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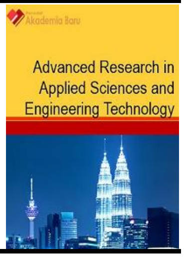

Forced-Convection Heat Transfer in Solar Collectors and Heat Exchangers: A Review

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ABSTRACT

Solar thermal collectors, as well as heat exchangers, are energy systems that have become very popular recently in various research centers around the world. Clean systems used to generate thermal energy for its importance in human life. Most of the studies focused on the impact of various physical factors on the efficiency and performance of these systems in the presence of different structures and problems. The current research is mostly focused on evaluating thermal performance in solar receivers and heat exchangers using forced thermal transfer. Due to its importance in numerous industrial domains, the current study is primarily focused on evaluating thermal performance based on forced thermal transfer in sola r receivers and heat exchangers.

Keywords:
Heat transfer; forced convection; solar collectors; heat exchangers

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1. Introduction

Renewable energy are vital clean energies that have been widely utilised in a variety of fields across the globe. Solar energy is one of the most extensively used energy sources for both thermal and electrical energy generation. When it comes to thermal energy, a number of recent studies on solar thermal energy converters have proved the utilization of heat exchange channels, which are commonly seen in solar receivers and heat exchangers. The performance and effectiveness of thermal systems are highly influenced by a variety of natural and structural elements. Natural parameters such as medium temperature, wind speed, humidity, solar radiation intensity, and so on should all be examined before employing any thermal system. The physical and chemical properties of the heat exchange fluid, the internal structure of the channel and the type of its walls, the presence or absence of blockages, the system's inclination, and other factors must all be considered. The thermal performance of two forced convection-based thermal systems is assessed in this study. In

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the presence of various boundary circumstances, a review of the most important current studies is undertaken. The first section analyzes the several types of solar receivers and their applications, while the second portion discusses the necessity of heat exchangers.

2. Assessment of Forced-Convection Heat Transfer in Solar Receivers

Bunchan *et al.,* [1] proposed to improve the heat transfer of the solar collector by using a stainless steel porous (WP) material on the absorber plate. In the turbulent flow region, white phosphorous of different diameters was investigated and air was used as the working fluid. When white phosphorous was applied to the absorbent plate, both the Nusselt number and the friction factor increased dramatically. 1.84 was the highest thermal improvement coefficient obtained. In order to investigate the environmental consequences of SAC, Alic *et al.,* [2] built four distinct absorption plates SACs using energy-based methodologies (energy indicators), Fig. 1. Its thermal efficiency and energy performance were measured. Geometric configurations of the SAC absorber plate were also investigated. These SACs were one-pass forced load collectors. The maximum environmental impact factor, thermal efficiency, and energy efficiency values among the four SAC designs are 0.32, 91 percent, and 4.7 percent, respectively. Seco-Nicolás *et al.,* [3] addressed 3D performance static laminar state analysis forced thermal transfer of a fluid flowing through a circular tube, taking into account the axial thermal conductivity in the fluid, when radially unequal external conditions were applied to the outer surface of the tube (known uniform temperature on the upper surface and a adiabatic state at the bottom). Differential equations were solved using numerical solutions. Temperatures in solar thermal equipment were also measured experimentally.

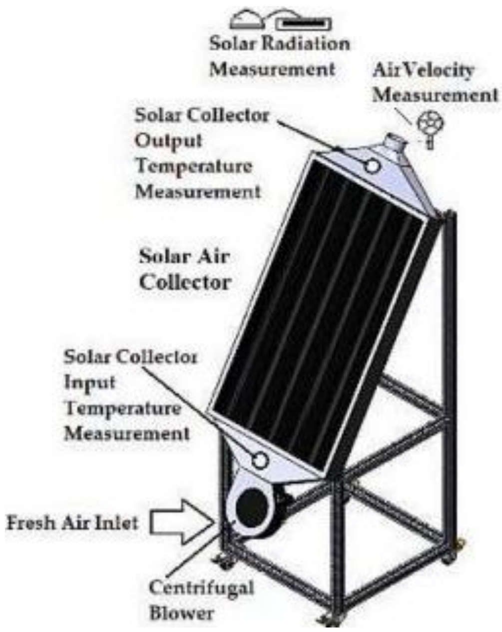

Fig. 1. Experimental setup and measurement points [2].

