MISR JOURNAL OF AGRICULTURAL ENGINEERING ISSN-Print: 1687-384X
https://mjae.journals.ekb.eg/ ISSN-Online: 2636-3062

Misr J. Ag. Eng.,37 (4): 393 - 406 **DOI:** 10.21608/mjae.2020.121552

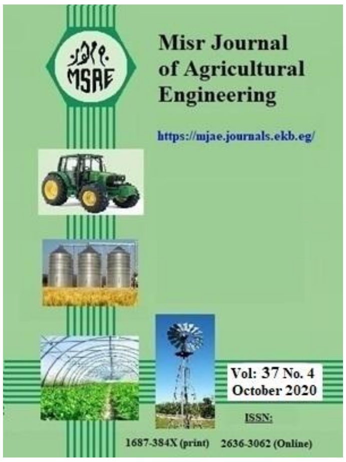
ENGINEERING STUDIES ON ABSORBENT SURFACES TO IMPROVE THE PERFORMANCE OF SOLAR COLLECTORS

Ahmed T. Taha[1&*] and Manar M. Helal[2]

[1] Assoc. Prof., Ag. Eng. Dept., Fac. of Ag., Menoufia U., Egypt.

[2] Res., Ag. Eng. Dept., Fac. of Ag., Menoufia U., Egypt.

* atht2020@gmail.com



Keywords:
solar energy, solar air collector, aluminum cans, v-corrugated

ABSTRACT

The aim of this work is to study the thermal performance of four configurations of absorber plates of solar air collectors under three levels of air mass flow rates (0.0199, 0.047 and 0.120kg/s) and fabricate an efficient and cheap solar air collector from recyclable aluminum cans. Solar air collectors were manufactured and tested under prevailing weather conditions of Shebin El-Kom city (30°.54'N and 31 E)، Egypt. Comparisons between the temperature difference of air across the collector and thermal efficiencies of the flat, aluminum cans, and v-corrugated plate solar air collectors were presented. The results revealed that the maximum thermal efficiency was obtained at mass flow rate of 0.047kg/s for an solar air collector with an absorber plate made of single layer of recyclable aluminum cans(type-I), whereas the lowest thermal efficiency was obtained for the solar air collector without cans (flat plate). The thermal efficiency of the solar air collectors depends principally on the solar radiation, surface geometry of the collectors and air mass flow rate.

1. INTRODUCTION

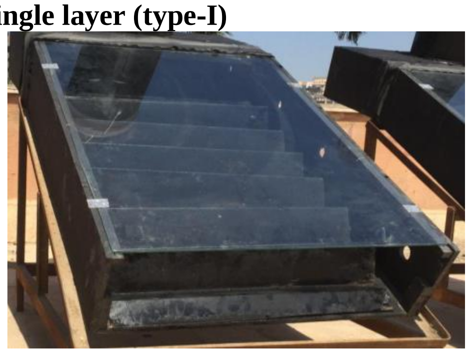
Fuels are the world's main energy resource and considered the center of energy demands. However, reserves of fossil fuels are limited and their large-scale use is associated with environmental deterioration. These facts have encouraged growth in the use of renewable energy resources (**Escobedo et al., 2010).** In order to solve dependency on fossil fuels, scientists, researchers, government and many organizations are working tirelessly on non-conventional fuels (renewable energy), which should be commercially viable, pollutant free, easy to access, and must be abundant in nature. For this purpose, renewable energies such as geothermal energy, solar energy, biofuels and wind energy to mention but few are more suitable compared to conventional sources of energy **(Chukwujindu, 2017).** Among the available forms of renewable energy resources, solar energy has received considerable attention due to abundance on the surface of the earth. The use of solar energy can help alleviate the requirement of conventional energy resources. It is therefore this reason that solar energy is deemed a perfect solution to the energy crisis. This makes solar energy a sustainable form of energy for varied applications **(Jamil and akhtar, 2017)**. The major component of any solar system is the solar collector. This is a device which absorbs the incoming solar radiation, converts it into heat, and transfers this heat to a fluid (usually air, water, or oil) flowing through the collector **(Kalogirou, 2004).** The key components of these systems are; a blackened absorber (normally made from a thin Aluminum sheet), a thin transparent glass (glazing), the ducts, an air blower or fans and insulation material **(Saxena et al., 2015).** Solar air collectors are cheap and have been widely used for years because of their inherent simplicity. They are a kind of heat exchangers that transform solar energy into heat. Most advantages of these systems are freezing or boiling of the fluid does not occur. Disadvantages are, however, the low density, the low thermal capacity and the small heat conductivity of air. The solar air collector occupies an important place among solar heating system because of minimal use of materials and cost **(Varun et al., 2007).** The performance of the solar air collector is affected by many parameters such as climate conditions, dimensions of the solar collector, type and design of the absorber plate, glass covers, and insulation material. The design of the solar collector and its performance is mostly affected by the glass cover and the absorber plate **(Omojaro and aldabbagh, 2010).** Some researchers have investigated the importance of solar absorbers to find out the significant effects on the performance of solar air collectors. **Akpinar and Koçyiğit, (2010)** designed, analyzed and experimentally investigated a flat-plate solar air collector having different obstacles on absorber plates. The experiments were carried out at two different air mass flow rates of 0.0074 and 0.0052 kg/s. It was found that the efficiency of the solar air collectors depends on various parameters such as solar radiation, the surface geometry of the collectors and extension of the air flow line. The efficiency of the collector has been found to be increasing function of mass flow rate. The energy efficiency was found to be varied between 20 and 82%. **El-Sebaii et al, (2011)** had investigated theoretically and experimentally the thermal performance of double pass finned plate and V-corrugated solar air collectors. The results were compared with those obtained for conventional flat plate solar air collectors. It was indicated that the double pass V-corrugated plate solar air collector was 9.3–11.9% more efficient compared to double pass-finned plate solar air collector. The best efficiency values were obtained when ($\dot{m}$) equal 0.125 and 0.0225kg/s for finned and V-corrugated solar air collectors, respectively. **Alvarez et al, (2004)** studied the performance of a solar air collector with an absorber plate that was made of recyclable aluminum cans. It was concluded that enhancement in the efficiency of a solar collector by using recyclable aluminum cans was achievable. The maximum efficiency that was obtained by using recycle aluminum cans was 74%. **Kabeel et al, (2016)** investigated the thermal performance of flat, finned, and v-corrugated plate solar air collectors. The results showed that maximum values of outlet temperatures of the v corrugated plate solar air collector were 5.0 and 3.5 ºC more than that of flat and finned plates at 0.062 kg/s mass flow rate. In this paper the single glass solar air collector was constructed and analyzed experiments were performed, and the thermal performance was compared with four types of absorber plates. In each configuration, the mass flow rate was changed at three rates. The aim of this research is to investigate the impact of the difference between the four geometries of absorber plates related to the thermal performance analysis of each one in order to help decision makers about the most effective design.

