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Construction of Photoelectric Thermal Performance Evaluation Experimental Platform for PVT- Hot Water Module

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Abstract: As a new type of energy utilization method, hybrid photovoltaic-thermal solar system has been paid more and more attention by scholars in recent years. In this project, the performance test platform of PVT- hot water component is set up to study its photoelectric and photo thermal performance. In meteorological parameters of typical conditions the photoelectric thermal performance evaluation experimental platform for PVT- hot water module is set up so that PVT- hot water components of the photoelectric properties and thermal properties can be evaluated by some tests such as working fluid inlet and outlet temperature and flow rate, and the maximum power point of the output voltage and current.

Keywords: PVT system, Experiment platform, Performance evaluation, Hot water assembly.

1. Introduction

The people gathering energy from the earth 99% from solar energy[1].According to the relevant data, the total radiation energy of the solar energy reaching the earth is about 177 ×1017 kW, and 30% of the solar energy is reflected back to the universe in the form of light[2]. The solar photovoltaic cells relied on their input light energy indefinitely are more and more people's favor[3]. However, in the application process, the efficiency of solar cell will decrease with the increase of the surface temperature of the battery. The research shows that the relative electric efficiency drops by 0.5% when the temperature of the battery increases by 1 degrees centigrade.[4] It has been proposed that will make the battery temperature heat recycle, which can make the battery temperature is maintained at a low level, but also can get additional heat gains, and solar photovoltaic / thermal integrated system came into being.

In view of such a new energy utilization system, many scholars have done a great deal of work. Compared with earlier research object for air cooling cooling panel, as most of the solar cell for the purpose, but actually even increases the heat preservation measures, by the air medium to collect heat is still relatively fragmented, difficult to use, so the later research more focused on water cooling panel. In the aspect of water cooled panel, many scholars have carried out experimental research. De and Zondag Vries made tube plate electric panel and the actual measurement results show that the electric panel ensures higher electrical efficiency at the same time, can provide additional heat efficiency higher than 50%, and the influence of temperature is lower than the traditional panels[5]. Huang and other scholars using the heat collecting plate built-in channel scheme, and the heat collecting plate material is composed of copper into a cheap polycarbonate corrugated plate[6]. In the system composed of the panel (non thermal insulation) and the heat preservation water tank, water pump and pipeline, the measurement result shows that the maximum temperature of the battery is 52 degrees centigrade, only within 4 degrees of the water in the tank[7]. Ji Jieand Cheng Hongbo designed a home built on the flat box Aluminum Alloy flat type solar water heater based on natural circulation type PVT experimental system, the system as a whole has high efficiency but also can obtain high temperature hot water.

In this project, the performance test platform of PVT- hot water component is set up to study its photoelectric and photo thermal performance on the basis of previous studies.In meteorological parameters of typical conditions the photoelectric thermal performance evaluation experimental platform for PVT- hot water module is set up so that PVT- hot water components of the photoelectric properties and thermal properties can be evaluated by some tests such as working fluid inlet and outlet temperature and flow rate, and the maximum power point of the output voltage and current.

2. Construction of Test Platform

PVT- hot water component performance evaluation experiment of photovoltaic thermal system platform is set up in two floor of training building of Guangdong University of Science & Technology and the physical diagram of test table is as seen firure1.

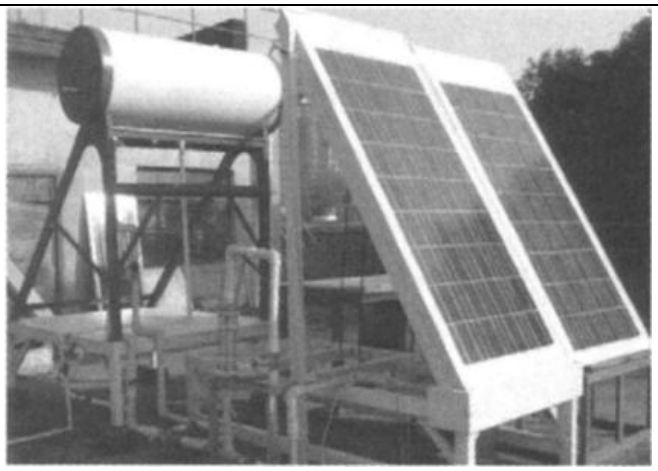

Figure 1: Physical diagram of test table

This platform can accept good solar radiation all day long ,and solar panel system has two pieces of the same appearance, one of which is a PVT component installed collector as shown in figure 2 and figure 3.