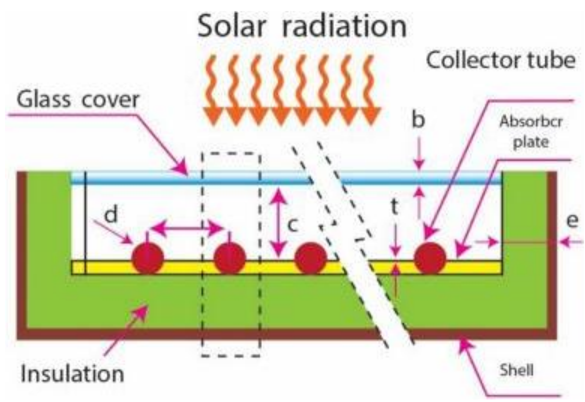

Fig. 2. Front view of a flat solar collector [4].

Alsarraf *et al.,* [4] studied the effects of nano-shaped nanoparticles on the hydrothermal properties and entropy production of MoS_2/water nanofluidic (NF) over a flat solar collector using a two-phase mixture model, Fig. 2. The researchers studied the blade, bricks, platelets and cylindrical nanoparticles. According to the data, the highest PEC corresponds to a condition ϕ = 3 percent, $\dot{m}$ = 0.5 kg/sec, and brick-shaped nanoparticles, while the lowest entropy production corresponds to a condition φ = 4 percent, $\dot{m}$ = 0.5 kg/s, and to a shaped nanoparticle blade. Abuşka *et al.,* [5] built new solar air collectors (SACs) to test whether cherry stone/powder is suitable for use as a reasonable thermal energy storage material (STES) in terms of energy and extreme energy in cloudy weather and after sunset. For crushed SAC cherry (Type I), SAC cherry (Type II) and flat plate SAC (Type III), the tests were performed at seven different air mass flow rates (ranging from 0.004 kg/sec to 0.048 kg/sec). Average thermal efficiency ranged from 6.05 percent to 39.99 percent, depending on the air mass flow rates used in the experiments and whether the collectors featured heat storage. Fterich *et al.,* [6] presented an experiment of drying and analyzing tomatoes using a combined sun-dried forced convection. The system under study consists of a photovoltaic (PV/T) air collector and a chamber dryer. The achieved prototype reduced the moisture content of the product from 91.94 percent to 22.32 percent for tray 1 and 28.9 percent for tray 2, but only to 30.15 percent for the open sun dryer. The drying temperature has been increased as well as the quality of the final product.

Using a computer model, Nasrin *et al.,* [7] explores forced convection across a flat panel solar collector, Fig. 3. Aqueous alumina nanofluid is the working fluid inside the solar collector tube. According to the numerical results, the largest Re and Pr have the highest heat loss. The efficiency ratio of the collector improves with the increase of Re and Pr. Bahrehmand *et al.,* [8] developed a mathematical model to simulate the thermal behavior of monoclinic and glass solar air collection systems with forced heat flow. Fin and thin sheet metal systems (TMS) are more energy and energy efficient than other systems evaluated. Turgut *et al.,* [9] reported experimental and three-dimensional numerical studies to determine the average heat transfer coefficients of forced convection airflow on a rectangular flat plate. The results were expressed in terms of heat transfer coefficients using heat and mass transfer analogies. All experimental data can be correlated in 12% margin of error.

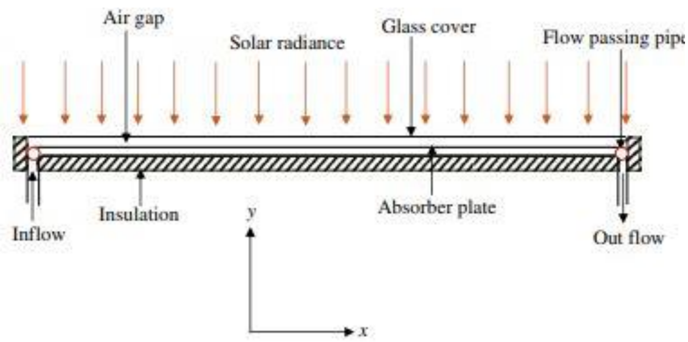

Fig. 3. Schematic diagram of the solar collector [7].