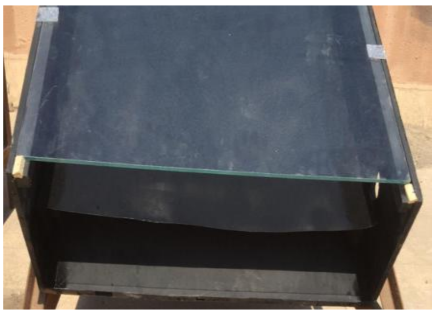
2. MATERIALS AND METHODS

2.1. Solar air collectors:

Four types of solar air collectors were manufactured in Agricultural and Bio Systems Engineering Department, Faculty of Agriculturel, Menoufia University and installed on the roof at latitude (30^{o}). Experiments were conducted during summer 2018. Four different types of the absorber plates had been tested. The first two types of the absorber plates were made of recyclable aluminum cans with internal diameter of 5.1cm. The absorber width was 63cm to accommodate a layer of 12 channels of these cans, with 98 cm length for each channel. The cans were opened from top and bottom. Their surface was washed with water and glued to each other using silicon glue, which stands temperature up to 315 ˚C, to form the air flow channels. The four absorber plates (cans or plates) painted with black paint to increase heat absorptivity of the collector (absorptivity ≈ 0.95-0.97) as shown in **Fig.1** The absorber type-I was consisted of one layer of 12 circular cross section air flow channels made of 84 aluminum cans**.** The absorber type-II was consisted of two layers of 24 circular cross section air flow channels made of 168 (84 cans in two layers)**.** The absorber type-III was a corrugated absorber made of galvanized iron sheet with thickness 0.5 mm with dimension 100cm long and 62cm width**.** The absorber type-IV was a flat plate (without cans) having dimension of 100 cm long 62cm wide and 0.5mm thick**.** Absorber was placed in a wooden cabinet having dimension of 1.0m long, 0.75m wide and 0.20m deep and covered with a glass plate with a thickness of 5mm (transparent surface) to convective loses to the atmosphere. The solar collector was attached with the drying chamber by an air duct. The air duct having across section area of 0.14 m^{2}. A cylindrical Chimney made of 0.5mm thick galvanized iron sheet, which was rolled to form a cylindrical shape with an internal diameter of 0.25m and 0.5m height. An extracting fan of 0.25m diameter (fresh, mode 20wuc made in Egypt) 220-240 volts (50 Hertz) to control the mass flow rate of air. The solar collectors were oriented to face the south direction and tilted at an angle of 30˚, which is the optimum slope angle for the experiments locations.

a) Single layer (type-I) **b) Double layers (type-II)**





c) Corrugated surface(type-III) **d) Flat plate (type-IV)**

Fig. 1: A photograph of absorber plates of solar air collectors

2.2. Experimental procedure

Experiments were carried out in the clear sky days from 9 a.m. till 4:30 p.m. during summer 2018 at the Faculty of Agriculturel, Shebin El-Kom city (30˚.54'N and 31 E), Egypt. The solar radiation was measured outside the collector using a TES- 1333 solar power meter and recorded data (W/m^2). The temperature (˚C) was measured using a digital clock &week (hygro-thermometer) and with mercury thermometer. The air velocity inside and outside the collector (wind speed) was measured by anemometer to the nearest m/sec. The measurements at a certain time intervals (30 min) were recorded. The temperature was measured in the required measuring points {air inlet, air outlet; ambient air, absorber plate temperature temperatures of flowing air at different locations in flow direction through the solar air collector (T_1, T_2)}.The air flow rate was measured by the means of calibrated anemometer at the collector exit which measures the air exit velocity at ten positions from the whole exit pipe diameter, and then, the average velocity was determined to get the mass flow rate by knowing also the cross section exit area and air density.

2.3 Thermal Performance Analysis of Solar Collectors:-

In order to evaluate the performance of the designed solar collectors, thermal efficiency was determined. Air mass flow rate (ṁ) was calculated by multiplying air density (ρ), the area of air flow duct (A_{duct}) and air speed (v) which measured by digital anemometer as shown in the following equation.

$$\dot{m} = \rho . v . A_{duct}$$

Finally, the thermal efficiency of solar heating systems (η) is defined as the ratio of useful energy gained by the air to solar radiation incident on the absorber of solar collector and can be calculated from the following equation according to **Kurtbas and Turgut**, (**2006)**

$$\eta = \frac{\dot{m}.\,C_P(T_O - T_i)}{I.\,A_C}$$

Where ṁ is air mass flow rate ($kg.s^{-1}$),C_P is specific heat of the air ($J.kg^{-1}.K^{-1}$) , T_O is outlet air temperature (K), T_i is inlet air temperature (K), I is the total solar radiation incident upon the plate of the solar collector (W/m^2) A_C is the area of collector absorber (m^2).

3. RESULTS AND DISCUSSION

3.1. Solar energy available, ambient air temperature and wind speed.

During the whole period of the experiment, the weather station data for: ambient air temperature and solar radiation followed a typical daily pattern for a typical day in September 2018 as illustrated in **Fig.2.** The solar radiation and the ambient air temperature always relatively low at both the beginning and the end of the day while they reached the maximum values at noon and then started to decrease again at afternoon. During the experiment, the daily values of ambient air temperature and solar radiation ranged from 20 to 38˚C and from 200 to 790 W/m^2. In 2nd of September 2018 the highest measured value of solar radiation was 730 W/m^2. The average ambient air temperature was 37.3°C at noon. The wind speed and its direction are always changing during the day and the month. It was changed between 0.1 to 1.6 m/s during the whole period of the experiments.