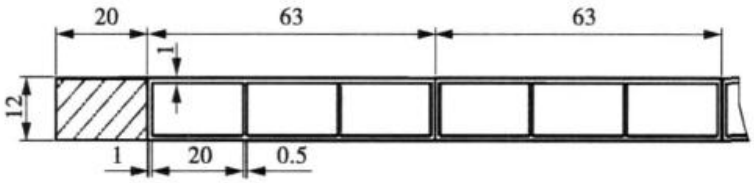

Figure 2: Local sectional drawing of the collector

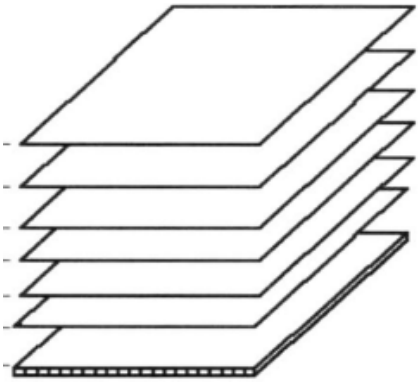

Figure 3: Schematic diagram of PVT component structure

From top to bottom are glass plates, EVA, batteries, EVA, opaque TPT, heat insulation glue and heat collector.

The test-bed test system, shown in Figure 4, consists of 6 temperature measurement points, 1 open circuit voltages and 1 short-circuit current test sections. In order to investigate the uniformity of the cooling of the back panel of the battery, 6 thermocouples are arranged in the length direction of the battery board for comparison.

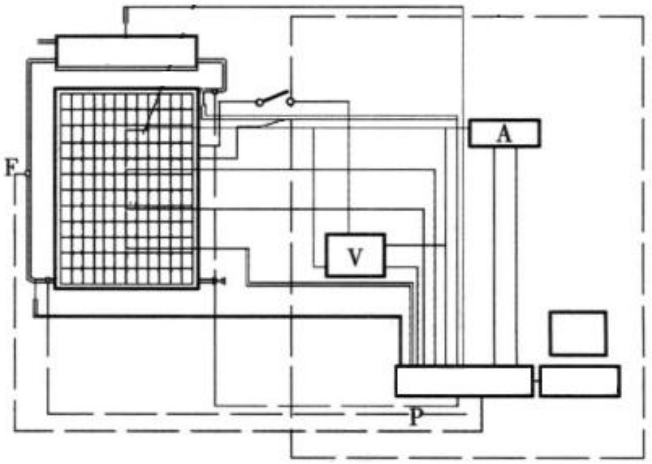

Figure 4: Schematic diagram of testing system

By contrast experiment, the PVT component and the ordinary battery component are placed south at the angle of 45 degrees, and the height is 0.8m. From 11:00 to 15 :00 of the sun's steady radiation, the temperature acquisition system reads and records data at every 5 min. Real time monitoring of the temperature changes of the backplane of PVT components.

3. Experimental data acquisition

From March 6, 2017 noon from 11: 00 to 13: 00, 1, 2 data list, the solar radiation in this period of time has reached the maximum of the day, and then a few clouds the sky due to occlusion, the collector PVT components into a thermal insulation device, influence the efficiency of PVT system. Therefore, the two parts of data are considered separately. The average temperature of the components is the average value of the temperature of the four measuring points on the backplane, and the system's circulating water flow is 100 L/ H.

Table 1: Experimental data from 11:00 to 12:00

Temperature	*Tin*	*Tout*	*Tpvt*	*Tn*	*Ta*	$\triangle T$
11:00	19.1	23.5	28.2	42.2	12.5	14.0
11:05	19.3	23.8	28.4	42.5	12.3	14.1
11:10	19.6	24.0	28.5	43.1	12.7	14.6
11:15	19.6	24.1	28.7	43.3	12.9	14.6
11:20	19.9	24.4	29.4	43.9	13.6	14.5
11:25	20.8	24.8	29.1	44.1	13.8	15.0
11:30	21.5	25.2	29.8	44.0	13.5	14.2
11:35	22.3	25.5	30.2	44.5	14.2	14.3
11:40	23.4	25.8	30.5	44.7	14.6	14.2
11:45	24.7	26.1	31.3	44.9	15.0	13.6

Table 2: Experimental data from 12:00 to 13:00

Temperature	*Tin*	*Tout*	*Tpvt*	*Tn*	*Ta*	$\triangle T$
12:00	24.3	26.4	30.1	38.1	12.1	8.0
12:05	24.2	26.7	30.1	38.3	12.8	8.2
12:10	24.5	26.5	30.6	38.5	12.6	7.9
12:15	24.6	26.8	30.9	39.4	12.6	8.5
12:20	24.7	27.1	31.0	39.6	13.3	8.6
12:25	25.4	27.4	31.2	39.9	13.4	8.7
12:30	25.9	27.8	31.5	40.1	13.7	8.6
12:35	26.2	27.9	31.7	40.3	14.0	8.6
12:40	26.5	28.2	32.2	40.4	14.3	8.2
12:45	26.6	28.5	32.0	40.7	14.9	8.7