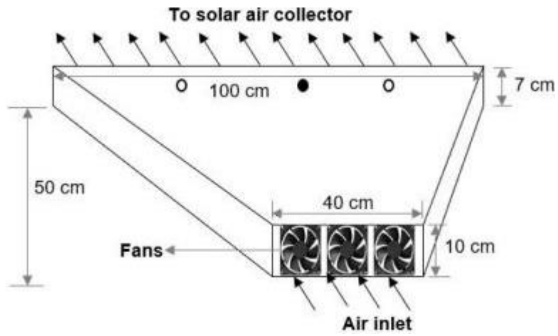

Fig. 4. Dimensions of divergent section coupled with CPU DC fans [10].

Mugi *et al.,* [10] conducted energy, exergy, and economics assessments of indirect-type solar dryers (Fig. 4), with forced and natural convection (ITSD) have been conducted. Forced convection experiments were performed using inlet fans powered by photovoltaic solar panels. The efficiencies of the collectors for forced and natural convection were 75.69% and 64.4%, respectively. The exergy efficiency of forced and natural heat drying of ITSD was found to be 56.12 and 51.85% room, respectively. Simo-Tagne *et al.,* [11] has used numerical simulation modeling to predict the performance of cocoa bean dryers under normal, forced and complex forced/natural convection in a tropical environment. The solar collector has a thermal efficiency of more than 30%, while the global thermal efficiency ranges from 5% to 18%. Gilago *et al.,* [12] evaluated the efficacy of indirect-type convection and forced solar dryers in drying ivy gourd. The natural convection design was modified to improve forced convection by inserting a trapezoidal duct fans and a CPU driven by photovoltaic panels. The actual heat generated by natural and forced convection was 776.6 and 997.76 W, respectively. The average collector efficiency was 62.56% in both cases and 77.2% in the other. The drying efficiency was 6.62% and 7.8%, respectively, for the same.

Mugi *et al.,* [13] examined and compared dryer performance, thermal properties and drying kinetics of guava in indirect convection solar dryer (NCISD) and indirect convective solar dryer (FCISD). Mugi *et al.,* [14] also performed an energy and exergy output analysis (EEA) while drying okra in an indirect solar dryer (ISD) under forced and natural convection, and compared the results to obtain the best ISD performance evaluation and optimization drying (Fig. 5). Processing taking into account energy. The average efficiencies of SAC and forced convection drying were 74.98% and 24.95% respectively while they were 61.49% and 20.13% under natural convection. Gupta *et al.,* [15] used a unique PVT solar dryer to dry star fruits and studied sustainability factors based on energy and exergy performance, as well as environmental and economic factors rating (4E) under forced thermal drying (FCD) and natural thermal drying (NCD). The power and energy efficiencies of PVT in FCD mode are 69.27% and 31.12%, respectively, but they are 43.58% and 17.89% in NCD mode.

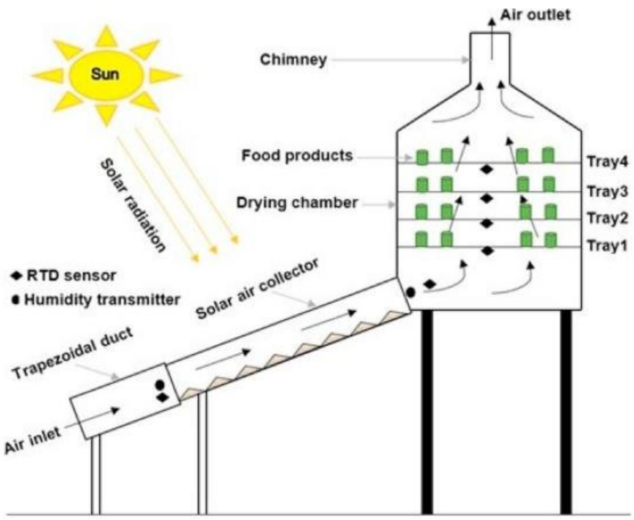

Fig. 5. ISD integrated with trapezoidal duct [14].