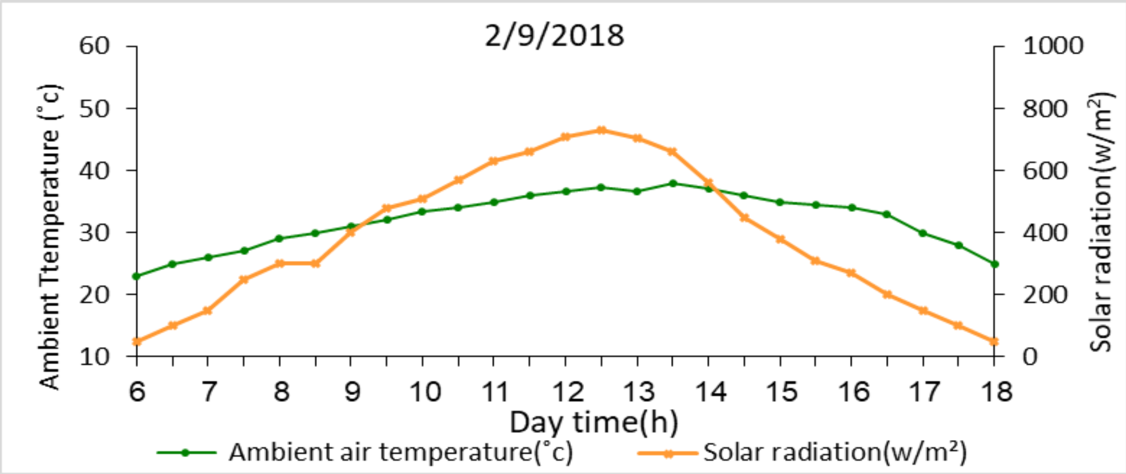


Fig. 2: Solar radiation intensity and ambient temperature in September2018

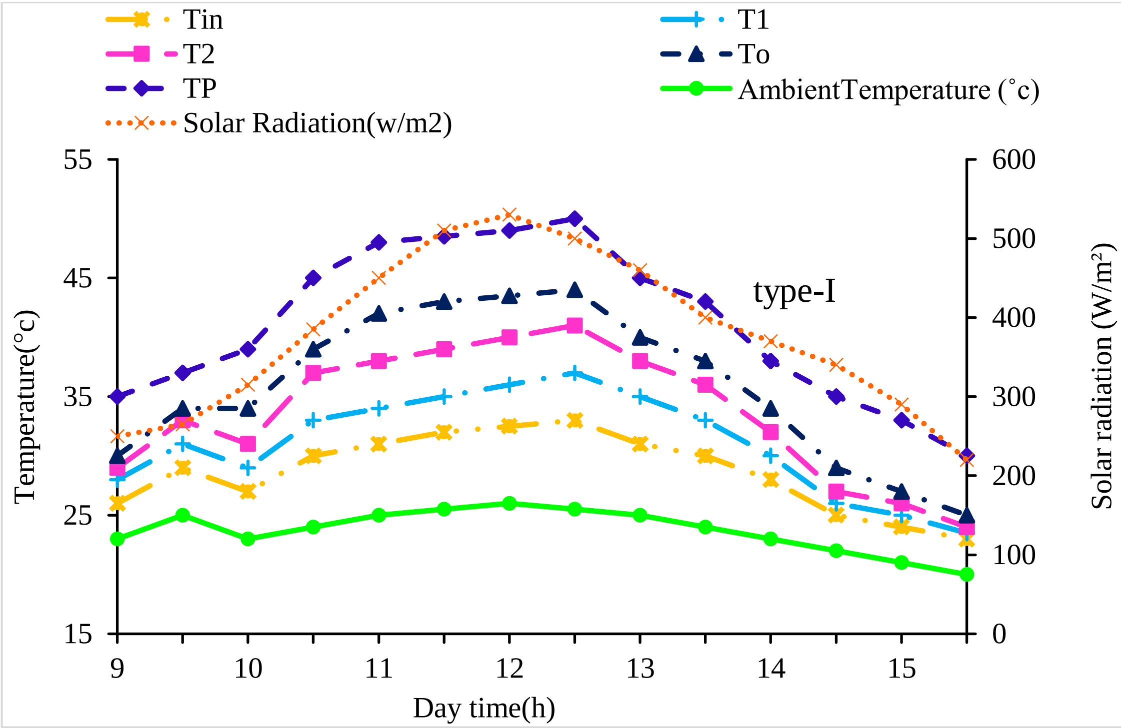


Fig. 3: Daily Variation for the different temperatures and solar radiation for collector type-I with 0.0199kg/s of air mass flow

3.2. Thermal Performance of Solar Air Collectors

Air mass flow rate of 0.0199kg/s

Fig.3 shows the variation of collector temperatures for type-I at mass flow rate of 0.0199 kg/s in a clear day on 19 November 2018 for every half hour during daytime. The results show that the collector temperatures increases with the solar radiation. As can be seen, the highest daily solar radiation obtained was 530 W/m^2. In the following were the different temperatures measured for collectors type I. The inlet air temperature increases to a maximum value of 33˚C. The outlet air temperature increases to a peak value of 44˚C. The absorber temperature increase to a maximum value of 50˚C at noon and then decreases as solar radiation drops to lower values later during the day. The maximum difference between inlet and outlet air temperatures was approximately 12°C at mid-daytime. Besides, the minimum air temperature difference was about 2°C at 15:30 p.m. The increment temperature increase occurred through solar air collector type-I, while the lowest through solar air collector type-IV. Owing to the decline in the air flow rate, the air moves at very slow speeds, and thus, it leads to a very significant rise in the degree of the absorbent surface temperature. **Fig.4** indicates a comparison of outlet temperature of air across four solar air collectors at mass flow rate of 0.0199 kg/s. It is found that the outlet temperatures of air of the single layer (type-I) collector are more efficient than the other collectors at mass flow rate of 0,0199 kg/s this is due to the increased heat transfer area of the collector type-I. Besides, increases the turbulence inside the air channel. Then, it enhances the heat transfer coefficient between the absorber plate and the flowing air. **Fig.5** shows the hourly variation of the temperature difference at the collector inlet and outlet (T_{in} and $T_{,out}$) during the experiments for mass flow rates of 0.0199 kg/s. This figure shows that there is increase in temperature difference of aluminum cans solar collector (type-I) compared with flat plate. Where, the maximum increment was 3 °C at the peak period. This is may be due to the circulation time of air over the aluminum surfaces is very low. The air temperature difference across the collectors is more higher compared with the other two mass flow rates. Owing to the decline in the flow rate, the air moves at very slow speeds, and thus, it leads to a very rise in the degree of the absorbent surface temperature. Therefore, higher temperature difference rises across the collector.

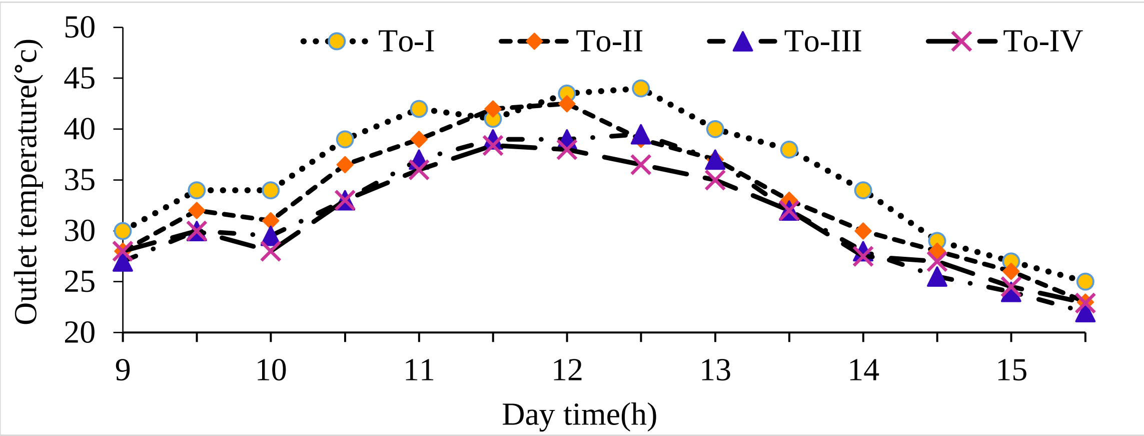


Fig.4: Daily Variation for outlet temperature for collectors of air mass flow with 0.0199kg/s

