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Effective Study on Domestic Application of Hybrid Photovoltaic-Thermal (Pv/T) System

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Abstract : This study presents an overview of the development and application aspects for the hybrid photovoltaic-thermal (PV/T) systems. Over the last 30 years, a significant amount of research and development work on the hybrid photovoltaic-thermal (PV/T) technology has been carried out. The hybrid PV/T systems are very promising devices and its technology is expected to become strongly competitive with the conventional power generation in the near future. In recent years, various methods of thermal management in hybrid photovoltaic-thermal (PV/T) systems have been observed by many researchers due to its importance in the system's overall efficiency improvement. Different types of hybrid photovoltaic-thermal (PV/T) systems and the theory behind its operation and performance were briefly presented. This study presents the trend of research and development of technological advancement in hybrid photovoltaic-thermal (PV/T) systems and its useful domestic applications like as water heating, air heating and HVAC system.

Keywords : Hybrid Photovoltaic-thermal (PV/T) system, Thermal management, Overall efficiency, Application.

1. Introduction

A hybrid photovoltaic-thermal (PV/T) system is a combination of photovoltaic (PV) module and solar thermal collector. In this way both heat and electricity are generated from single integrated system simultaneously. In other words, Photovoltaic (PV) module is act as a thermal absorber [1].Since the demand for heat energy (without pollution) and electricity are often supplementary, it seems to be a logical idea to develop a PV/T system that can comply with both demands. Air and water both have been used as heat transfer medium in practical PV/T system, yielding air and water heating systems respectively. PV/T water heating systems are more efficient than those of PV/T air heating systems [2] because the water has high thermo-physical properties as compared to air, However, PV/T air heating systems are utilized in many practical applications due to low fabrication and operating cost among others. Experiments on the effectiveness of PV/T systems during daytime heating and night time cooling have been undertaken, for both air and water-based systems [3–5].In this study,a thorough review of the existing literature on performance and domestic application ofphotovoltaic-thermal(PV/T) system is done andfuture potential of PV/T technology is discussed.

2. Experimental Setup

2.1 PV/T Water Heating System

IlhanCeylana et al. [6]designed and experimentally analyzed the PV/T water heating system with process control equipment is shown in Fig. 1. When the process control equipment (PCE) reaches the set temperature, it activate the solenoid valve which is normally close. When the collector temperature decreases under the set temperature, PCE deactivate the solenoid valve. Since the water entering thetransparent pipes behind the Photovoltaic (PV) modules each time, it will extract the heat from the PV modules at the same time. In that way, a water heating is done.

