THERMAL MANAGEMENT OF PV SOLAR PANEL

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DEFINITION OF THE PROBLEM

- One of the most common renewable sources of energy is solar energy. Solar energy refers to the utilization of radiant light and heat emitted by the Sun.
- PV solar Panel is one of the ways to harness this energy.
- It is observed that only a small amount of energy from sunlight is converted into electricity and most of it goes to heat up the solar panels.
- Solar radiation has contradictory effects: on one hand it increases the electricity generation by the solar panel on the other hand heat pile up inside the solar panel negatively impacts the efficiency of solar panel.
- Hence it is essential to cool down the solar panel so that we can get optimized output from the solar panels.

LITERATURE REVIEW

1. **Title**-"Experimental investigations of spray flow rate and angle in enhancing the performance of PV panels by steady and pulsating water spray system"

   Link-https://doi.org/10.1007/s42452-021-04169-4

   Authors-Mojtaba Nateqi,Mehran Rajabi Zargarabadi, Roohollah Rafee

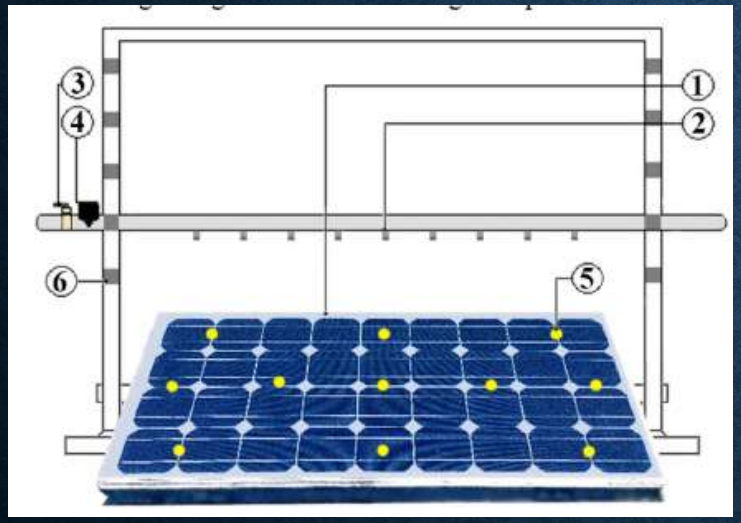
   Review- This paper talks about the effects of changing various parameters like spray angle, nozzles to PV panel distance, number of nozzles, and pulsating water spray on the PV panel performance for spray cooling on front side. It concludes that low spray angle , low nozzles to panel distance and higher no. of nozzles increases the electrical efficiency and pulsating water spray reduces water consumption by half as compared to steady water spray with very small loss in efficiency. It also tells us how cooling from front side has a cleaning effect to it.

2. **Title**-" An efficient pulsed- spray water cooling system for photovoltaic panels: Experimental study and cost analysis"

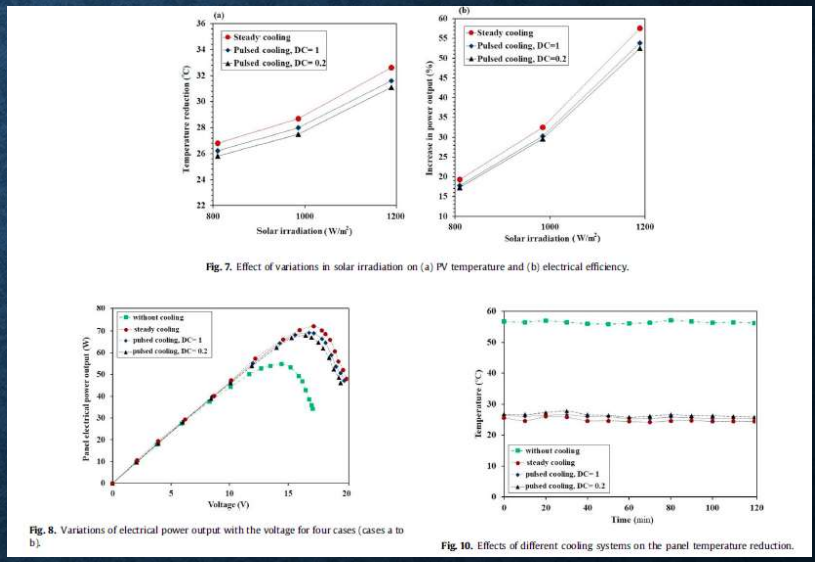
   Link-https://doi.org/10.1016/j.renene.2020.09.021

   Authors-Amirhosein Hadipour , Mehran Rajabi Zargarabadi , Saman Rashidi

   Review-This paper discusses about pulsed spray cooling from front side rather than traditional steady spray cooling in detail and also highlight how very less water is required for cooling in pulsed as compared to steady spray cooling. Another additional information it discusses is that reflection of solar radiation by water film is small and absorption of solar radiation occurs in red infrared region but efficiency of solar panels is affected by visible portion of solar radiation.