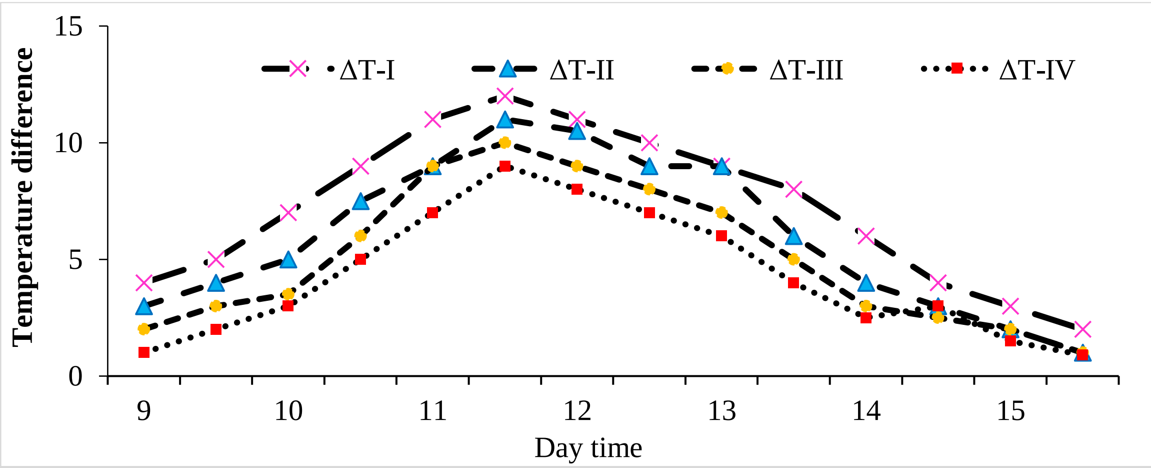


Fig. 5: Temperature difference for collectors of air mass flow rate with0.0199kg/s

Air mass flow rate of 0.047kg/s

Fig.6 shows the variation of collector temperatures for type –I at air mass flow rate of 0.047 kg/s in a clear day (2 September 2018) for every half in hour during daytime. The results show that the collector temperatures increases with the solar radiation. As can be seen, the obtained highest daily solar radiation was 730 W/m^2. In the following were the different temperatures measured for collector type-I. The inlet air temperature increases to a maximum value of 40˚C. The outlet air temperature increases to a peak value of 50 ºC. The absorber temperature increases to a maximum value of 56°C at 12:30 pm and then decreases as solar radiation reduced to lower values later during the day. The maximum difference between inlet and outlet air temperatures was approximately 10°C at mid-daytime. Besides, the minimum air temperature difference was about 1°C at 16:30 p.m. **Figs.7 and 8** shows that the highest temperature increase occurred through solar air collector type-I and type-II where the aluminum cans serve as fins that increase the capability of the absorber plate to absorb energy, consequently increasing the heat transfer coefficients. It is also found that the maximum temperature difference of collector type-I 10°C at noon more than the other collectors.

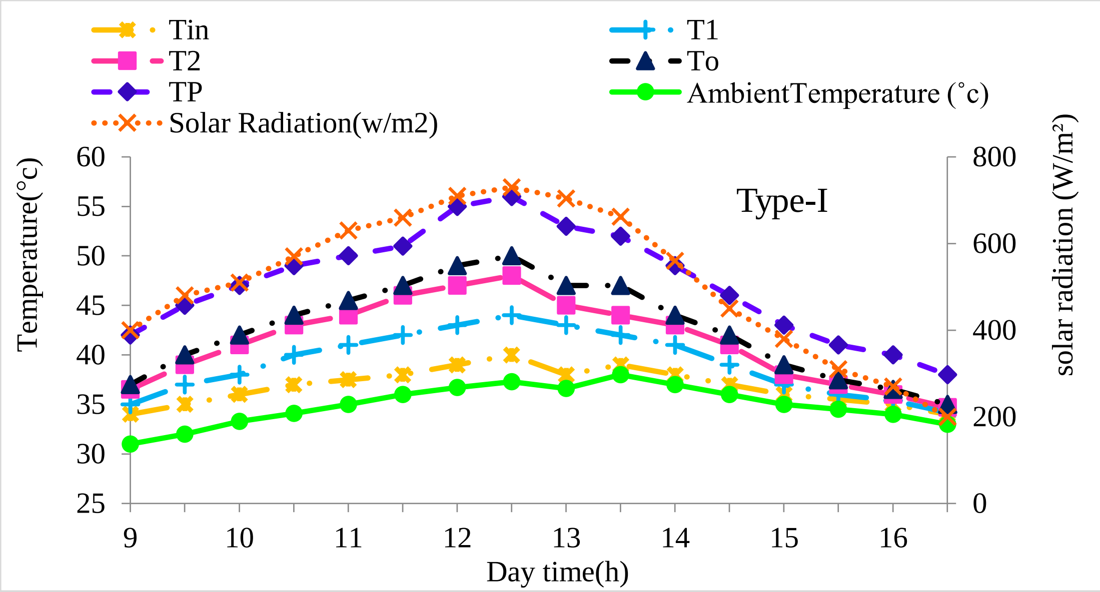


Fig. 6: Daily Variation for the different temperatures and solar radiation of collector type-I with 0.047kg/s of air mass flow.

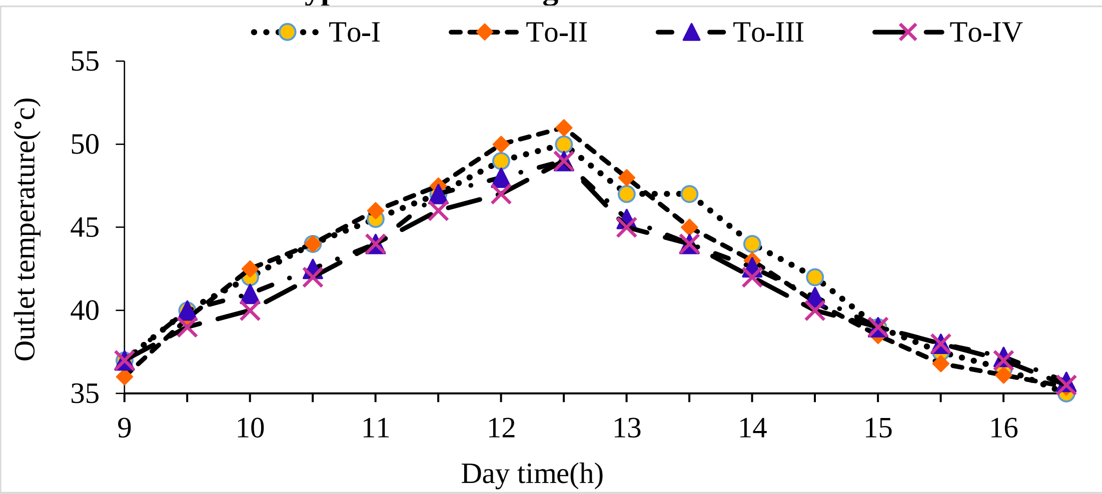


Fig.7: Daily Variation for outlet temperature for collectors of air mass flow with 0.047kg/s

