Title: Design, Construction and Testing of Solar Photovoltaic-Thermal Systems at Al-kharj

Students: Mohanad Alrafiah, Saud Al-hilal, and Yazeed Al-otaibi

Supervisor: Dr. Ibrahim B. Mansir

1st Semester 2021/2022 (GP1)

ABSTRACT

The production of electricity by traditional energy methods includes many effects such as causing an increase in global warming and environmental effects. One way to get rid of these effects is to use solar photovoltaic-thermal (PVT) systems. In this project, an intensive literature review about solar air and water PVT systems were conducted. Selections of solar air and water PVT systems and solar photovoltaic (PV) cell type were conducted. Selection of the proposed concepts of PVT systems to be designed and developed in graduation project 2 were conducted.

INTRODUCTION

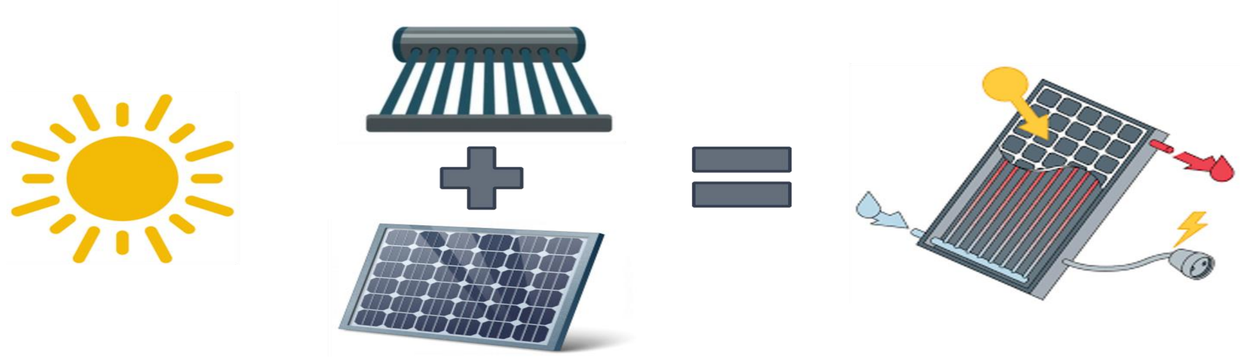
The emerging concerns over the fossil-fuel depletion, global warming and environmental pollution have promoted the use of efficient energy processes. Renewable technologies are based on clean sources of energy and the optimal use of these resources minimize environmental effects. One of these sources is solar energy. Solar energy can be utilized by ***solar thermal systems*** which convert solar energy into heat, ***PV systems*** to produce electricity by photovoltaic effect**,** and ***PVT systems*** which combine the use of thermal and PV systems.

OBJECTIVES

- Conduct an intensive literature survey in the topic.
- Identify the main design parameters of the air and water PVT systems.
- Identify the mathematical models for designing water and air PVT systems.
- Select suitable concepts of the PVT systems to be developed in project (2).

LITERATURE REVIEW

Solar PVT systems combines the functions of two technologies, thermal and PV technologies. Solar PVT system solves the issue of increasing PV cell temperature that result in decrease in its performance. Solar PVT system uses a working fluid to extract the excess heat in the PV cell. Common PVT systems use air or water as a working fluid.



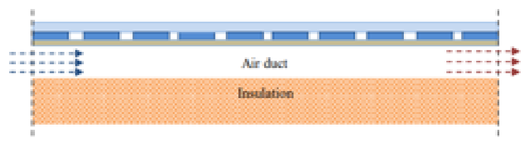
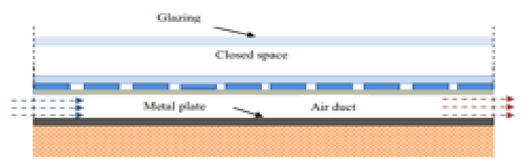
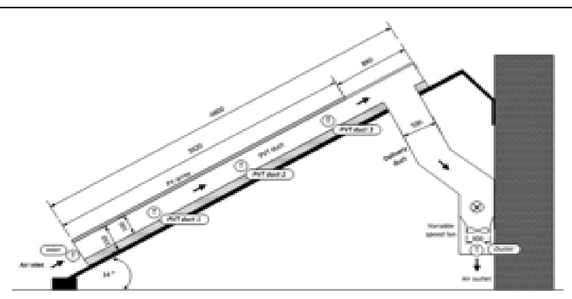
SOLAR PVT SYSTEM

