Title: Design, construction and testing of solar photovoltaic-thermal systems at Al-kharj

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ABSTRACT

The hybrid photovoltaic-thermal (PVT) technologies utilize the solar energy and convert it into electrical and thermal energy. Three systems are going to be designed, constructed, and tested. The systems are Solar Air PVT System, Solar Water PVT System, and Solar Normal System (Base PV Panel). The use of Solar Water PVT System improves the electrical and overall efficiencies by about 0.4% and 58%, respectively. The use of Solar Air PVT System improves the electrical and overall efficiencies by about 1% and 31%, respectively. The Normal System undergo higher thermal losses compared the PVT systems.

INTRODUCTION

The radiation emitted by the sun is called solar energy. It reaches the earth in form of electromagnetic waves after experiencing considerable interactions with the atmosphere. Solar energy can be utilized by ***solar thermal systems*** which convert solar energy into heat, ***PV systems*** to produce electricity by the photovoltaic effect**,** and ***PVT systems*** which combine the use of thermal and PV systems.

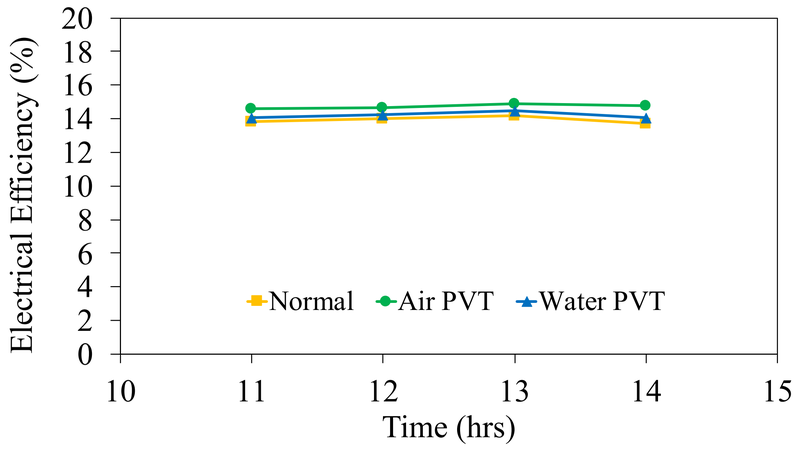
OBJECTIVES

- Design the Photovoltaic-Thermal air and water systems.
- Construct the Photovoltaic-Thermal air and water systems.
- Conduct experimental measurements of heat and electrical power.
- Conduct power analysis of the three systems.

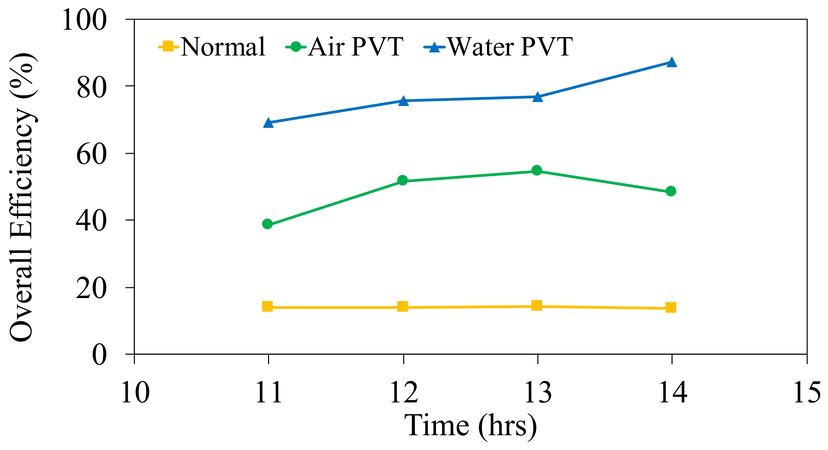
CONSTRUCTION OF THE PVT SYSTEMS

The systems that were used in this project.