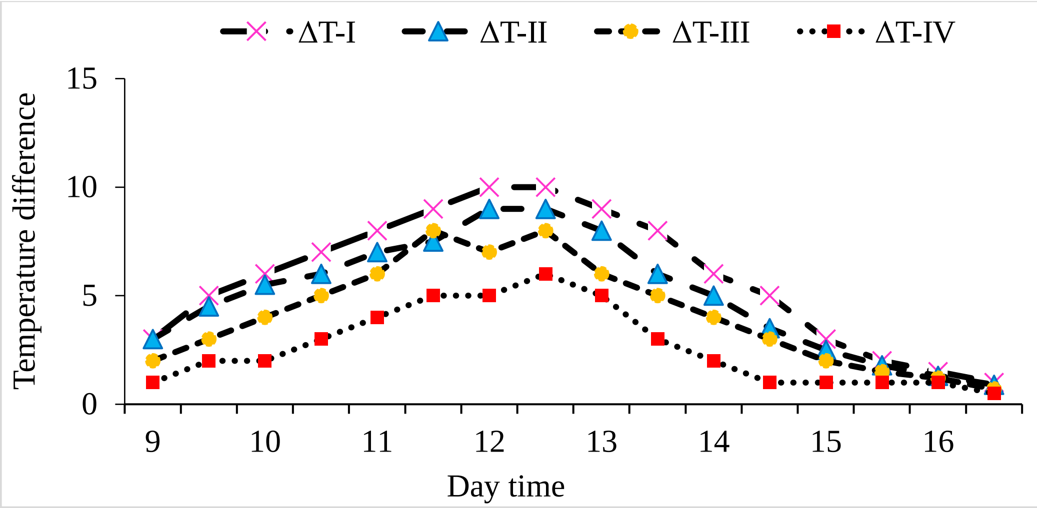


Fig.8: Temperature difference for collectors of air mass flow rate with0.047kg/s

Air mass flow rate of 0.120kg/s

Fig.9 shows the variation of collector temperatures for types-I at air mass flow rate of 0.120 kg/s in a clear day on 14 august 2018 for every half hour during daytime. The results show that the collector temperatures increases with the solar radiation. The inlet air temperature increases to a maximum value of 42, ºC. The outlet air temperature increases to a peak value of 45.5 ºC and then decreases as solar radiation drops to lower values later during the day and the absorber temperature increase to a maximum value of 51°C at 01:30 pm before it starts to decrease in the afternoon.

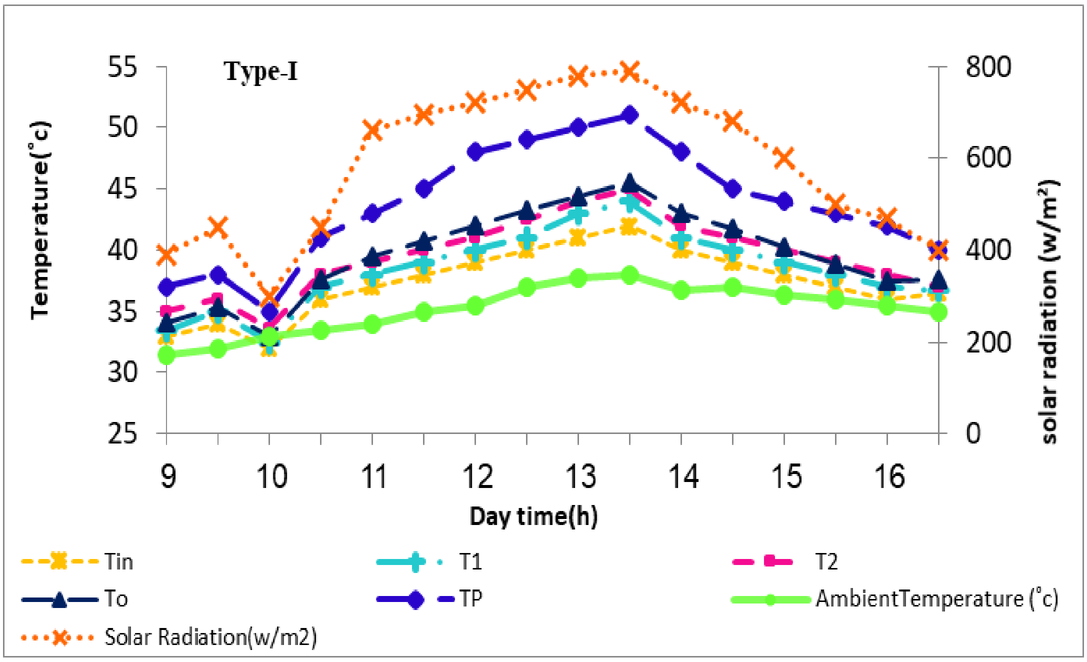


Fig.9: Daily Variation for the different temperatures and solar radiation of collector type-I with 0.120kg/s of air mass flow

Fig.10 shows daily variation for outlet temperature for collectors with 0.120 kg/s of air mass flow. **Fig.11** shows the hourly variation of the temperature difference at the collector inlet and outlet (T_{in} and T_{out}) during the experiments for mass flow rates of 0.120 kg/s. That shows there is increase in temperature difference solar air collector (type-I) compared with other collectors.

This is due to the increased heat transfer area of the aluminum cans plate compared with the corrugated and flat plates. Besides, the cans increase the turbulence inside the air channel. Then, it enhances the heat transfer coefficient between the absorber plate and the flowing air. It is also concluded that the maximum temperature difference of the solar collector type-I are 3.5°C more than others solar collectors when the mass flow rate is 0.120 kg/s.

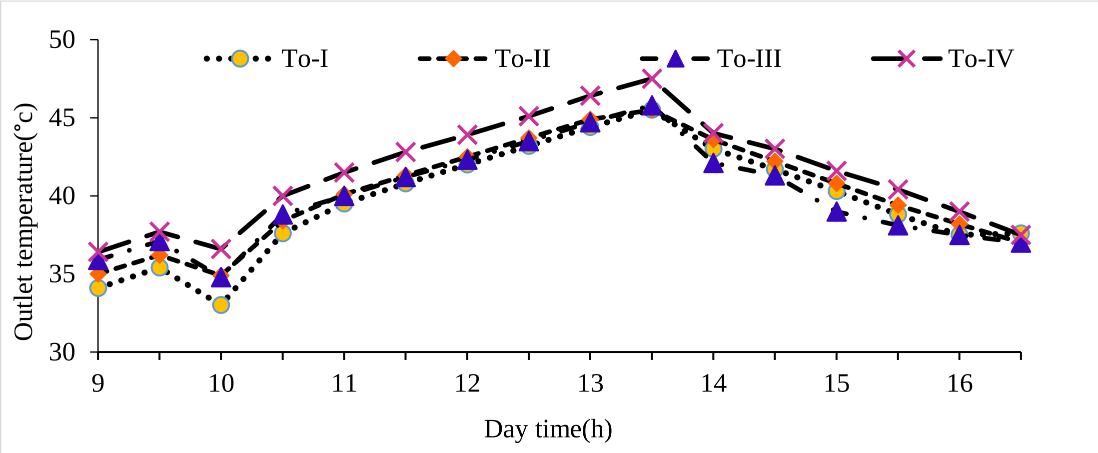


Fig.10: Daily Variation for outlet temperature for collectors of air mass flow with 0.120kg/s