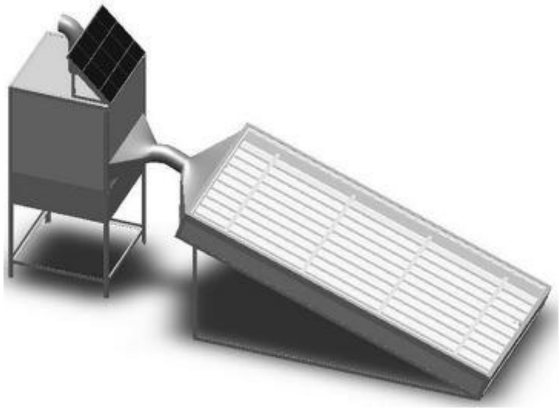

Fig. 6. 3D Design of Developed Cabinet Solar Dryer [18].

Hawa *et al.,* [16] used the indirect forced convection solar dryer. Drying behavior and drying pattern of fruit shrinkage and motility were all evaluated. The results showed that boiling cabya fruits with hot water had a significant effect on the drying behavior of the fruits. Rezaei *et al.,* [17] found that in the dryer, the use of coil absorption plate and PCM increases the average efficiency of the collector and dryer by 28.5 and 52.1%, respectively, compared to the plate. Flat absorption plate without PCM, with a ratio of 26.4 and 36.3% compared to coil absorbent plate without PCM, and 12.2 and 12.9% compared to flat absorbent plate with PCM. Design and development of cabinet style solar dryer (Fig. 6) with natural and forced convection air circulation by Bhavsar *et al.,* [18]. They wanted to compare the effectiveness of natural convection solar dryers for fruit and forced convection solar dryers to see how much moisture content and weight ginger lost during the drying process. After examination, it was discovered that the original moisture content of ginger was 80 percent per 4000 grams weight.

Sivakumar *et al.,* [19] combined forced convection solar dryer and a flatbed solar collector covered with CuO nanoparticles for drying maize under atmospheric conditions in Coimbatore, India. The efficiency of the complex increased by 4% when a black coating was applied with an absorbent coated with 0.04 volume of Cu nanoparticles. According to Xiao *et al.,* [20], the secondary flow of slurry microalgae improves the heat transfer coefficient. Komolafe *et al.,* [21] studied the thermodynamics of a forced convection solar dryer using a black-coated heat-sensitive storage material (STSM) for cocoa. The study was conducted as a static thermodynamic system, with the first and second laws of thermodynamics used to calculate the energy used in the solar drying of cocoa beans. With a minimum and maximum solar radiation of 49.6 and 759.6 W/m^2 and an average mass flux of 0.032 kg/s over the two days, the efficiency of the collector ranged from 4.2 to 61.2%.

Gupta *et al.,* [22] studies the effect of operating conditions on the performance of a solar photovoltaic thermal (PVT) dryer in sunny and cloudy weather. Atmospheric conditions for three different cases: the first case (natural convection), the second case (forced convection at an air speed of 0.096 m/s) and the third case (forced convection at an air speed of 0.014 m/s). Shrivastava *et al.,* [23] studied the effect of different configurations on the thermal efficiency of 150W photovoltaic solar thermal collectors. The air cooling changes detected in the PV/T system are free ducts without fins, ducts with fully transverse fins, partly transverse fins, and longitudinal fins with straight baffles and angled baffles. Hidalgo *et al.,* [24] built a photovoltaic-assisted direct solar dryer and underwent natural and forced convection tests to see how well it worked (Fig. 7). For natural load drying, the average solar dryer efficiency and specific energy consumption were 34.2 percent and 18.3 kW/kg, respectively, and 38.3 percent and 16.4 kW/kg for forced convection drying.

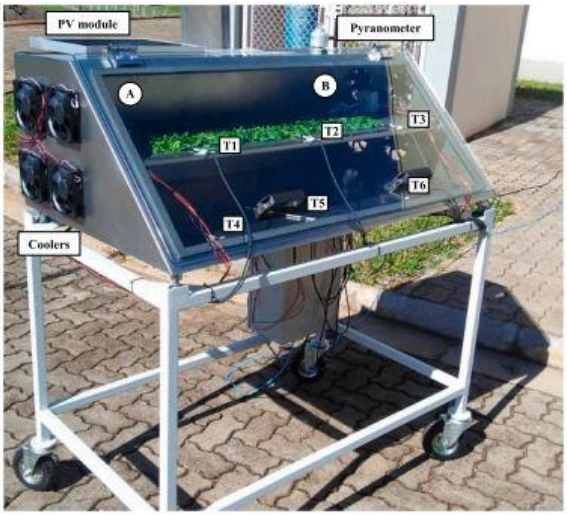

Fig. 7. Direct solar dryer [24].