CONSTRAINTS

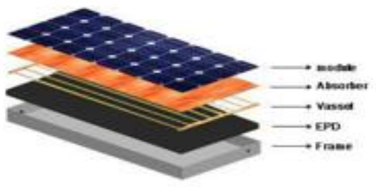
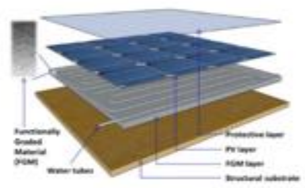
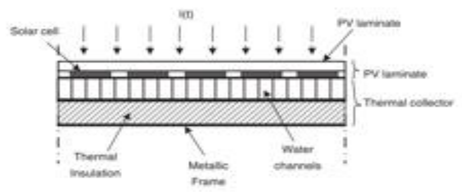
This study takes in consideration the following constraints:

- Economy
- Environment
- Safety
- Ethical
- Political
- Social
- Sustainability
- Technical

PREVIOUS WORK ON SOLARAIR PVT SYSTEMS

S.N	Description	ΔT (°C)	η_{th} (%)	η_{el} (%)	Configuration
1	Conventional air PVT Collector with natural circulation [42]	4.47	21.19	10.73	
2	Single glazed air PVT Collector with natural circulation [42]	6.7	40.77	10.33	
3	Unglazed air PVT Collector with forced circulation [43]	7	55	12.2	

PREVIOUS WORK ON SOLAR WATER PVT SYSTEMS

S.N	Description	ΔT (°C)	η_{th} (%)	η_{el} (%)	Configuration
1	Unglazed water PVT collector with forced circulation [44]	3.3	30	17	
2	Water tubes PVT collector with forced circulation [45]	16.1	59.4	15.82	
3	Parallel-plate water PVT collector with forced circulation [46]	22	39.4	11.5	

MATHEMATICAL MODELING

Useful thermal energy and thermal efficiency can be calculated by

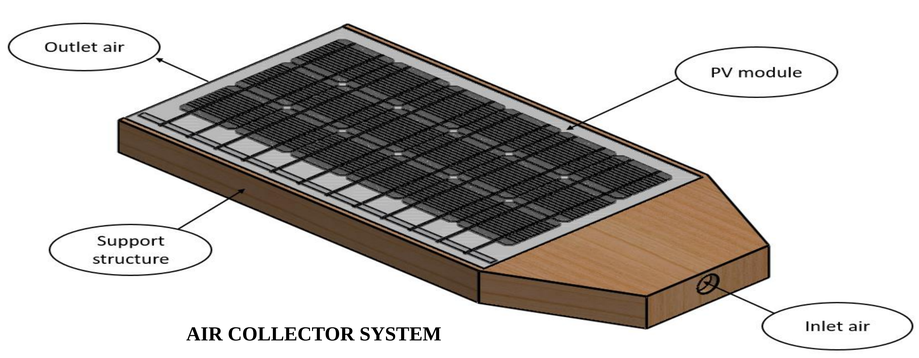
$$\dot{Q}_u = \dot{m} \times C_P(T_{fo} - T_{fi}), \qquad \eta_{th} = \frac{\dot{Q}_u}{G \times A_C}$$

Electrical power, electrical efficiency, and overall efficiency can be calculated by

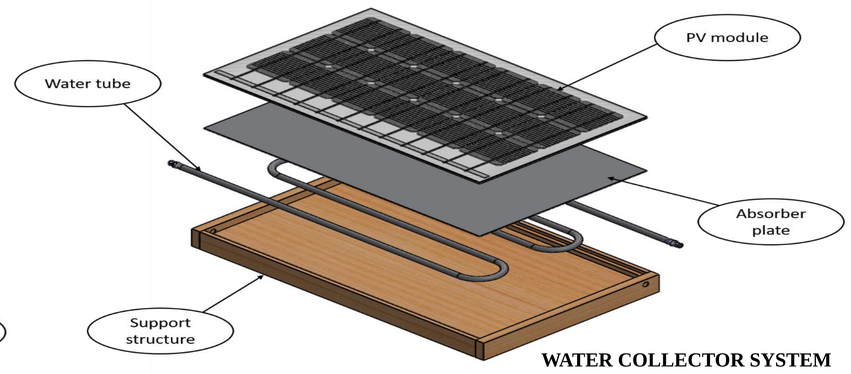
$$P_{max} = I_{mp} \times V_{mp}, \qquad \eta_{el} = \frac{P_{max}}{G \times A_C}$$

$$\eta_{overall} = \eta_{el} + \eta_{th}$$

PROPOSAL CONCEPTS



AIR COLLECTOR SYSTEM



WATER COLLECTOR SYSTEM

FUTURE PLAN

- Design and construct the air and water PVT systems.
- Conduct experimental measurements of the systems.
- Thermal analysis of the air and water PVT systems.

CONCLUSION

An intensive literature review about solar air and water PVT systems, selection of the systems, and the proposal concepts were conducted.

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