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Electrical Characteristic Analysis of Photovoltaic Thermal With And Without ∇-Groove Absorber

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ABSTRACT

The photovoltaic thermal (PVT) system is an up-and-coming renewable energy technology that simultaneously produces thermal and electrical energy. The objective of this paper is to improve the electrical efficiency of the photovoltaic thermal system with and without ∇-groove absorber. This study is an experimental investigation under an indoor solar simulator at The National University of Malaysia. The electrical characteristic of the PVT system is characterized by the scheming current (*A*), voltage (*V*), power (*W*) curves. The solar intensity and mass flow rate affected the electrical characteristic. The increase of produced power and electrical efficiency is caused by increasing the solar intensity and mass flow rate. The comparison between ∇-groove absorber and without ∇-groove absorber shows that the use of ∇-absorber can increase electrical efficiency.

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1. INTRODUCTION

Thermal and electrical energy can be harvest by solar energy. Many technology achievements occurred to connect the energy from the sun and practiced it in the application. The heat of the photovoltaic panel is utilized for the application of PVT technology. The elimination of heat from the PV panel is transferred by fluid (water or air); it is called the cooling process to improve electrical efficiency. The heat useful is converted to hot water or hot air for the current application. The main benefits of the PVT system are that its system can produce thermal and electrical simultaneously, for any application, such as for cooling, heating, and drying. For efficiency, a combination of photovoltaic panels and solar thermal is good for limited space.

For the cheap and practice, integration of the PVT system in the building is negligible variation, manufacture and material can be reduced significantly. PVT system is a hybrid technology between the photovoltaic cell and solar heater technology. The photovoltaic panel problem is overhead when the PV panel is treated under the sun, the PV panel temperature increases obviously. It becomes electrical efficiency decreased. To increase electrical efficiency, this overheat is removed by transitory a heat removing fluid by air or water under PV panel [1]-[9].

The electrical and thermal efficiency of PVT based-air was conducted by Hazami et al. [10]. Using energy study, electrical and thermal efficiency was 15% and 50% correspondingly. The theoretical and experimental approach of PVT performances was studied by Slimani et al. [11] for unintended solar dryers. The results of electrical, thermal and all performances of the PVT system were 10.5%, 70%, and 90%, respectively. Ameri and Glolampour [12] analyzed PVT with flat transpired collectors by theoretical and experimental investigation. With the energy equation, thermal and PVT efficiency was 69.9% and 55% respectively. In condition warm summer and cold winter region, Li et al. [13] have done analysis thermal and

PVT air absorber with a theoretical and experimental study. Electrical and Thermal and PVT efficiency was 12.4%, 50%, and 77.7%, respectively.

Azriyenni et al. [14] have done an experimental investigation of solar radiation effect with different Module slope angle. The different slope angle namely is 300, 400 and 500 respectively. The effect of weather conditions, likely sunny or cloudy, have been analyzed. The yield of the experimental presented the overhead condition achieved the voltage produced by the photovoltaic system. Ananth and Kumar [15] have simulated the solar PV inverter by A Matlab/ Simulink. The results show that the inverter is fewer voltage and current harmonic gratified. Razman et al. [16] have introduced the reverse triangular number of PV model and the operational point with PV emulator. The PV model analysis results by the PV model have been computed correctly. Sunita and Kdhir et al. [17] have designed the controlling of the photovoltaic integrated hybrid multilevel inverter. The offered model is tested by Matlab or Simulink as simulation tools.