Standard Spray cooling distribution system



OBJECTIVES

- In this BTP ,Thermal Management of PV solar panel is to be done since at higher temperature , the efficiency of the PV solar panel decreases.
- The project aims at designing a water spray cooling system for the heated solar panel to improve its efficiency.
- The solar panel used is a monocrystalline PV panel with maximum power of 75 W and a size of 60.5*67*3.5 cc.
- In this project three panels are compared, one representing reference solar panel with no cooling, next one with a designed water spray cooling distribution system and last one with a standard water spray cooling distribution system.
- The parameters used for comparison are voltage , output power , Temperature and electrical efficiency.

NOVELTY OF PROPOSED WORK

- After literature review,front end spray cooling distribution system has been decided to be used in this BTP due to its added benefits as discussed before.
- The experiments will be started with basic spray cooling distribution system proposed by other researchers and through the experience gain the design of new spray cooling distribution system will be explored and implemented

METHODOLOGY AND WORK PLAN

- In this experiment , the parameters used are temperature, voltage, power ,solar radiation intensity and electrical efficiency.
- Temperature is measured using K type thermocouples . The output of these thermocouples is logged and stored in 34972A Agilent Data logger . The voltage is measured across a resistor load directly by Agilent 34901A 20 channel Multiplexer and stored in the data logger.
- The solar radiation intensity is measured using Fluke FLK-IRR1-SOL solar irradiation meter.
- The electrical efficiency is calculated using solar radiation as input power per unit area and output power calculated from recorded voltage.

- Using the above measured parameters the three solar panels , one representing reference solar panel with no cooling, next one with a designed water spray cooling distribution system and last one with a standard water spray cooling distribution system will be compared.

EXPERIMENTAL DETAILS

Solar panel 1

Compartment for solar irradiation meter

Support for water supply line

Solar panel 2

Clamping system for thermocouples

Extra link to change height of water distribution system

1. **Solar panel 1:** Solar panel for proposed water spray cooling distribution system
2. **Solar panel 2:**a standard water spray cooling distribution system where four nozzles will be used along upper edge of solar panel , one for each column.
3. **Solar panel 3:** reference solar panel with no cooling

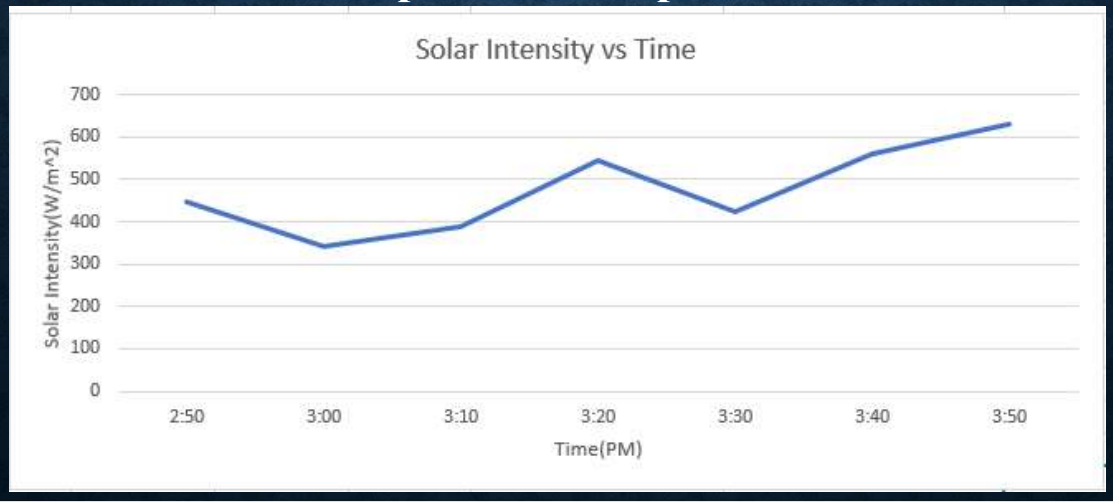
   Solar panel stand is designed such that solar panel tilt angle is around 19 degrees and it is facing the south direction to receive maximum sunlight throughout the day.