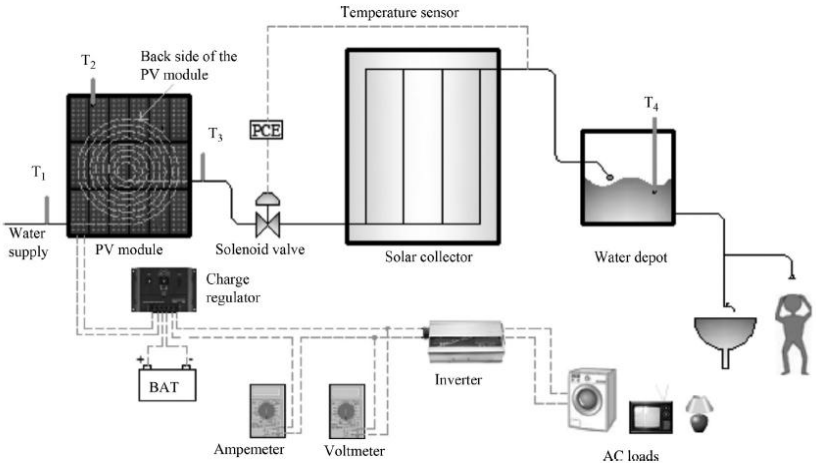

Figure 1. Schematic diagram of the PV/T water heating system

2.2 PV/T Air Heating System

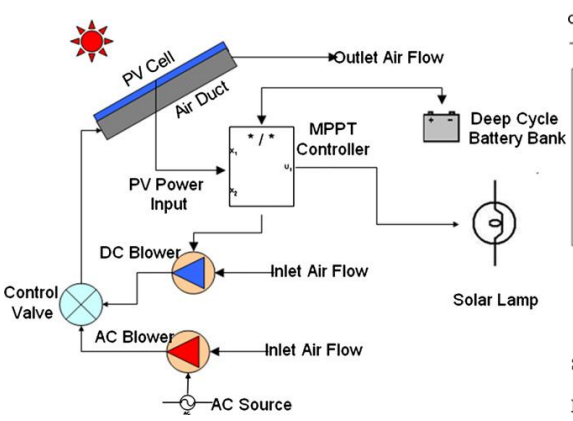

Figure 2.Schematic diagram of the PV/T air heating system

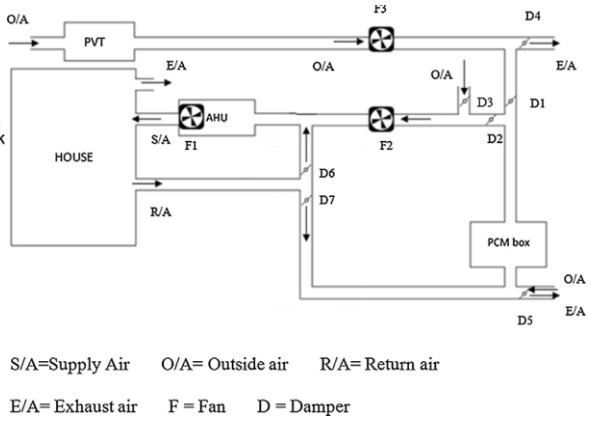

Figure 3.Schematic diagram of the PV/T HVAC system

H.G. Teo et al. [7] fabricated the test setup to investigate the thermal and electrical performances of the PV/T air system is shown in Fig.2. An array of air ducts that allowed air to pass through was attached underneath the PV modules. Fins were fixed in the air duct to increase the heat transfer rate from the PV panel to the moving fluid. The maximum power point tracker (MPPT) was used to modulate the power output from solar panel and AC blower used to control the flow rate of air passing through the duct.

2.3 PV/T HVAC System

Massimo Fiorentini et al. [8]developed a Solar Decathlon house is shown inFig. 3. The HVAC system consisted of an air-based PV/T system, thermal energy storage unit (PCM), and a reverse cycle ductedair-conditioning system.In HVAC system, air as a working fluid to facilitate retrofitting of house, with featuresincluding lessmaintenance and the ability to integrate with ordinary air-conditioning systems.