Fig. 8. Photographic view of experimental setup [25].

Bhardwaj *et al.,* [25] evaluates the performance of a new low-cost and economical forced conduction solar drying system (Fig. 8). The drying unit RT-42 contained paraffin as a thermal energy storage medium (TES), while the solar air collector (SAC) was fitted with a reasonable heat storage medium (SHSM) to regulate temperature changes throughout the day and night drying process. The energy efficiency and energy efficiency of SAC were calculated to be 9.8 (26.10) and 0.14 (0.81) percent, respectively, without (with) TES. Pathak *et al.,* [26] performed an experimental examination of two types of corrugated solar panel collectors (CPSC) using water as a working fluid. The absorbent plates tested were in two CPSC designs and dimensions, but they were made of different materials: collector 1 was copper, and collector 2 was aluminum. According to the results, increasing the MFR in water from 0.0167 kg/s to 0.033 kg/s improves the thermal efficiency of the copper-aluminum complexes. To evaluate the vacuum tube solar collecting system used to dry grapes, Ubale *et al.,* [27] developed a two-dimensional performance model. The solar collector is designed and produced for drying 10 kg of seedless Thompson grapes using forced convection. The experimental thermal efficiency of the system was set at 31.2%, which is higher than the thermal efficiency of a flat panel solar system (15 percent). Farshad *et al.,* [28] proposed an algorithmic method for dealing with three-dimensional turbulent flow using twisted bars. The nanomaterial was warmed up using solar heat flux. When it is lower the diameter ratio is chosen, and the thermal boundary layer becomes thicker. Both engineering variables are directly related to thermal performance. Based on early tests under regulatory drying conditions, Pardhi *et al.,* [29] designed a combined solar dryer with forced convection using fine and coarse solar collectors (Fig. 9). Under no-load condition, the temperature of the dryer absorbent plate reached 69.2°C. The maximum air temperature in the dryer was 64.1 °C under these conditions. The dryer was loaded with 3 kg of grapes with an initial moisture content of 81.4%, and a final moisture content of 18.6% achieved. In 4 days versus 8 days for drying in the open sun. Active air cooling can improve the overall performance of a low-concentration solar photovoltaic collector [30]. The profile of the daily back-surface temperature of the solar cells and the resulting electrical energy are shown, as well as data from concurrently tested deconcentrating solar cells, demonstrating the function of this cooling strategy in enhancing the transmission efficiency of the photovoltaic system.

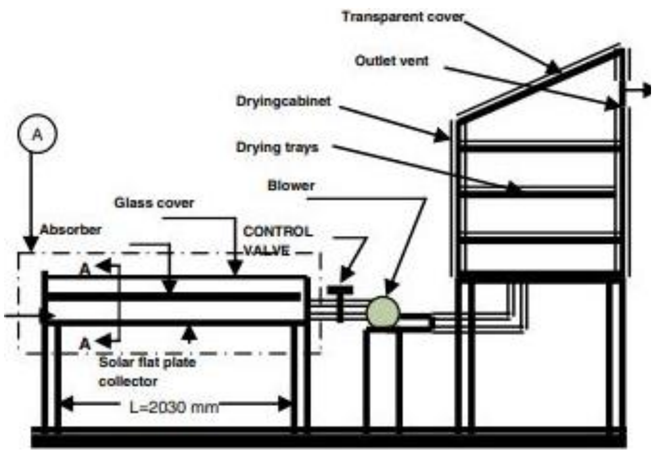

Fig. 9. Diagram of experimental setup [29].

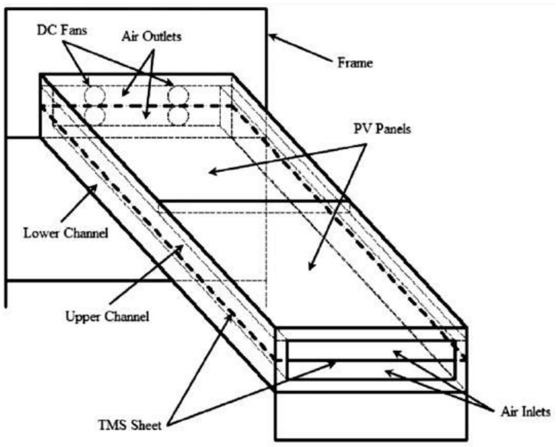

Fig. 10. Diagram of studied PV/T air system [40].