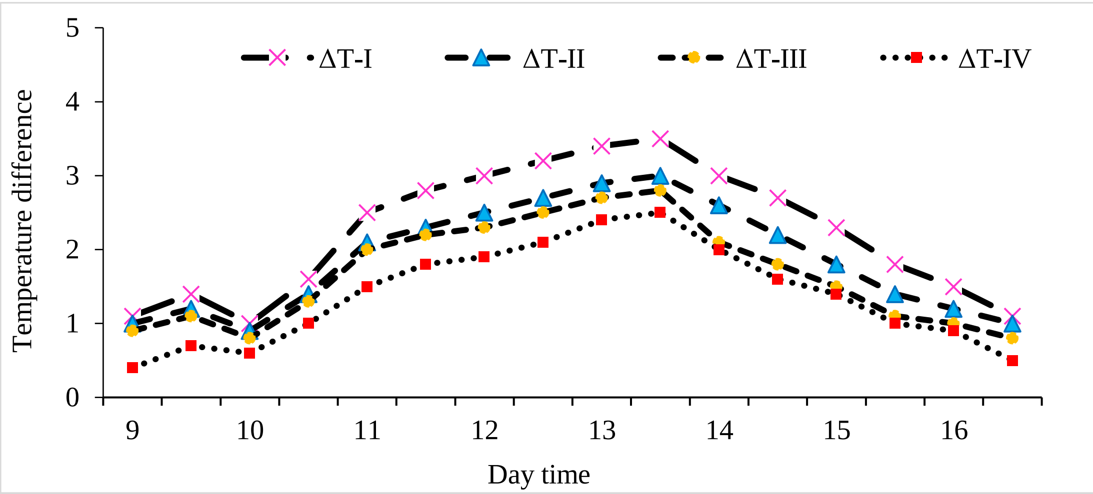


Fig. 11: Temperature difference for collectors of air mass flow rate with0.120kg/s

3.3. Thermal efficiency of solar air collectors

Air Mass flow rate of 0.0199kg/s

Fig.12 show the variation of thermal efficiency of types (I, II, III, IV) at mass flow rate of 0.0199 kg/s. As can be seen the efficiencies increase to a maximum value for types (I, II, III, and IV) which were 64, 57, 52 and 46% before it starts to decrease later in the afternoon. The efficiency of type-I is higher than that of type-II, followed by type-III and type-IV was the last one. The results showed that the difference between the instantaneous thermal efficiencies for the four types of solar air collector at $\dot{m}$=0.0199 kg/s were the least because the useful energy gained by the air reduced as a result of the reduction in the air flow rate.

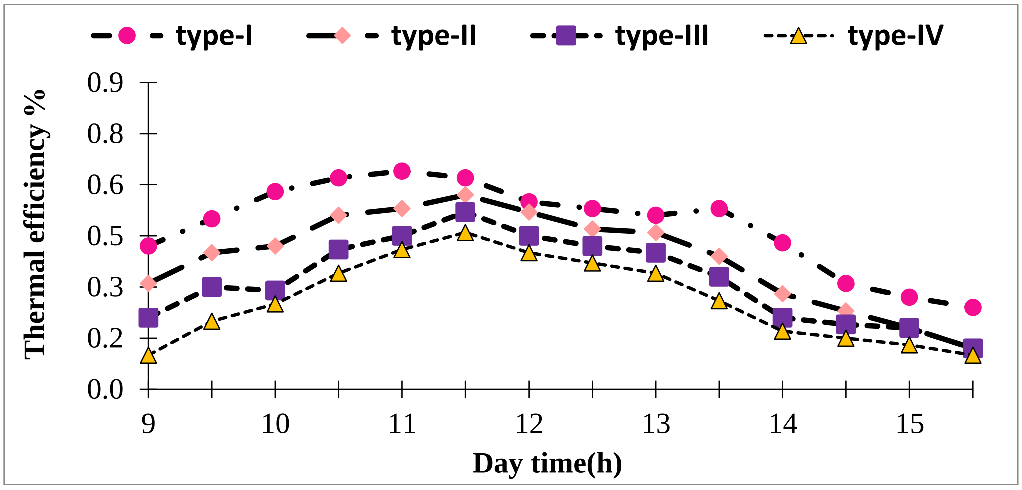


Fig.12: thermal efficiency for the four tested types of solar collectors with 0.0199 kg/s of air mass flow rate

B- Air Mass flow rate of 0.047kg/s

Fig.13. Indicates a comparison of instantaneous thermal efficiency between the all types of solar air collectors at 0.047 kg/s air mass flow rate. As can be seen the efficiencies increase to a maximum value at 12:00.pm for types (I, II, III) which were 88, 79 and 70%, respectively. For type (IV) it was 51% at 12:30.pm before it starts to decrease later in the afternoon owing to solar radiation intensity. As seen from the figure, the efficiency of type-I is higher than that of type-II followed by type-III and type-IV was the last one. The minimum values of efficiency for type (I, II, III and IV) were 31, 28, 21% and 13%, respectively. The increment of surface area and turbulence effect may be achieved with type-I, which leads to an increase of convective heat transfer rate between the absorber plate and air. Thus, it improves the thermal efficiency. Also the increase in the air mass flow rate of air reduces collector outlet temperatures and increases the collector efficiency significantly. The results show that the collector efficiency increases with air mass flow rate.

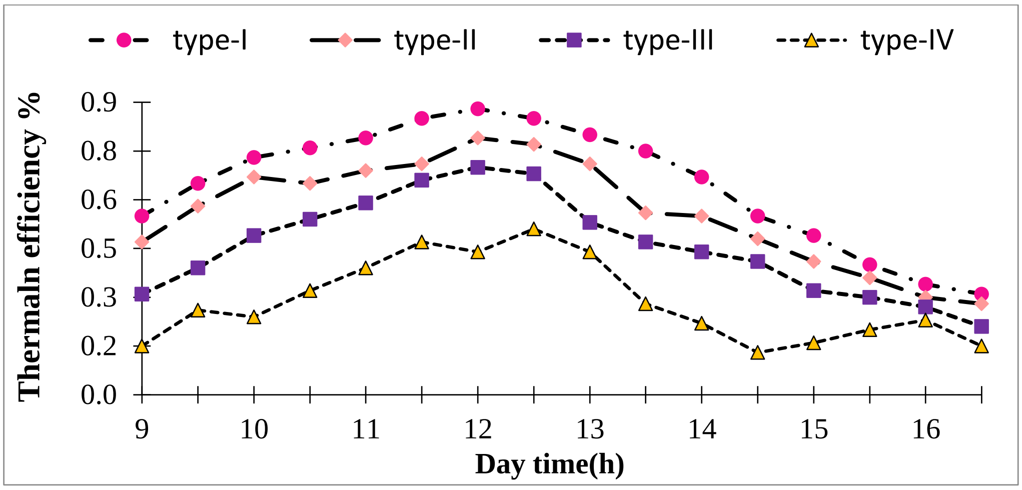


Fig.13: thermal efficiency for the four tested types of solar collectors with 0.047 kg/s of air mass flow rate

C-Air Mass flow rate of 0.120kg/s

Fig.14 shows the hourly variation of solar air collectors efficiencies for types (I, II, III, and IV) at air mass flow rate 0.120 kg/s. As can be seen the efficiencies increase to a maximum value at 01:30.pm for all types, before it starts to decrease later in the afternoon. In addition, it show that, the efficiency of type-I is the higher one followed by type-II, then type-III and type-IV was the last one. Air mass flow rate is very important in calculations of collector efficiency. The efficiency varies between 44 and 70% for type-I, between 40 and 60% for type-II, between 32 and 56% for type-III and between 20 and 50% for type-IV at air mass flow rate 0.120 kg/s. It was revealed that the effect of absorber construction on the collector efficiency is important.