3. Result and Discussion

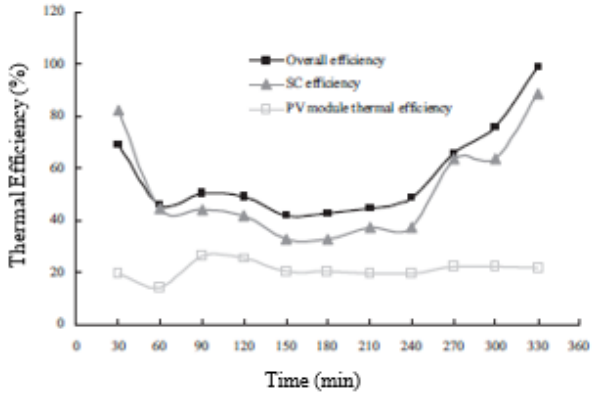

Figure 4. Time Vs Efficiency

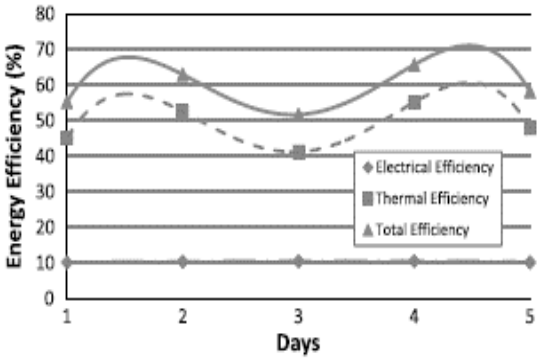

Figure 5. Days Vs Efficiency

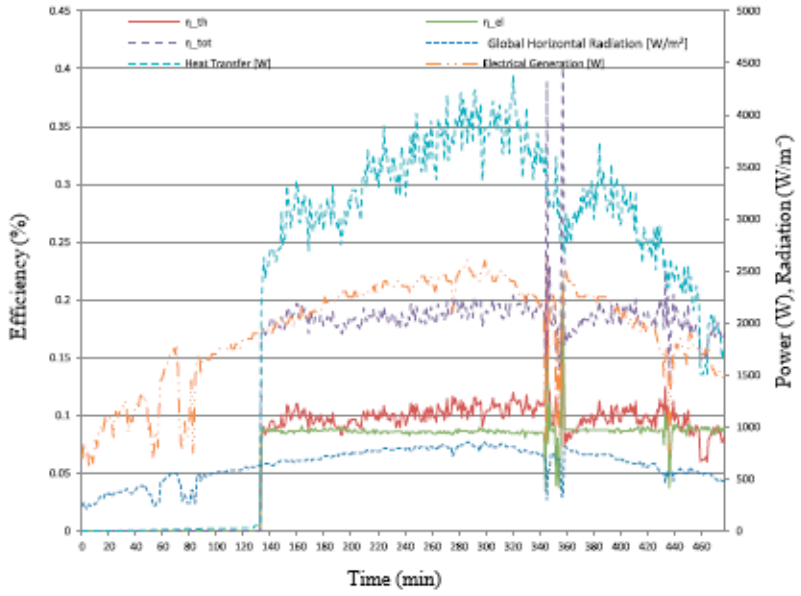

Figure 6. Time Vs Efficiency, Power and Radiation

These results [6] were observed at the experimentswith an increase in the solar radiation, the temperature of the water entering the PV/T system increased and as the difference between the temperature of the inlet and outlet water decreased, it decreased the solar collector efficiency shown in Fig.4.The efficiency of the PV/T system shown in Fig. 5 indicated that the average electrical efficiency range is around 10-10.8 %. However, the thermal efficiency is much higher than electrical efficiency of the PV/T system [7].

The efficiency of the PV/T HVAC system [8] under the experimental testsare shown in Fig. 6. It can be seen that the electrical efficiency of the PV/T system is relatively constant (i.e. ~8.5%) and consistent with the expected efficiency. The effect of extracting thermal energy from the PV module was to increase the overall efficiency of the PV/T system to around 17%.

4. Conclusion

All of the described methods were compared on their ability to reduce Photovoltaic (PV) module temperature and increase the electrical and thermal efficiency of the photovoltaic-thermal (PV/T) system. The reviewed results shown that overallefficiency and performance of the PV/T system in real world could be significant improved by applying appropriate cooling technologies.The different applications of solar PV/T system such as water heating system, air heating system, HVAC system are also presented. This paper would be useful for the solar photovoltaic (PV) module manufactures, researchers, academicians, students and decision makers.

Reference

1. PVT Roadmap – a European guide for the development and market introduction of PV-thermal technology; 2006, PVT forum: <http:// www.pvtforum.org/index.html>.
2. Prakash J. Transient analysis of a photovoltaic/thermal solar collector for co-generation of electricity and hot air/water. Energy Conversion and Management 1994;35:967–72.
3. Y. Chen, A.K. Athienitis, K. Galal, Modeling, design and thermal performance of a BIPV/T system thermally coupled with a ventilated concrete slab in a low energy solar house: Part 2, ventilated concrete slab, Solar Energy 84 (2010)1908–1919.
4. S. Pantic, L. Candanedo, A.K. Athienitis, Modeling of energy performance of ahouse with three configurations of building-integrated photovoltaic/thermalsystems, Energy Build. 42 (2010) 1779–1789.
5. Ursula Eicker, Antoine Dalibard, Photovoltaic–thermal collectors for night radiative cooling of buildings, Solar Energy 85 (2011) 1322–1335.
6. IlhanCeylan, Ali EtemGürel, Hüsamettin Demircan, BahriAksu, Cooling of a photovoltaic module with temperature controlled solar collector, Energy and Buildings 72 (2014) 96–101.
7. H.G. Teo, P.S. Lee, M.N.A. Hawlader, An active cooling system for photovoltaic modules, Applied Energy 90 (2012) 309–315.
8. Massimo Fiorentini, Paul Cooper, Zhenjun Ma, Development and optimization of an innovative HVAC system withintegrated PVT and PCM thermal storage for a net-zero energy retrofitted house, Energy and Buildings 94 (2015) 21–32.

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