An integrated collector between V-Absorber and plat plate absorbers as a collector in the PVT system is called ∇-Absorber. The use of V-Absorber to cooling of Photovoltaic panel based-on air improved the thermal performance [18]-[21]. In this study, the v-groove is changed by the ∇-Absorber. An integrated collector between V-Absorber and plat plate absorbers as a collector in the PVT system is called ∇-Absorber. Two materials will expend surface area contact of photovoltaic. Heat conductivity by using ∇-Absorber is expected to be higher than v-groove alone. The modification of v-groove to expand the performance is designed with ∇-groove. The purpose of this design is to improve heat conductivity. The surface's conductivity in contact is expected to increase the heat conductivity that touches the photovoltaic panels (PV). However, the use of ∇-groove is expected to contact all of the photovoltaic panel's backsides. Heat transfer can be expected to increasing the performance of the PVT system. This paper proposes the electrical characteristic with experimental indoor testing of photovoltaic thermal with and without ∇-Absorber.

2. RESEARCH METHOD

The material of this research is ∇-absorber which was produced from a bar of aluminum. There are 13 units of the bar. The width and length are 3.4 cm and 114 cm respectively. The vertex angle of ∇-absorber is 60^{o}. The ∇-absorber was positioned under a photovoltaic or PV panel. The photovoltaic panel was used by monocrystalline of 100 Watt. For the design and equation detailed and explained in reference [22]. The solar simulator is used to trying indoor with the experimental investigation. The simulator was made with 40 halogen lamps, and the intensity of the simulator measured by the voltage regulator. Before collecting data such as the temperature of the PVT system, the PVT system ensured until balance condition around 30 minutes. The installation of PVT with and without ∇-absorber with the variation of mass flow rate and solar intensity in Solar Energy Research Institute (SERI), The National University of Malaysia as Figure 1. The variations of voltage and current are recorded by the electronic load with model 8500 from BK precision as Figure 2.

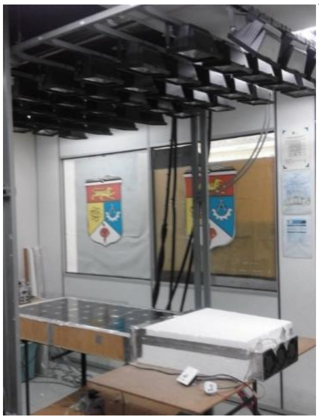

Figure 1. Indoor experimental of PVT with and without ∇-absorber

Figure 2. Electronic load model 8500 from BK precision

An amount of real I-V typical is the fill factor of a Photovoltaic panel or cell. The fill factor is formulated as

$$FF = \frac{P_m}{V_{oc} x I_{sc}} \quad (1)$$

Where the maximum power ratio is P_m, Open circuit voltage product is V_{oc} and closed circuit current is I_{sc}. The structures of the PVT system are described by subsequent I-V curved countryside of the curve. The curve variation is resulted by changing temperature (T_{pv}) and solar intensity (S) PVT system. The power maximum is calculated as

$$P_m = V_m \, x \, I_m \quad (2)$$

Where P_m is power maximum, V_m and I_m are the maximum voltage and current of PVT system respectively. The electrical efficiency is calculated as [23-28]

$$\eta_{pv} = \frac{P_m}{SA_c} \quad (3)$$

Where S is the solar intensity and A_c is the surface of an area of the absorber.

3. RESULTS AND DISCUSSION

The electrical characteristic of PVT based-air with and without ∇-absorber has been conducted under the solar simulator. The consequence of solar intensity and mass flow rate variation of the PVT system with ∇-absorber has been shown in Figures 3 and 4, as summarized in Table 1. Table 1 shows the electrical characteristic with voltage (V_{sc}) versus current (I_{sc}) and power (P_m) at the solar intensity of 520 W/m^2 and 820 W/m^2. The maximum current (I_{sc}) of the PVT system with ∇-absorber is 1.60 Ampere with a mass flow rate of 0.0069 kg/s and the maximum voltage (V_{sc}) is 18.77 volts with a mass flow rate 0.0491 kg/s. Optimum electrical efficiency is 4.22% at the mass flow rate of 0.0069 kg/s. The decreased mass flow rate from 0.0491 kg/s to 0.0069 kg/s of PVT ∇-absorber increased the current (I_{sc}), Power (P_m) and electrical efficiency.

