Documents

Harun, M.A.[a] , Majid, Z.A.A.[b] , Zakaria, Z.A.[a] , Ismail, A.F.[a] , Ihsan, S.I.[a] , Sopian, K.[c] , Razak, A.A.[d] , Sharol, A.F.[d]

Performance Analysis of Flat Plate Base-Thermal Cell Absorber (FPBTCA): Low Thickness Design

(2022) *Journal of Advanced Research in Fluid Mechanics and Thermal Sciences*, 96 (2), pp. 122-133.

DOI: 10.37934/arfmts.96.2.122133

[a] Kuliyyah of Engineering, International Islamic University Malaysia, Jalan Gombak, Kuala Lumpur, 53100, Malaysia
[b] Kuliyyah of Allied Health Sciences, International Islamic University of Malaysia, Kuantan Pahang, Bandar Indera Mahkota, 25200, Malaysia
[c] Solar Energy Research Institute, Universiti Kebangsaan Malaysia, Bangi Selangor, 43600, Malaysia
[d] Faculty of Mechanical Engineering Technology, Universiti Malaysia Pahang, Pekan Pahang, 26600, Malaysia

Abstract
Research to improve flat plate solar collector performance such as design and material used continuously developed. This paper's objective is to analyze the performance of the thermal cell absorber attached to a flat plate absorber collector (FPBTCA) through a low thickness design. It will produce a lightweight and portable collector application with efficient temperature conversion duration and has energy storage ability. Stainless steel and aluminum materials with different thicknesses use as thermal cell absorbers then aluminum materials use as a flat plate absorber base-collector. The experiment performs using a solar simulator with solar radiation of 700 W/m2. Referring to the results in term of heat storage (Qstorage), the heat transfer rate of the collector ($\dot{Q}$) and efficiency of the collector shows that stainless steel 1.0 mm with an aluminum base absorber (Case E) has a higher value which is 412 kJ, 18.21 kW, and 47.08 %, respectively. The higher total energy gain collected at the bottom plate as dummy load in the drying chamber (T1 and T2) is stainless steel 1.0 mm with an aluminum absorber base-collector (Case E) value of 2.85 kJ. Stainless steel 1.0 mm with an aluminum absorber base-collector (Case E) has the maximum value of energy gain at 300 seconds which is 116.08 J for the bottom plate (T1 and Ta). Flat plate base absorber thermal cell (FPBTCA CASE E) shows better performance in thermal storage than Flat Plate Solar Collector (FPSC).

Author Keywords
Flat plate solar collector; Solar thermal collector; Thermal cell absorber

References

- Timilsina, Govinda R., Kurdgelashvili, Lado, Narbel, Patrick A.
  Solar energy: Markets, economics and policies
  (2012) *Renewable and sustainable energy reviews*, 16 (1), pp. 449-465.
  [1]
- Timilsina, Govinda R., Kurdgelashvili, Lado, Narbel, Patrick A.
  Solar energy: Markets, economics and policies
  (2012) *Renewable and sustainable energy reviews*, 16 (1), pp. 449-465.
  [2]

- Kannan, Nadarajah, Vakeesan, Divagar
  Solar energy for future world:-A review
  (2016) *Renewable and Sustainable Energy Reviews*, 62, pp. 1092-1105.
  [3]

- Belessiotis, V., Delyannis, E.
  Solar drying
  (2011) *Solar energy*, 85 (8), pp. 1665-1691.
  [4]

- El-Sebaii, A. A., Shalaby, S. M.
  Solar drying of agricultural products: A review
  (2012) *Renewable and Sustainable Energy Reviews*, 16 (1), pp. 37-43.
  [5]

- Rebhi, Redha, Menni, Younes, Lorenzini, Giulio, Ahmad, Hijaz
  Forced-Convection Heat Transfer in Solar Collectors and Heat Exchangers: A Review
  (2022) *Journal of Advanced Research in Applied Sciences and Engineering Technology*, 26 (3), pp. 1-15.
  [6]

- Musembi, Maundu Nicholas, Kiptoo, Kosgei Sam, Yuichi, Nakajo
  Design and analysis of solar dryer for midlatitude region
  (2016) *Energy procedia*, 100, pp. 98-110.
  [7]

- Fudholi, Ahmad, Sopian, Kamaruzzaman
  A review of solar air flat plate collector for drying application
  (2019) *Renewable and Sustainable Energy Reviews*, 102, pp. 333-345.
  [8]

- Kalogirou, Soteris A.
  Solar thermal collectors and applications
  (2004) *Progress in energy and combustion science*, 30 (3), pp. 231-295.
  [9]

- Razak, A. A.
  (2017) *Performance of Bi-Metallic Cross Matrix Absorber in Air Based Solar Air Collector*,
  [10] PhD Thesis, Univ. Kebangs. Malaysia

- Sharol, A. F., Razak, A. A., Majid, Z. A. A., Azmi, M. A. A., Tarminzi, M. A. S. M.
  Performance of force circulation cross-matrix absorber solar heater integrated with latent heat energy storage

material."
(2019) *In IOP Conference Series: Materials Science and Engineering*, 469 (1), p. 012107.
[11] IOP Publishing

- Pakdaman, M. Fakoor, Lashkari, A., Basirat Tabrizi, H., Hosseini, R.
Performance evaluation of a naturalconvection solar air-heater with a rectangular-finned absorber plate
(2011) *Energy conversion and management*, 52 (2), pp. 1215-1225.
[12]

- Shbailat, Suhaib J., Jassim, Najim A.
Energy and Exergy Analysis of Dual Channel Solar Air Collector with Perforating "V" Corrugated Absorber Plate
(2018) *Basrah Journal for Engineering Science*, 18 (1).
[13]

