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Power Output Comparison for a PV-Water Hybrid Energy System Coupled with Different Types of Concentrators

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ABSTRACT: PV-Fluid hybrid energy systems are used for concurrent production of electric and thermal power. These systems have the advantages of portability and lesser space requirements. This paper deals with PV-water hybrid energy system. Different types of Concentrators are also integrated with the system. Concentrator types used are, Single mirror concentrator, V-trough concentrator, and Compound parabolic concentrator. A comparison is done between the outputs obtained for the system without cooling and with cooling for different types. Optimum trough angles are also found for single mirror concentrator and V-trough concentrators. It is found that the output increases with increase in concentration ratio and that the power output is more with cooling than without cooling.

Keywords: PV-water, Concurrent, Portability, V-trough concentrator, Compound parabolic concentrator

I. INTRODUCTION

PV-Fluid hybrid energy systems are a very useful technology. These systems can produce electric and thermal power concurrently. Hybrid energy systems are portable and require less space. A literature review shows that many studies have been done on the PV-water hybrid energy systems.

Research work on the PV/T hybrid energy systems started during the 70's which got intensified in the 1980's. PV/T hybrid energy systems are complete energy systems for supplying electricity as well as heating a home [1].

PV/T systems can be used to meet electrical as well as heat demand. PV/T collector systems combine together heat technology and electrical technology. PV/T collectors convert the absorbed solar radiation partly into electrical energy and partly into heat. PV/T collectors help to increase the overall efficiency of the system. Since they make use of waste heat generated from the PV module. It has been found that the PV cell efficiency decreases as the operating temperature increases, therefore PV/T collector can be used to overcome this problem as it can extract the heat from the PV module. PV/T systems have a higher yield of energy per unit area [2].

Concentrators can be integrated with PV/T collectors to augment the solar radiation intensity on the photovoltaic cells. Commonly the reflective surfaces and refractive lenses are used in c-PVT. Reflector based c-PVT system are suitable for use with liquid coolants. Moreover liquid coolants are effective compared to air coolants, for obtaining higher electric outputs [3].

II. EXPERIMENTATION

The current work was aimed to find the effect of concentration ratio and cooling on the output of the PV-water hybrid energy system. The program was divided into following steps:

(i) A PV panel integrated with a coolant box was fabricated to build a cooling arrangement.

(ii) A PV stand was fabricated that also had arrangements to hold the concentrators.

(iii) Single mirror concentrators, V-trough concentrators, and a CPC were designed and fabricated. The single mirror concentrator is designed for a concentration ratio of 1.5. The V-trough concentrator is designed for a concentration ratio of 2. The compound parabolic concentrator is designed for a concentration ratio of 1.4.

(iv) Fabricated systems were then put to test in sunlight. The systems were simple PV (with and without cooling), PV-single mirror concentrator (with and without cooling), PV-V-trough (with and without cooling), PV-CPC (with and without cooling)

(v) A comparison of outputs obtained from each type (with cooling and without cooling) was done.

(vi) Results obtained were analyzed.

(vii) Conclusions were drawn from the results obtained.

A PV-V-trough without cooling is shown in Fig. 1.

Fig. 1. PV-V-trough without cooling.

III. RESULTS AND DISCUSSION

After the PV-water system and the different concentrator arrangements have been built they are then put to test. The power output values are noted for each of the systems.

First of all a simple PV panel is taken into consideration. The power output values given by a simple PV without cooling arrangement are noted first followed by the values obtained by integrating it with a cooing arrangement. The power outputs obtained from a simple PV (with and without cooling) are shown in Fig. 2. The power output is given in Watts (W). The power output values obtained for the system (with and without cooling) are shown on the same graph for comparison with each other.

Similarly the power output values for a PV-single mirror concentrator (with and without cooling) are noted. The values thus obtained are shown in Fig. 3. The power output values for PV-V-trough (with and without cooling) are plotted on a graph as is given in Fig. 4.