Table 1. Electrical characteristic of photovoltaic thermal with ∇-absorber under solar intensity and mass flow rate variation

Solar intensity (W/m^2)	Mass flow rate (Kg/s)	Isc	Voc	Pm	FF	η_{PV}
820	0.0069	1.60	17.02	22.01	0.81	4.22
	0.0353	1.57	17.84	21.00	0.75	4.03
	0.0491	1.49	18.14	20.00	0.74	3.83
520	0.0069	0.89	18.13	12.20	0.76	3.69
	0.0353	0.86	18.41	12.08	0.76	3.65
	0.0491	0.82	18.77	11.97	0.78	3.62

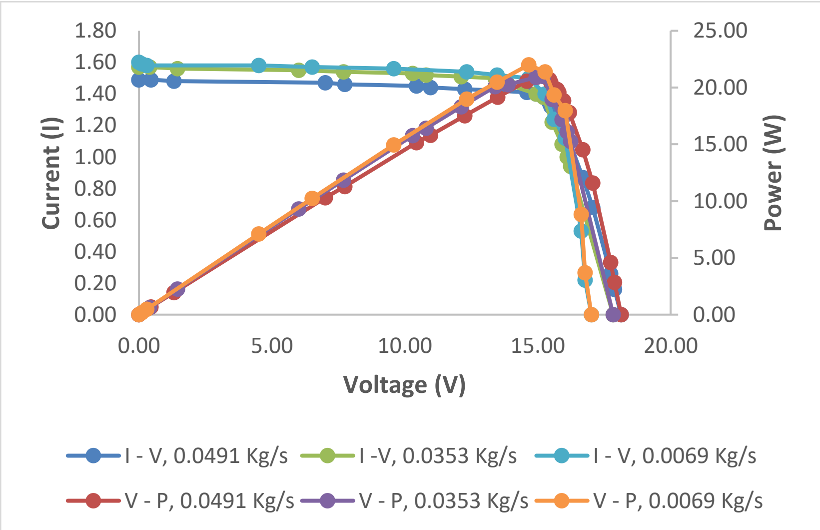

Figure 3. voltage (V), Current (A) and Power (P) of PVT with ∇-absorber at the solar intensity of 820 W/m^2

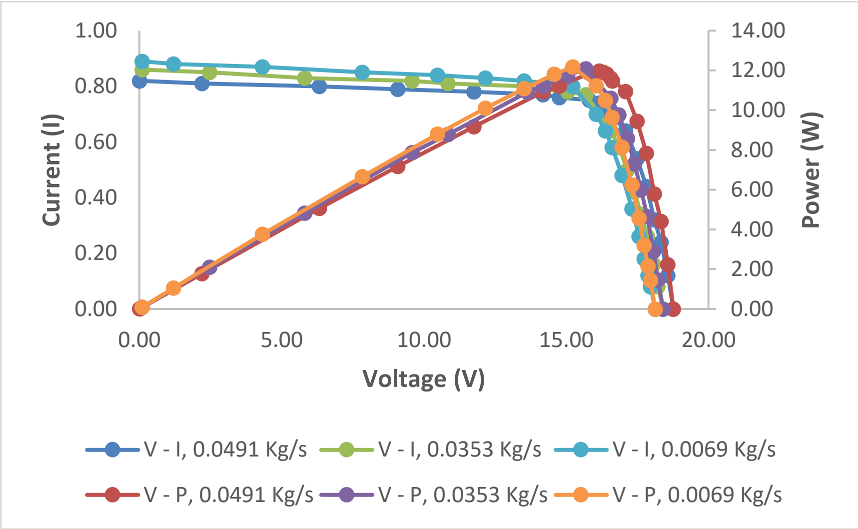

Figure 4. voltage (V), Current (A) and Power (P) of PVT with ∇-absorber at the solar intensity of 520 W/m^2