At noon, the sky was clear and Shaoyang, inlet water temperature of heat exchanger is low, then you can see the PVT component relative to the common advantage of battery components. After calculation, the average temperature difference between PVT component and common component is 12.56 DEG C between 11 and 00 to 12 to 00. As the midday sun is obscured by a few clouds in the sky, the solar radiation decreases and the temperature of the solar panel is lowered. As a result of the cooling of the ambient winds, the temperature of the common battery components begins to decrease. Because of the heat preservation function of the collector, the temperature of the PVT battery component fluctuates little. Thus, although the average temperature difference between the two has been reduced, the PVT component can maintain a relatively stable temperature to maintain a stable output of electrical power.

4. Experimental Result Analysis

As shown in Figure 5, the triangle represents the temperature of the PTV component and the square represents the common component temperature and the diamond represents the ambient temperature. Theambient temperature remains at (15~25) C throughout the day, and the average temperature of the PVT component is no more than 32 degrees throughout the day, while the ordinary battery is over 40 at noon. In the afternoon of 14: 00, PVT module temperature is higher than that of common components, but there is still no more than 35 degrees, this is because the intensity of solar radiation in the afternoon is greatly reduced, and the environment temperature is relatively low, 30 degrees of water specific heat at constant pressure of 3.958 J / (G - K), and 10 at ambient temperature C, air specific heat is only 0.985 J / (G - K), so heat common battery components much faster than the PVT component.

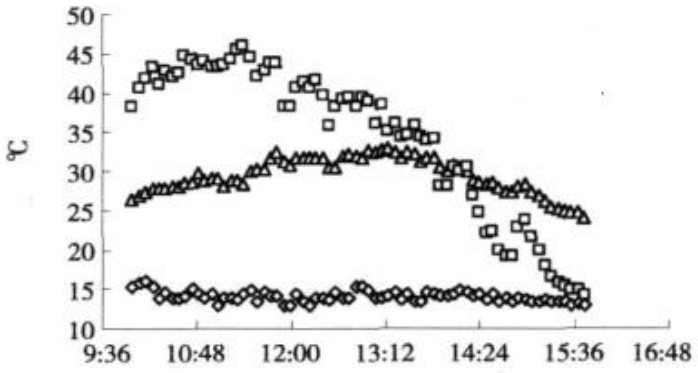

Figure 5: The change of mean temperature with time

As shown in Figure 6, The triangle represents the inlet water temperature and the square represents the outlet water temperature and the diamond represents the ambient temperature. The same effect is reflected in the change of heat collector water inlet and outlet temperature on the 14: 00 after the solar radiation intensity is reduced, continued to decline in the ambient temperature, the heat collector is more heat flow through the collector to heat environment, abnormal phenomenon of water the inlet temperature is higher than the outlet temperature.

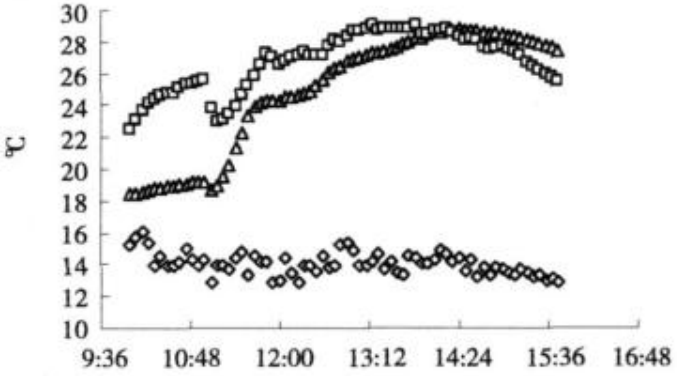

Figure 6: The variation of water temperature at inlet and outlet of collector

5. Conclusions

The present study focuses on solar photovoltaic and thermal system, firstly focused on the parameters and characteristics analysis of influence of photoelectric properties of PVT components by photo thermal; focus on the feasibility study of PVT architecture integration, PVT hot water system and combined operation of PVT-heat pump heating system, which involves in order to solve the heating demand based PVT cogeneration system, and there is no it is reported, in domestic issues. Therefore, it is necessary to study the key issues of PVT cogeneration system design and operation through theoretical analysis, numerical simulation and experimental research.

Acknowledgments

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