The power output values obtained in case of PV-CPC (with cooling and without cooling) are shown in Fig. 5. The optimum trough angles are also found for the PV-single mirror concentrators and PV-V-trough concentrators. The optimum trough angle is the angle at which the power output by the system is at maximum.

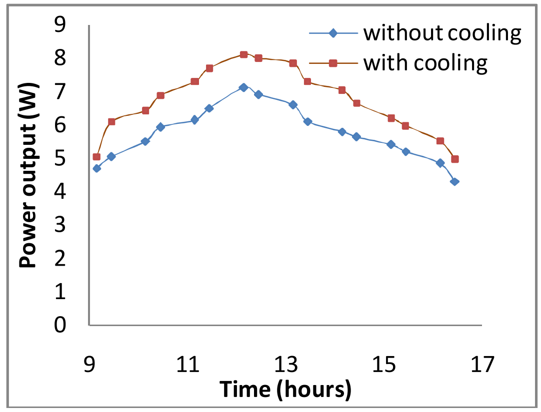

Fig. 2. Output comparison for Simple PV panel.

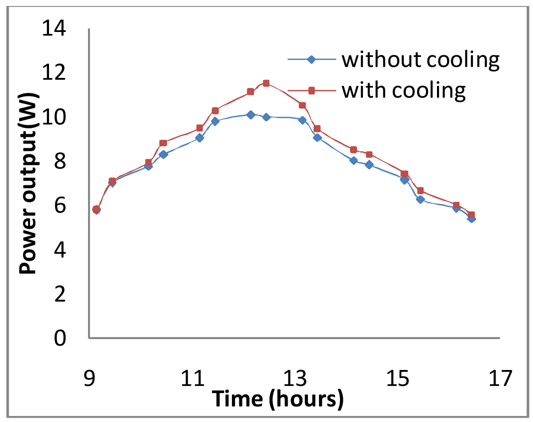

Fig. 3. Output comparison for PV-single mirror concentrator.

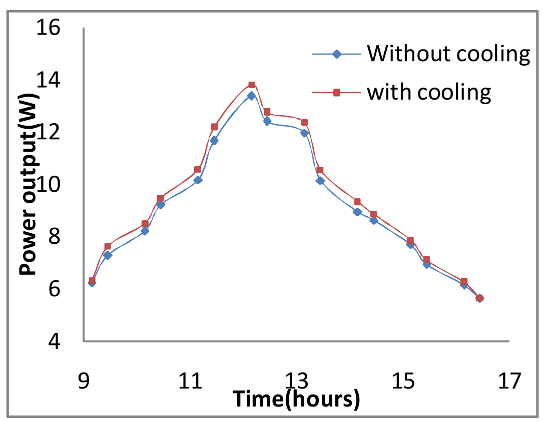

Fig. 4. Output comparison for PV-V-trough concentrator.

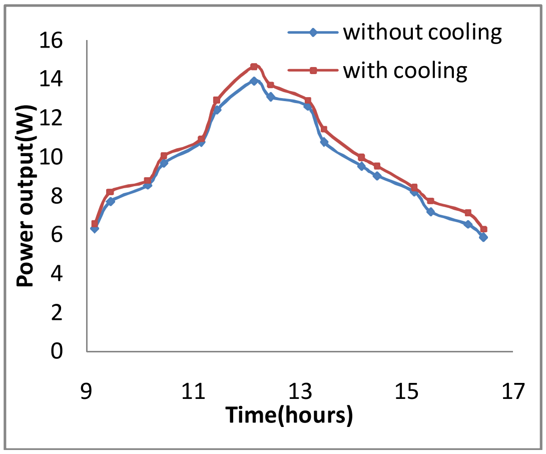

Fig. 5. Output comparison for PV-CPC.