Figures 5 and 6 show the difference between Power and current versus voltage of PVT without ∇-absorber at the solar intensity of 820 W/m^2 and 520 W/m^2. Table 2 shows the electrical characteristic with voltage (V_{sc}) versus current (I_{sc}) and power (P_m) at the solar intensity of 520 W/m^2 and 820 W/m^2. The maximum current (I_{sc}) of a PVT system without ∇-absorber is 1.57 Ampere with a mass flow rate of 0.0069 kg/s and maximum voltage (V_{sc}) is 18.36 volt with a mass flow rate of 0.0491 kg/s at the solar intensity of 520 W/m^2. Optimum electrical efficiency is 3.98% at the mass flow rate of 0.0069 kg/s. The decreased mass flow rate from 0.0491 kg/s to 0.0069 kg/s of PVT without ∇-absorber increased the current (I_{sc}), Power (P_m) and electrical efficiency.

Table 2. The electrical characteristic of photovoltaic thermal without ∇-absorber under solar intensity and mass flow rate variation

Solar intensity (W/m^2)	Mass flow rate (Kg/s)	Isc	Voc	Pm	FF	η_{PV}
820	0.0069	1.57	17.09	22.78	0.76	3.98
	0.0353	1.54	17.49	20.63	0.77	3.96
	0.0491	1.50	17.97	20.49	0.77	3.93
520	0.0069	0.92	17.56	12.26	0.76	3.71
	0.0353	0.89	18.09	12.17	0.76	3.68
	0.0491	0.87	18.36	12.13	0.76	3.67

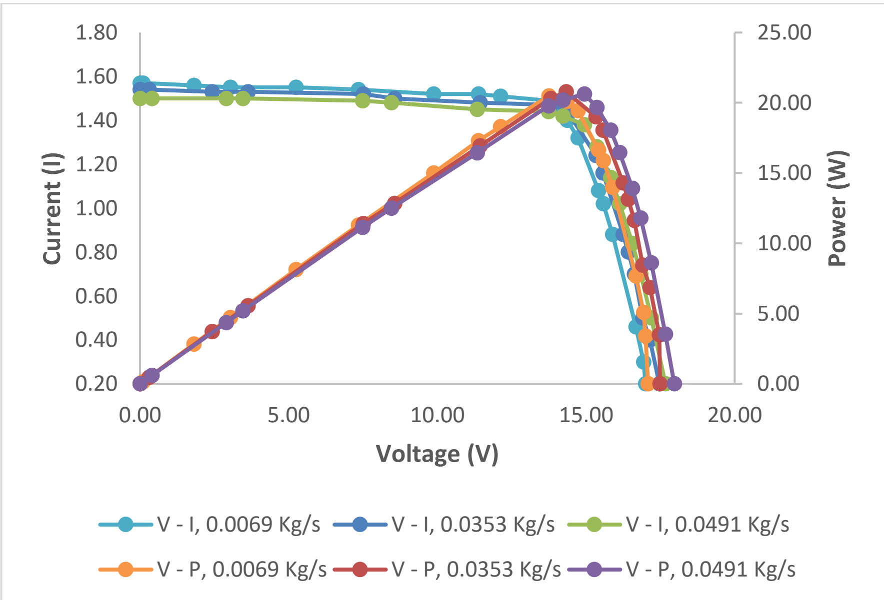

Figure 5. Voltage (V), Current (A) and Power (P) of PVT without ∇-absorber at the solar intensity of 820 W/m^2