- Su, Di, Jia, Yuting, Lin, Yaxue, Fang, Guiyin
Maximizing the energy output of a photovoltaic-thermal solarcollector incorporating phase change materials
(2017) *Energy and Buildings*, 153, pp. 382-391.
[14]

- Arun Venu, AK, Arun, P.
Simulation studies on porous medium integrated dual purpose solar collector
(2013) *International journal of renewable energy research*, 3 (1), pp. 114-120.
[15]

- Moghadam, Ali Jabari, Farzane-Gord, Mahmood, Sajadi, Mahmood, Hoseyn-Zadeh, Monireh
Effects of CuO/water nanofluid on the efficiency of a flat-plate solar collector
(2014) *Experimental Thermal and Fluid Science*, 58, pp. 9-14.
[16]

- Alawi, Omer A., Kamar, Haslinda Mohamed
Performance of Solar Thermal Collector Using Multi-Walled Carbon Nanotubes: Simulation Study
(2020) *Journal of Advanced Research in Micro and Nano Engineering*, 2 (1), pp. 12-21.
[17]

- Ango, Do, Mintsa, AC, Medale, Marc, Abid, Cherifa
Optimization of the design of a polymer flat plate solar collector
(2013) *Solar Energy*, 87, pp. 64-75.
[18]

- Senthil, Ramalingam, Kishore Kumar, K., Rajendra, Kodak Rohan, Juneja, Aniyush
Enhancement of absorptance of absorber surfaces of a flat plate solar collector using black coating with graphene

(2021) *Energy Sources, Part A: Recovery, Utilization, and Environmental Effects*, 43 (20), pp. 2595-2608.
[19]

- Bhowmik, Himangshu, Amin, Ruhul
Efficiency improvement of flat plate solar collector using reflector
(2017) *Energy Reports*, 3, pp. 119-123.
[20]

- Ho, C. D., Yeh, C. W., Hsieh, S. M.
Improvement in device performance of multi-pass flat-plate solar air heaterswith external recycle
(2005) *Renewable Energy*, 30 (10), pp. 1601-1621.
[21]

- Yeh, Ho-Ming, Lin, Tong-Tshien
Efficiency improvement of flat-plate solar air heaters
(1996) *Energy*, 21 (6), pp. 435-443.
[22]

- Jouybari, Nima Fallah, Staffan Lundstrom, T.
Performance improvement of a solar air heater by covering theabsorber plate with a thin porous material
(2020) *Energy*, 190, p. 116437.
[23]

- Alvarez, A., Cabeza, O., Muniz, M. C., Varela, L. M.
Experimental and numerical investigation of a flat-plate solar collector
(2010) *Energy*, 35 (9), pp. 3707-3716.
[24]

- Chabane, Foued, Moummi, Noureddine, Benramache, Said, Bensahal, Djamel, Belahssen, Okba
Collector efficiency by single pass of solar air heaters with and without using fins
(2013) *Engineering journal*, 17 (3), p. 4355.
[25]

- Yeh, H-M., Ho, C-D., Hou, J-Z.
Collector efficiency of double-flow solar air heaters with fins attached
(2002) *Energy*, 27 (8), pp. 715-727.
[26]

- Fudholi, Ahmad, Sopian, Kamaruzzaman, Othman, Mohd Yusof, Ruslan, Mohd Hafidz, Bakhtyar, B.
Energy analysis and improvement potential of finned double-pass solar collector
(2013) *Energy Conversion and Management*, 75, pp. 234-240.
[27]

- Moummi, N., Youcef-Ali, S., Moummi, A., Desmons, J. Y.
  Energy analysis of a solar air collector with rows of fins
  (2004) *Renewable energy*, 29 (13), pp. 2053-2064.
  [28]

- Ho, Chii-Dong, Chang, Hsuan, Wang, Rei-Chi, Lin, Chun-Sheng
  Performance improvement of a double-pass solarair heater with fins and baffles under recycling operation
  (2012) *Applied Energy*, 100, pp. 155-163.
  [29]

- Jain, Dilip
  Modeling the system performance of multi-tray crop drying using an inclined multi-pass solar air heater with in-built thermal storage
  (2005) *Journal of food engineering*, 71 (1), pp. 44-54.
  [30]

- Fudholi, Ahmad, Sopian, Kamaruzzaman, Gabbasa, Mohamed, Bakhtyar, Ba, Yahya, M., Ruslan, Mohd Hafidz, Mat, Sohif
  Techno-economic of solar drying systems with water based solar collectors in Malaysia: a review
  (2015) *Renewable and Sustainable Energy Reviews*, 51, pp. 809-820.
  [31]

- Duffie, John A., Beckman, William A.
  (2013) *Solar engineering of thermal processes*,
  [32] John Wiley & Sons

- Kabeel, A. E., Mecarik, K.
  Shape optimization for absorber plates of solar air collectors
  (1998) *Renewable Energy*, 13 (1), pp. 121-131.
  [33]

- Hamed, Mouna, Fellah, Ali, Brahim, Ammar Ben
  Parametric sensitivity studies on the performance of a flat plate solar collector in transient behavior
  (2014) *Energy Conversion and Management*, 78, pp. 938-947.
  [34]

Correspondence Address
Majid Z.A.A.; Kuliyyah of Allied Health Sciences, Kuantan Pahang, Malaysia; email: zafriazran@yahoo.com

Publisher: Penerbit Akademia Baru

ISSN: 22897879
Language of Original Document: English
Abbreviated Source Title: J. Advance Res. Fluid Mechanics Therm. Sciences

2-s2.0-85135279067
Document Type: Article
Publication Stage: Final
Source: Scopus