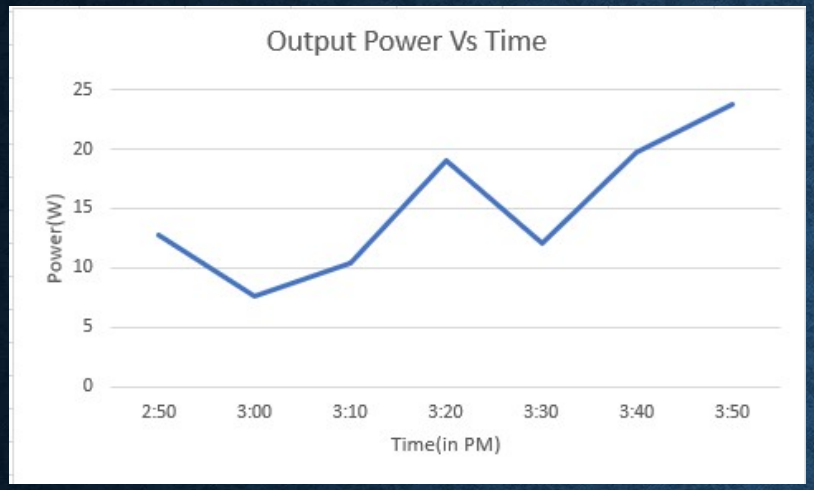
INITIAL EXPERIMENTS

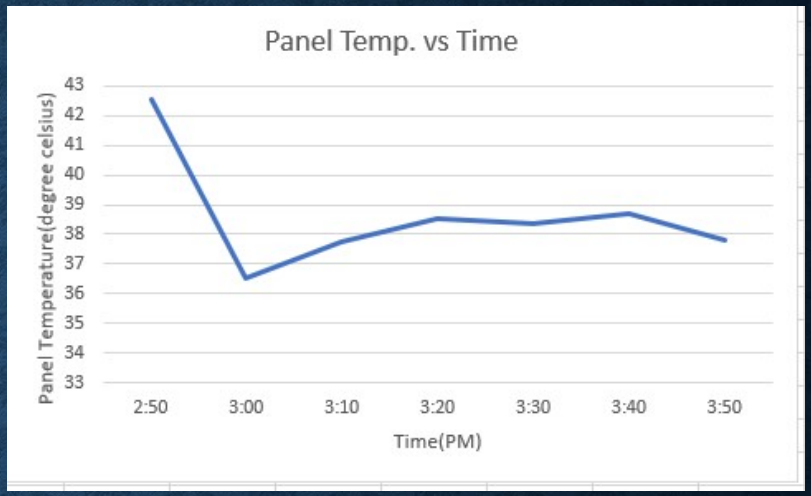
Readings for solar panel 3

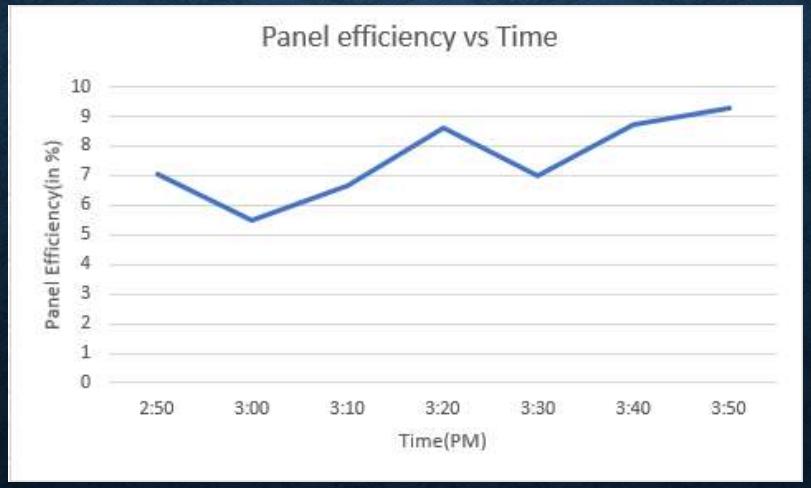
Sr. no.	Time(PM)	Voltage(V)	Power(W)	Temp(celsius)	Solar Intensity(W/m^2)	Efficiency(%)
1	2:50	8.23	12.77979	42.54	447	7.0531984
2	3:00	6.36	7.632	36.51	343	5.489263319
3	3:10	7.44	10.44408	37.73	387	6.657771092
4	3:20	10.05	19.05708	38.55	545	8.626399644
5	3:30	7.99	12.0453	38.35	425	6.991954309
6	3:40	10.24	19.78445	38.69	561	8.700235434
7	3:50	11.23	23.79489	37.82	631	9.30302325

Graphs for solar panel 3




Output Power Vs Time
Power(W)
25
20
15
10
5
0
2:50
3:00
3:10
3:20
3:30
3:40
3:50
Time(in PM)


Panel Temp. vs Time
Panel Temperature(degree celsius)
43
42
41
40
39
38
37
36
35
34
33
2:50
3:00
3:10
3:20
3:30
3:40
3:50
Time(PM)


Panel efficiency vs Time
Panel Efficiency(in %)
10
9
8
7
6
5
4
3
2
1
0
2:50
3:00
3:10
3:20
3:30
3:40
3:50
Time(PM)

CONCLUSION

- In conclusion, the project findings will help in developing the effective thermal management system based on spray cooling for PV panels, which can simultaneously work as cleaning system for PV panels.
- It is aimed to develop new design of spray network for the cooling of PV panels and compare the performance of proposed system with conventional system suggested by other researchers.
- It is also aimed to study the effect of various parameters such as height of spray nozzles from solar panel etc.

THANK YOU