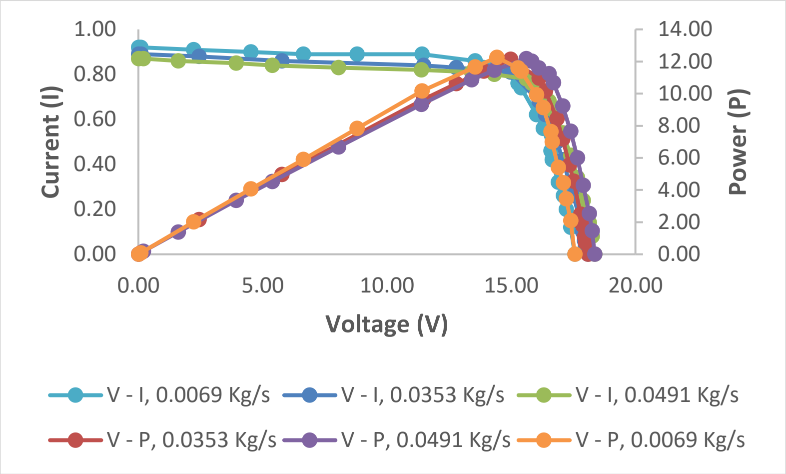

Figure 6. Voltage (*V*), Current (A) and Power (P) of PVT without ∇-absorber at the solar intensity of 520 W/m^2

The graphs from Figures 3-6 show the comparison between PVT with ∇-absorber and without ∇-absorber. The experiments were tested on the mass flow rate from 0.0069 kg/s to 0.0491 kg/s and under the solar intensity of 520 W/m^2 and 820 W/m^2. Moreover, for the PVT with ∇-absorber, the electrical efficiency increases from 3.62 % to 4.22 %, and for the PVT without ∇-absorber, the electrical efficiency increases from 3.67 % to 3.98 %. The results show that the use of ∇-absorber increases the performance of electrical efficiency.

Table 3. The previous study of the PVT system

References	Design of absorber to cooling PV	Finding
Hernandez et al. [29]	Segmented fins	Electrical efficiency enhancement of 4%
Zhao et al. [30]	Small cell with a glass	Electrical efficiency of 12.4%
Selimefendigil et al. [31]	Two fins thicknesses	Power enhancement reached 7.26
Mojumder et al. [32]	Unglazed PVTC and rectangular fins attached to thin flat sheet	The maximum electrical efficiency is 14.03%
Nishioka et al. [33]	CPV and Fresnel lenses	Electrical efficiency increased by 0.5%
Dubey et al. [34]	Glass to glass and glass to tedlar	0.66 % outcome different with and without channel
Liu et al. [35]	CPC with microencapsulated phase change slurry	enhanced electrical efficiency 1.8%
Lee et al. [36]	Nanofluids PVT system	The electrical efficiency of 12.80%.
Present study	∇-absorber	The electrical efficiency increased by 0.6%

Table 3 shows the previous study of the PVT system to cooling the photovoltaic module. The variation design to absorber is fins, nanofluid, CPC, microencapsulated, glass, and others. The use of unglazed PVTC and rectangular fins attached to a thin flat sheet reaches the maximum electrical efficiency is 14.03%. The electrical efficiency of a PVT system with nanofluid is 12.80%. The enhancement of electrical efficiency with concentrator photovoltaic module (CPV) and CPC with microencapsulated of 0.5% and 1.8%, respectively, aligns with our outcome in this paper. The increase of the PVT system depends on the parameters of the PVT system. The parameters are solar intensity, mass flow rate, fluid, type of absorber, and photovoltaic module type.

4. CONCLUSION

Electrical characteristic analysis of the PVT system with and without ∇-absorber has been conducted under the solar simulator. The maximum current (Isc), Voltage (Vsc), Power (Pm) and electrical efficiency are 1.60 A, 18.77 V, 22.01 W, and 4.22% respectively in PVT system with ∇-absorber. The comparison of electrical characteristics between with ∇-absorber and without ∇-absorber shows that the use of the ∇-absorber is higher performance than without ∇-absorber.

REFERENCES

[1] R. Kumar and M.A. Rosen, "A Critical Review of Photovoltaic-Thermal Solar Collectors for Air Heating," Applied Energy, vol. 88, no.11, pp. 3603-14, 2011.
[2] N,S. Nazri, et al., "Energy Economic Analysis of Photo-Voltaic–Thermal-Thermoelectric (PVT-TE) Air Collectors," Renewable and Sustainable Energy Review, vol. 92, pp. 187-97, 2018.
[3] N,S. Nazri, et al., "Mathematical Modeling of Photovoltaic Thermal-Thermoelectric (PVT-TE) Air Collector," International Journal of Power Electronics and Drive Systems (IJPEDS), vol. 9(2), pp. 795-802, 2018.