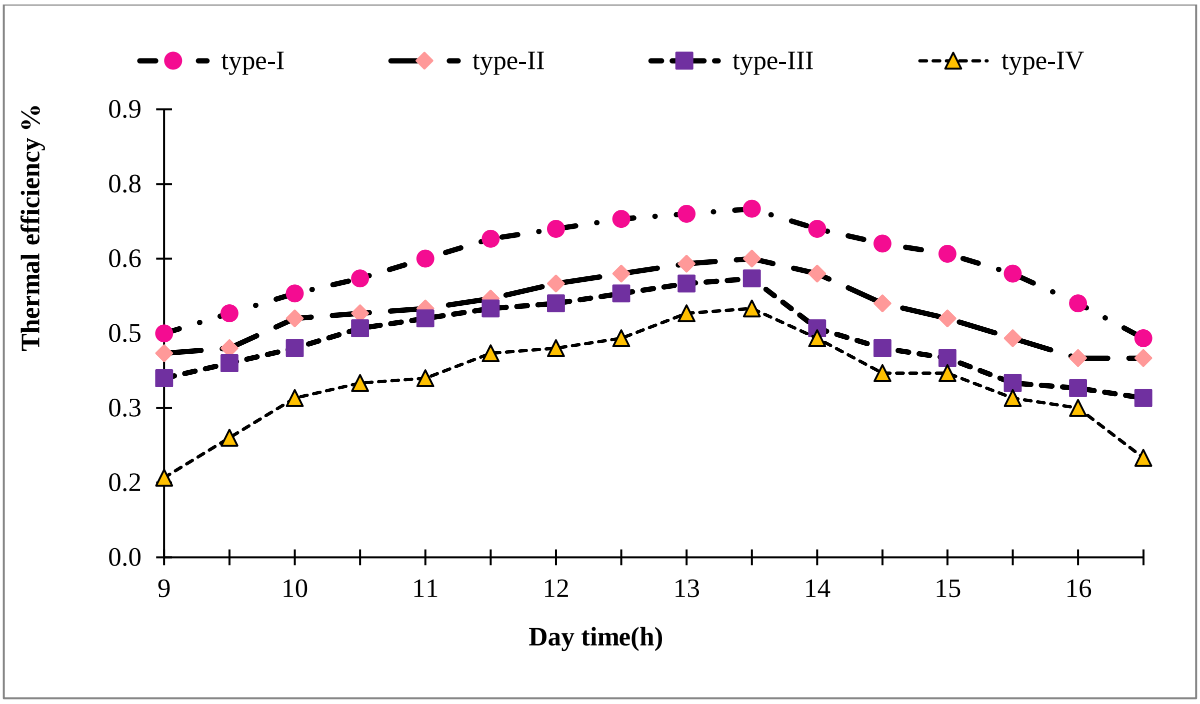


Fig.14: thermal efficiency for the four tested types of solar collectors with 0.120 kg/s of air mass flow rate

<u>3.3.1 The effect of the absorber plate area on the thermal efficiency</u>

It is clear that the collector type-I that has the greatest contact area has the highest thermal efficiency followed by collector type-III and at last the collector type-IV, which has the smallest contact area. Taken in mind that, the collector type-II has lower efficiency than collector type-I, although it has double contact area, because the most gained heat to the air get from the top layer and the lower layer has very little effect on the gained heat.

<u>3.4. Comparison of the daily average efficiency for solar air collectors</u>

Fig.15 illustrates a comparison of the daily average efficiency of plate solar air collectors with different air mass flow rate. It is clear that the collectors, which made of aluminum cans type (I and type II) are more efficient than corrugated (type-III) and flat-plate (type-IV) collectors and the corrugated collector (type-III) is more efficient than flat-plate collector (type-IV). This increase as result of the using of aluminum cans because aluminum cans serve as fins that increase the capability of the absorber plate to absorb energy, consequently increasing the heat transfer coefficients, as well as contributing to the breakage of the boundary layer and reducing its growth. It is observed that the daily efficiency of the V-corrugated plate (type-III) is much higher than flat plate (type-IV) owing to the fact that the accumulative useful heat gain by the air for the v-corrugated plate is the higher compared with the flat plate design.

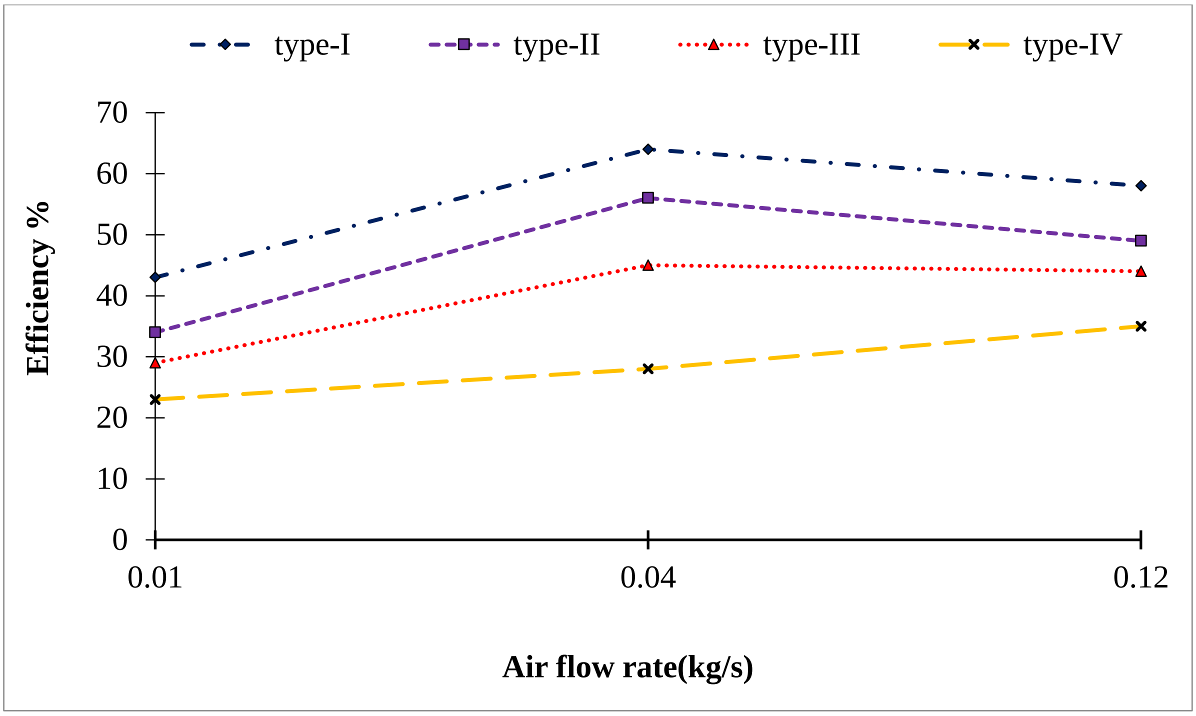


Fig. 15: changing of daily average efficiency for all the tested solar air collectors according to the rate of air mass flow

4.5. Prices of solar air collector's construction

Approximate estimation of the average cost for constructing a low cost solar air collector is given in **Table (1).**The overall cost and selected materials would promote mass production and hence, it can be a substitute to the expensive conventional absorbers thereby making it accessible and affordable. From table it found that solar air collector with absorber type- III has high cost than other types and solar air collector with absorber-I and II have low cost because of aluminum cans are cheap and it depend on number of cans.