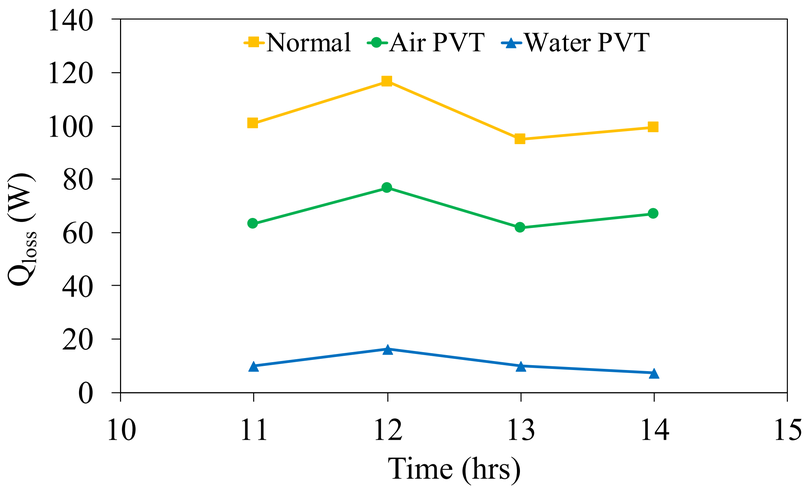
POWER ANALYSES OF PVT SYSTEMS



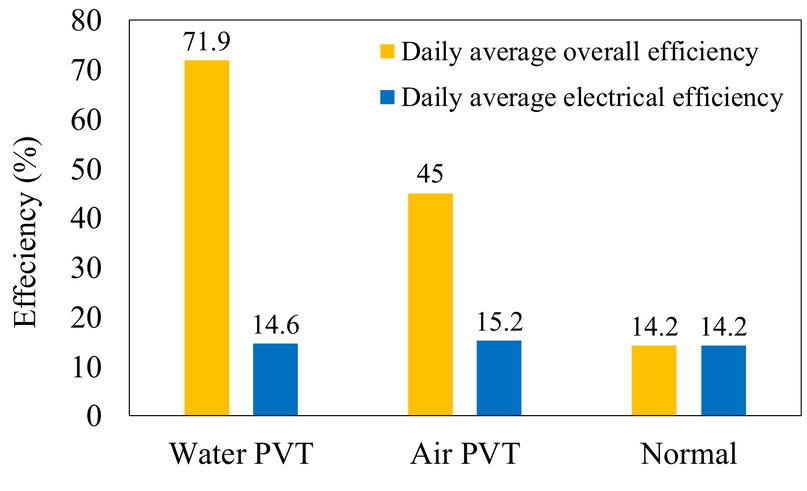
Variation of electrical efficiency.



Variation of overall efficiency.

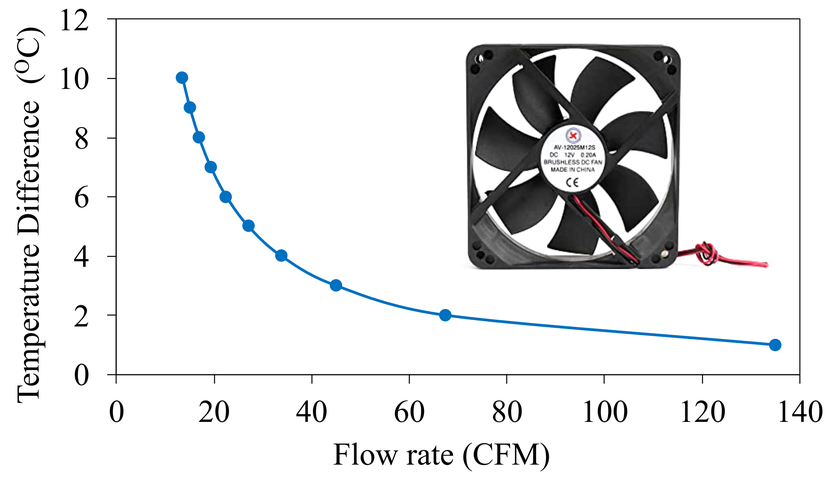


Variation of thermal losses.



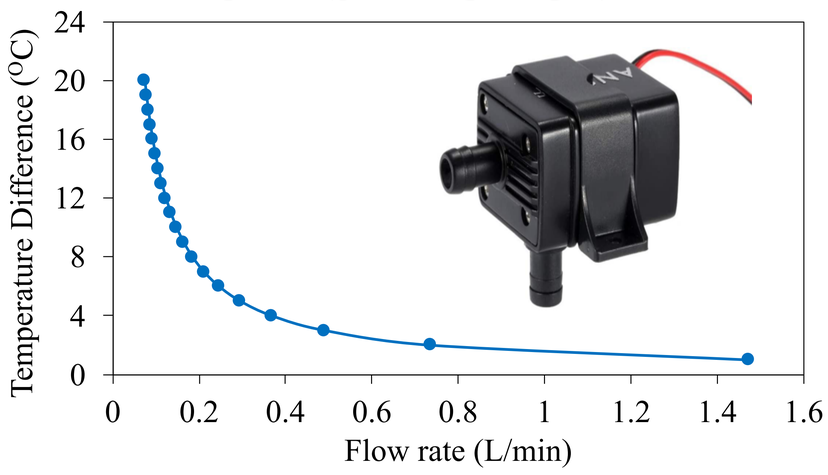
Daily average overall and electrical efficiencies.

FAN SELECTION



Variation of temperature difference against the air flow rate.

PUMP SELECTION



Variation of temperature difference against the water flow rate.

COST ANALYSES

System	Cost (SAR)	SAR/Watt
Normal System	250	7
Water PVT System	900	5
Air PVT System	412	4

CONCLUSIONS

- The overall efficiency is improved by using the PVT Systems.
- The Solar Water PVT System showed the highest overall efficiency followed by the Solar Air PVT System.
- The thermal losses were highest for the Solar Normal System followed by the Solar Air PVT System.
- The Normal System costs more to produce one Watt followed by the Water PVT System with the Air PVT System having the lowest.

RECOMMENDATIONS

- We recommend future work to cover the whole day and the annual variation of the performance.
- We recommend to use an automated measuring system.

Saudi Arabia, Prince Sattam bin Abdulaziz University, College of Engineering, Mechanical Engineering Department