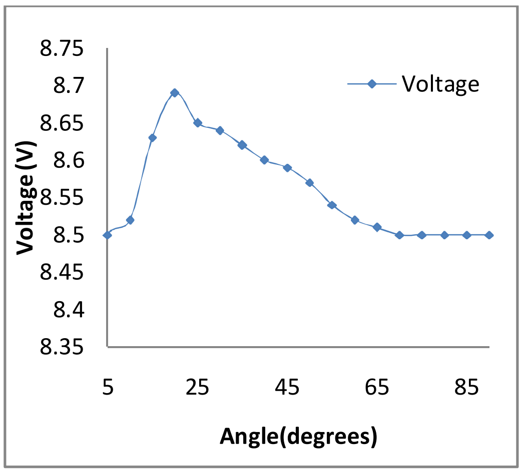

Fig. 6. Optimum trough angle for Single mirror concentrator.

The analysis done to find the optimum trough angles for the PV-single mirror concentrator system and PV-V-trough concentrator systems is given in Fig. 6 and Fig. 7 respectively.

A comparison is also done for power output obtained with different concentration ratios. The comparison is given in the Fig. 8. The power output values increase as the value of concentration ratio is increased. The power output obtained is at maximum when PV-V-trough concentrators are used.

IV. CONCLUSION

The main aim behind this work is to compare the outputs obtained for different systems (with and without cooling) and to study the effect of concentration ratio on the power output. It was concluded that:

- The power obtained increased with the use of cooling for each of the systems.
- The power output increased as the concentration ratio was increased, with the maximum value of power output given by V-trough concentrator.
- PV–water hybrid energy systems are portable and very useful compared to a single PV panel since they are producing two powers at the same time.

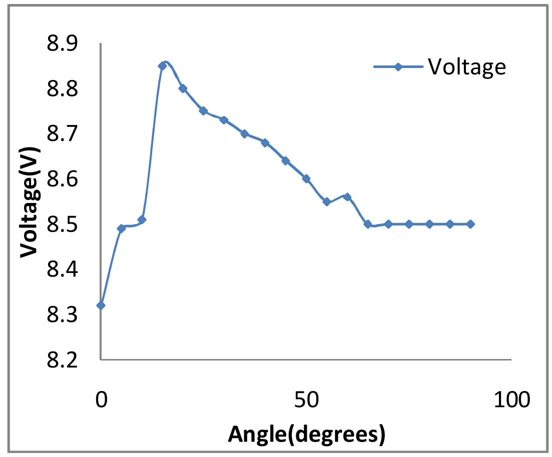

Fig. 7. Optimum trough angle for V-trough concentrator.

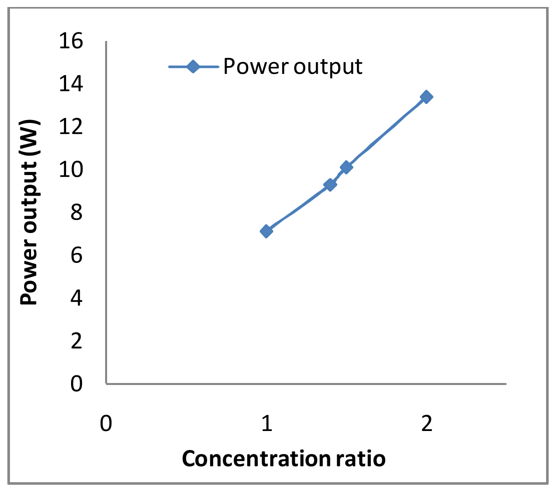

Fig. 8. Variation of Power output with concentration ratio.

REFERENCES

[1]. K. Touafek, A. Khelifa, M. Adouane, and H. Haloui, "Design of an Energy System Based on Photovoltaic Thermal Collectors in the South of Algeria," *Journal of Renewable Energy*, vol. 2014, Article ID 824529, 6 pages, 2014. doi:10.1155/2014/824529.

[2]. Nualboonrueng, T., Tuenpusa, P., Ueda, Y., and Akisawa, A., "Field experiments of PV-thermal collectors for residential application in Bangkok", *Energies*, vol. **5**, pp: 1229-1244, 2012.

[3]. T.T. Chow, G.N. Tiwari, and C. Menezo, "Hybrid Solar: A Review on Photovoltaic and Thermal Power Integration," *International Journal of Photoenergy,* vol. 2012, Article ID 307287, **17** pages, 2012. doi:10.1155/2012/307287.