[4] M. Zohri, et al., "Exergy Assessment of Photovoltaic Thermal with V-Groove Collector Using Theoretical Study. TELKOMNIKA (Telecommunication, Computing, Electronics and Control), vol. 16(2), pp. 550-57, 2018.
[5] A. Fudholi, et al., "R&D of Photovoltaic Thermal (PVT) Systems: An Overview." International Journal of Power Electronics and Drive Systems (IJPEDS), vol. 9(2), pp. 803-10, 2018
[6] A. Fudholi, et al., "Review on Exergy and Energy Analysis of Solar Air Heater" International Journal of Power Electronics and Drive Systems (IJPEDS), vol. 9(1), pp. 420-26, 2018.
[7] A. Fudholi, et al., "Review on Solar Collector for Agricultural Produce." International Journal of Power Electronics and Drive Systems (IJPEDS), vol. 9(1), pp. 414-19, 2018.
[8] A. Fudholi, et al., "Primary Study of Tracking Photovoltaic System for Mobile Station in Malaysia." International Journal of Power Electronics and Drive Systems (IJPEDS), vol. 9(1), pp. 427-32, 2018.
[9] M. Hazami, et al., "Energetic and Exergetic Performances Analysis of a PV/T (photovoltaic thermal) Solar System Tested and Simulated under to Tunisian (North Africa) Climatic Conditions,"Energy, vol. 107, pp. 78-94, 2016.
[10] M.E.A.Slimani, et al., "Study and Modeling of Energy Performance of A Hybrid Photovoltaic/Thermal Solar Collector: Configuration Suitable For an Indirect Solar Dryer",Energy Conversion and Management, vol. 125, pp. 209-21, 2016.
[11] M. Gholampour & M. Ameri,"Energy and Exergy Analyses of Photovoltaic/Thermal Flat Transpired Collectors: Experimental and Theoretical Study", Applied Energy, vol. 164, pp. 837-56, 2016.
[12] Y. Li, et al., "Performance Study of a Solar Photovoltaic Air Conditioner in the Hot Summer and Cold Winter Zone", Solar Energy, vol. 117, pp. 167-79, 2015.
[13] A. A. Zakri, I. H. Rosma, D. P. H. "Simanullang, Effect of Solar Radiation on Module Photovoltaics 100 Wp With Variation of Module Slope Angle", Indonesian Journal of Electrical Engineering and Informatics (IJEEI) Vol. 6, No. 1, pp. 45-52, 2018.
[14] D. V. N Ananth, G. V. Nagesh Kumar, "Design of Solar PV Cell Based Inverter for Unbalanced and Distorted Industrial Loads", Indonesian Journal of Electrical Engineering and Informatics (IJEEI) Vol. 3, No. 2, pp. 70-77, 2015.
[15] R. Ayop, C. W. Tan, K. Y. Lau, "Computation of current-resistance photovoltaic model using reverse triangular number for photovoltaic emulator application",Indonesian Journal of Electrical Engineering and Informatics (IJEEI) Vol. 7, No. 2, pp. 314-32, 2019.
[16] S. Kumari, S. Y. Kumar, "A Novel Approach of Controlling the Solar PV Integrated Hybrid Multilevel Inverter", Indonesian Journal of Electrical Engineering and Informatics (IJEEI) Vol. 6, No. 2, pp. 143-151, 2018.
[17] E. A. M. Elshafei, M. M. Awad, E. E. Negiry, A. G. Ali, "Heat transfer and pressure drop in corrugated channels", Energy. 35(1): 101–110, 2010
