVT system and focused on the effects of utilising Ag/water and alumina/water nanofluids as working fluids.

Results showed that the thermal efficiency and the heat transfer coefficient improve by increasing the volume fraction of t nanoparticles. Comparison with pure water indicated 12% and 43% of maximum increment in heat transfer coefficients for alumina/water and Ag/water nanofluids, respectively. Sardarabadi investigated and compared the effects of using pure water and silica/water nanofluids on PVT units. Two different concentrations were prepared and assessed at constant optimum mass flow rate, with a tilt angle of 32 °C. Economical assessment on nanofluid preparation and silica/water nanofluid suspension revealed improved PVT system's performances and exergy efficiency. Yun and Qunzhi used film of magnesium oxide (MgO)/water nanofluid with different concentrations on top of PV cells. Evaluation on the system proved that film thickness exerts no influence on the system's output. Both energy efficiencies are decreased at fixed light irradiance when thick film is used.

The integration of phase change material (PCM) to the PVT system often relates to its use along nanofluids which act as coolants. PCM stores heat energy. This material also absorbs sensible heat until it reaches melting temperature. PCM is used with nanofluid-based PVT to control the heat capacitance of the system and consequently maintain electrical efficiency and increase the overall efficiency in the same operation time. High efficiency is attained by using nanofluid due to the establishment of high thermal conductivity. Delisle and Kummert also confirmed considerable improvement in the PVT systems by applying different design structures and using various materials. Nonetheless, they must be within an acceptable amount so as to avoid high energy cost or extended payback periods. Advanced research on the application of PCM as coolant for PVT system was also performed. Many previous and current studies on preparation, characterisation, properties and applications of nanofluids have been reported. Devinderan and Amir focused on the preparation of metal, metal oxide nanofluids and hybrid nanofluids, as well as on the methods applied in studying their physical and chemical features. An outlook focusing on the uses of PCM for PV module thermal regulation and electrical efficiency improvement was also reported.

The system may be impractical economically in enhancing PV conversion efficiency. Indoor analysis and computational study were also carried out by Jay by focusing on the performance of PV-PCM system. A honeycomb structure made up of aluminium was used to encapsulate the PCM and boost heat conduction. They reported an improvement of approximately 18% in electrical efficiency compared with that in stand-alone PV panel. An experimental study conducted by Huang validated a PV/PCM numerical model. The analysed system design with and without fins and integrated with RT25 and paraffin waxed was used as PCM. This study confirmed that the use of fin designs to the system is crucial on thermal management of PV/PCM. The effect of PCM thickness on temperature reduction in panel module was investigated by Indartono they obtained the optimum PCM thickness based on CFD simulation results among three PCM thickness values. The optimum thickness considered among three thickness variables is 80mm.

Heat pipe integration guarantees high thermal conduction that allows heat transfer with nearly no decrease in temperature. Gang investigated a heat pipe PVT system that can be applied in cold states without it freezing compared with the conventional water-based PVT system. A study in 1995 confirmed that the thermal efficiency of a heat-pipe-based collector is comparable to that of a water-based solar collector. The use of heat pipes in solar collectors prevents the freezing and backflow of working fluid during night time. Hence, highly stable operating conditions can be achieved. Yang studied heat pipe with sodium as coolant. They concluded that inclination angle and heat input influence thermal performance. The system exhibits good temperature uniformity and excellent thermal conductivity. Boo investigated on loop heat pipes filled with different sodium ratios. They concluded that fill ratio affects the thermal resistance, effective thermal conductivity, start-up time and isothermal characteristics. Xia probed the effects of the PVT module size on its performance in heating-dominated residential building. The ideal PVT collector size in this research was insisted through economic analysis. High initial investment causes short-term economics and increases the significance of the system's main design parameter optimisation. Recent advances on heat pipe implementation are obtained by designing optimisation plan for ground source heat pump systems which are integrated with the PVT collectors. The study gap on design optimisation of hybrid ground source heat pump systems has been governed and computationally comprehensive.