Table (1) Estimation of the solar air collectors construction prices

S.N	Material	Type-I	Type-II	Type-III	Type-IV
1	Glass Sheet (m2)	0.6	0.6	0.6	0.6
2	External Box(m2)	1.01	1.01	1.01	1.01
3	Silicon Glue(bottle)	1	1	—	—
4	Black Paint(bottle)	2	2	2	2
5	Air Fan	1	1	1	1
6	Chimney	1	1	1	1
7	Absorber Plate	84 cans ≈1kg	168 cans ≈2kg	Corrugated Absorber plate	flat plate
Total Cost EGP	—	1143	1161	1540	1390

4. CONCLUSIONS

1) The solar air collector with absorber plate type-I was found to be the most efficient collector and the flat plate had the least efficient
2) The efficiency of the solar air collectors depended on the solar radiation, surface geometry, mass flow rate and area of the absorbers.
3) The maximum efficiency reached was at air mass flow rate=0.047kg/s for an air solar collector with an absorber plate made of recyclable aluminum cans.
4) The advantages of using recyclable materials to build absorber plates of solar air collector imply to have cheaper absorbers and cleaner environment.

5. REFERENCES

Akpinar. E. K.; and F. Kocyigit (2010) "Energy and exergy analysis of a new flat plate solar air heater having different obstacles on absorber plates". Applied Energy; 87: 3438–3450

Al varez, G.; J. Arce.; L. Lira.; and M.R. Heras (2004) "Thermal performance of an air solar collector with an absorber plate made of recyclable aluminum cans". Solar Energy; 77:107–13.

Chukwujindu, N.S (2017) "A comprehensive review of empirical models for estimating global solar radiation in Africa". Renewable and Sustainable Energy Reviews; 78: 955–995.

El-Sebaii, A.A.; S. Aboul-Enein.; M.R.I. Ramadan.; S.M. Shalaby.; and B.M. Moharram (2011) "Thermal Performance investigation of double pass-finned plate solar air heater". Applied Energy; 88(5):1727–1739.

Escobedo, Q.H.; F. Manzano-Agugliaro; and A. Zapata-Sierra (2010) "The wind power of Mexico". Renewable & Sustainable Energy Reviews; 14:2830 – 2840.

Jamil, B; and N. Akhtar (2017) "Comparative analysis of diffuse solar radiation models based on sky clearness index and sunshine period for humid-subtropical climatic region of India: A case study." Renewable and Sustainable Energy Reviews, 78: 329–355.

Kabeel, A.E.; A.S.M. Khalil Shalaby; and M.E. Zayed (2016) "Investigation of thermal performances of flat, finned, and V-corrugated plate solar air heaters. " Solar Energy Engineering; 138: 051004-051007.

Kalogirou, S. A (2004) "Solar thermal collectors and applications". Progress in Energy and Combustion Science; 30:231–295.

Kurtbas, I.; and E. Turgut (2006) "Experimental investigation of solar air heater with free and fixed fins: efficiency and exergy loss". International Journal of Science & Technology, 1: 75-82.

Omojaro, A.P.; and L.B.Y. Aldabbagh (2010) "Experimental performance of single and double pass solar air heater with fins and steel wire mesh as absorber". Applied Energy; 87:3759-3765.

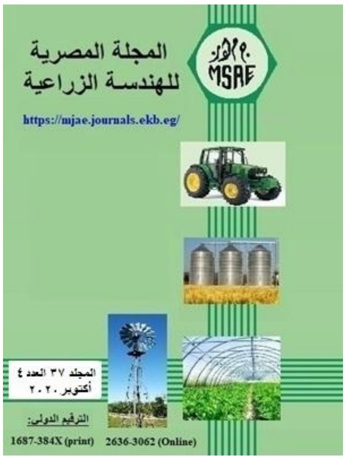
Saxena. A; Varun; and A.A. El-Sebaii (2015) "A thermodynamic review of solar air heaters". Renewable and Sustainable Energy Reviews, 43:863–890.

Varun; R.P. Saini.; and S.K. Singal (2007) "A review on roughness geometry used in solar air heaters". Solar Energy; 81:1340–1350.

دراسات هندسية على الأسطح الماصة لتحسين أداء المجمعات الشمسية

د./ أحمد توفيق طـه[1] و م./ منار ماهر هلال[2]

[1] أستاذ مساعد - قسم الهندسة الزراعية - كلية الزراعة - جامعة المنوفية - مصر.
[2] مهندسة زراعية - كلية الزراعة - جامعة المنوفية - مصر.



الكلمات المفتاحية:
طاقة شمسية، مجمع شمسي، عبوات ألومنيوم

الملخص العربي

أجرى هذا البحث بمعمل الهندسة الزراعية - كلية الزراعة - جامعة المنوفية، واستهدف استخدام مواد قابلة للتدوير كنزات الألمونيوم ذات تكلفة منخفضة لعمل مجمع شمسي يعمل بالهواء. و لدراسة الأداء الحراري وحساب الكفاءة الحرارية استخدام أربع أنواع من الأسطح الماصة للحرارة) طبقة واحدة من كنزات الالمونيوم I - طبقتين من كنزات الالمونيوم II - سطح مموج III - سطح أملس IV) عند ثلاث قيم من معدلات تدفق الهواء (٠,٠١٩٩-٠,٠٤٧-٠,١٢٠كجم/ث) لكل نوع من المجمعات الشمسية. تم قياس الإشعاع الشمسي خارج المجمع الشمسي وقياس درجات الحرارة وقياس سرعة الهواء خارج وداخل المجمع الشمسي وتوصلت الدراسة إلى النتائج الآتية:

١- تتأثر الكفاءة الحرارية للمجمع بالتغير في الاشعاع الشمسي وشكل السطح الماص وسرعة تدفق الهواء خلال المجمع.
٢- أعطي معدل التدفق ٠,٠٤٧كجم/ث أعلي كفاءة حرارية بينما كانت اقل كفاءة حرارية مع معدل التدفق ٠,٠١٩٩كجم/ث.
٣- المجمع الشمسي الأول طبقة واحدة من كنزات الالمونيوم وجد أنه أكثر كفاءة وفعالية والمجمع الرابع السطح الأملس هو الأقل في الكفاءة.
٤- استخدام المواد القابلة للتدوير في بناء أسطح ماصة للمجمعات الشمسية يؤدي إلى خفض التكلفة والمحافظة على البيئة.