[18] M. A. Karim, M. N. A. Hawlader, "Performance investigation of flat plate, v-corrugated and finned air collectors". Energy, 2006; 31(4): 452–470.
[19] M. A. Karim, M. N. A. Hawlader. Performance evaluation of a v-groove solar air collector for drying applications". Appl. Therm. Eng. 2006; 26(1): 121–130.
[20] B. F. Parker. "Derivation of efficiency and loss factors for solar air heaters", Sol. Energy, 1981; 26(1): 27–32.
[21] B. F. Parker, M. R. Lindley, D. G. Colliver, W. E. Murphy. "Thermal performance of three solar air heaters". Sol. Energy. 1993; 51(6): 467–479.
[22] Fudholi A, et al. , "Energy and exergy analyses of pho-tovoltaic thermal collector with ∇-groove". Solar Energy, 2018, 159, 742-50.
[23] E. Skoplaki and J. A. Palyvos, "On the temperature dependence of photovoltaic module electrical performance: A review of efficiency/power correlations," Sol. Energy, vol. 83, no. 5, pp. 614–624, 2009.
[24] R. K. Agarwal and H. P. Garg, "Study of a Photovoltaic-Thermal System - - Thermosyphonic Solar Water Heater Combined With Solar Cells," Energy Convers. Manag., vol. 35, no. 7, pp. 605–620, 1994.
[25] T. T. Chow, "A review on photovoltaic/thermal hybrid solar technology," Appl. Energy, vol. 87, no. 2, pp. 365– 379, 2010.
[26] M. Zohri, A. Fudholi, M. H. Ruslan, and K. Sopian, "Mathematical modeling of photovoltaic thermal PV/T system with v-groove collector", AIP Conference Proceedings 1862, 030063 (2017); doi: 10.1063/1.4991167.
[27] A. Fudholi, K. Sopian, M. Y. Othman, M. H. Ruslan, and B. Bakhtyar, "Energy analysis and improvement potential of finned double-pass solar collector," Energy Convers. Manag., vol. 75, pp. 234–240, 2013.
[28] M. Zohri, A. Fudholi, M. H. Ruslan, K Sopian. "Performance Analysis of Photovoltaic Thermal (PVT) with and without v-groove Collector". J. Eng. Appl. Sci. 2017; 12(22): 6029–6032
[29] Hernandez-Perez, J.G., Carrillo, J.G., Bassam, A., Flota-Banuelos, M., Patino- Lopez, L.D., 2020. "A new passive PV heatsink design to reduce efficiency losses: a computational and experimental evaluation. Renew". Energy 147, 1209-1220.
[30] Zhao, B., Hu, M., Ao, X., Huang, X., Ren, X., Pei, G., 2019b. "Conventional photovoltaic panel for nocturnal radiative cooling and preliminary performance analysis". Energy 175, 677-686.
[31] Selimefendigil, F., Bayrak, F., Oztop, H.F., 2018. "Experimental analysis and dynamic modeling of a photovoltaic module with porous fins". Renew. Energy 125, 193-205.
[32] Mojumder, J.C., Chong, W.T., Ong, H.C., Leong, K.Y., Abdullah Al, M., 2016. "An experimental investigation on performance analysis of air type photovoltaic thermal collector system integrated with cooling fins design". Energy Build. 130, 272-285.
[33] Nishioka, K., Ota, Y., Tamura, K., Araki, K., 2013. "Heat reduction of concentrator photovoltaic module using high radiation coating". Surf. Coating. Technol. 215, 472-475.

[34] Dubey S, Sandhu GS, Tiwari GN. "Analytical expression for electrical efficiency of PV/T hybrid air collector". Appl Energy 2009;86:697–705.
[35] Liu L, Jia Y, Lin Y, Alva G, Fang G. "Numerical study of a novel miniature compound parabolic concentrating photovoltaic/thermal collector with microencapsulated phase change slurry". Energy Convers Manag 2017;153:106–14.
[36] Lee, H. J., et al. "Efficiency Improvement of a Photovoltaic Thermal (PVT) System Using Nanofluids". Energies 2019, 12, 3063; doi:10.3390/en12163063.

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Saprizal Hadisaputra is a physical chemistry lecturer in the chemistry education program at the University Mataram, Lombok Island, Indonesia. He finished his undergraduate study in 2003 at Gadjah Mada University Indonesia. Then he obtained a master of nanotechnology from Flinders University, Australia, in 2007. His doctoral degree was completed in computational physics-chemistry from the Austrian-Indonesian Center for Computational Chemistry, Gadjahmada University in 2014. He has experience doing computational chemistry research at the University of Innsbruck, Austria. Since 2016, he has received a research grant in materials and energy topics from the Ministry of Education of the Republic of Indonesia. He is actively conducting research and publishing articles in national and international journals.

Muhammad Zohri obtained his S.Si (2009) in physics and received the Master of Science degree in Solar Energy Research Institute from The National University of Malaysia, Malaysia in 2017, with a thesis based on PVT system. He was appointed a Graduate Research Assistant (GRA) under Dr. Ahmad Fudholi in Solar Energy Research Institute (SERI) in UKM Malaysia, during his master's degree. He worked at State Islamic University (UIN) Mataram, Indonesia. He was a speaker at The 2nd International Symposium on Current Progress in Mathematics and Science (2nd ISCPMS) FMIPA UI in Depok and The 4th Solar Energy Research Institute (SERI) Colloquium 2016, in UKM Bangi, Malaysia. He has published many paper in Scopus and WoS Index.

Ahmad Fudholi obtained his S.Si (2002) in physics. He has working experience about 4 years (2004-2008) as Head of Physics Department at Rab University Pekanbaru, Indonesia. A. Fudholi started his master course in Energy Technology (2005-2007) at UniversitiKebangsaan Malaysia (UKM). After his master he became Research Assistant at UKM up to 2012. After his Ph.D (2012) he became Postdoctoral in Solar Energy Research Institute (SERI) UKM up to 2013. He joined the SERI as a Lecture in 2014. More than USD 304,000 research grant in 2014–2017 obtained. More than 25 M.Sc project supervised and completed. Until now, he managed to supervise 6 Ph.D (4 main supervisor and 1 Co. supervisor), 2 Master's student by research mode, and 5 Master's student by coursework mode, he was also as examiner (3 Ph.D and 1 M.Sc). His current research focuses on renewable energy, especially energy technology. He has published more than 100 peer-reviewed papers, which 25 papers in ISI index (20 Q1, impact factor more than 3) and more than 48 papers in Scopus index, 10 more currently accepted manuscript, 20 more currently under review, and 2 book chapters. Addition, he has published more than 70 papers in international conferences. His total citations of 571 by 395 documents and h-index of 12 in Scopus (Author ID: 57195432490). His total citations of 1093 and h-index of 19 in google scholar. He is appointed as reviewer of high impact journal such as Renewable and Sustainable Energy Reviews, Energy Conversion and Management, Applied Energy, Energy and Buildings, Applied Thermal Engineering, Energy, Industrial Crops and Products, etc. He is appointed as reviewer of reputation journals such as Drying Technology, International Journal of Green Energy, Drying Technology, Bio system Engineering, Journal of Sustainability Science and Management, Journal of Energy Efficiency, Sains Malaysiana, Jurnal Teknologi etc. He is also appointed as editor journals. He has received several awards such as Gold Medal Award at the International Ibn Al-Haytham's Al-Manazir Innovation and Invention Exhibition 2011, Silver Medal Award at the International Technology EXPO (ITEX) 2012, Silver Medal Award at the Malaysia Technology Expo (MTE) 2013, Bronze Medal Award at International Exposition of Research and Invention (PECIPTA) 2011, also 2 Bronze Medal Award at PECIPTA 2017. He was also invited as speaker: Workshop of Scientific Journal Writing; Writing Scientific Papers Steps Towards Successful Publish in High Impact (Q1) Journals