Sabareesh *et al.,* [31] used the method of drying tomatoes with two different flow rates of 0.153 and 0.077 kg/sec. A flow rate of 0.153 kg/s reduces the drying time by 6 hours compared to open solar drying, while a flow rate of 0.077 kg/s reduces the drying time by 5 hours. With R2 = 0.9806 and RMSE = 0.03175, the equivalent drying model shows that tomatoes are the best. Malakar *et al.,* [32] wanted to have a look at the thermal performance of the vacuum tube solar dryer (ETSD) and drying kinetics of the garlic clove. Five film drying were selected kinetic models and matched with experimental moisture values to determine the most suitable drying model. The Weibull model was determined to be the best fit curve capable of capturing drying kinetics at 2 m/s and 3 m/s, with the highest coefficient of determination (R^2), lowest chi-squared (χ^2), and root mean square error (RMSE) values. The modified PAGE model was found to be the most appropriate model to represent the drying behavior of garlic cloves at an air speed of 1 m/s. In Malakar *et al.,* [33], a 60 kg convection solar tunnel dryer was developed for drying fresh-sized silkworm cocoons. During the first stage of drying, the drying rate of silkworm cocoons under the solar tunnel dryer was found to be very high due to the improved moisture dispersion. The maximum temperature reached in the dry sun tunnel during drying of the silkworm pupae was 95.6 °C at an ambient temperature of 36.20 °C.

Dehghan *et al.,* [34] investigated the 3D forced heat flow within rectangular channels filled with porous media, commonly used in air-based solar thermal collectors, in order to determine the velocity distribution profile and other flow characteristics such as the Poiseuille (Po) number. According to the sensitivity analysis, the term for nonlinear drag affecting the Nusselt number is only significant in porous media with large Darcy numbers. Hematian *et al.,* [35] built a flat wind solar panel collector to achieve their research goals. In forced convection, the efficiency of the collector is found to be lower, but the heat loss is reduced due to the decrease in the air temperature between the input and the output. In this same forced convection, the average air velocity was found to be approximately 21% higher than in natural convection. The laboratory tests were performed with a solar thermal water heater consisting of a flat plate solar collector and a helical coil heat exchanger using Al_2O_3 nanoparticles dispersed in water as the working medium [36]. The studies were conducted with different nanoparticle concentrations ranging from 0% to 3% using forced convection cooling.

Mutabilwa *et al.,* [37] evaluated the proposed indirect forced convection solar drying system using a double-pass solar collector in an experimental and theoretical study (DPSC). Because of the unique arrangement of the component parts, the product dryer has surpassed similar dryers in terms of efficiency. Bhuyan *et al.,* [38] investigated the heat loss from a parabolic tube absorber for a trough solar collector (PTSC) system, as well as the heat loss link design. According to the research, increasing the wall of the tube increases the emissivity from 0.2 to 0.8, the Nusselt number from 5.66 to 18.6. GK *et al.,* [39] focused on the experimental investigation of heat loss associated with a vacuum receiver subject to uniformed/non-uniform wall heat flows. The boundary condition NUWHF (non-uniform wall heat flow) has an irregular wall heat flow. Heat losses due to natural and forced convection are compared in the bare shell and receptor glass. The results showed that the condition of the irregular heat flow limits of the wall has a significant effect on the heat loss by forced convection, especially at high wind speeds.

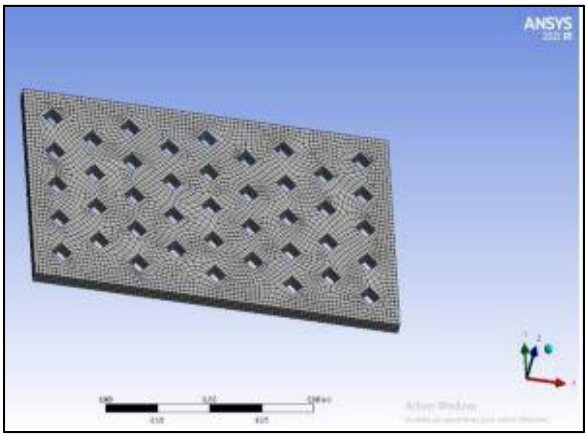

Fig. 11. 3D mesh of Solar Flat Plate Collector [41].

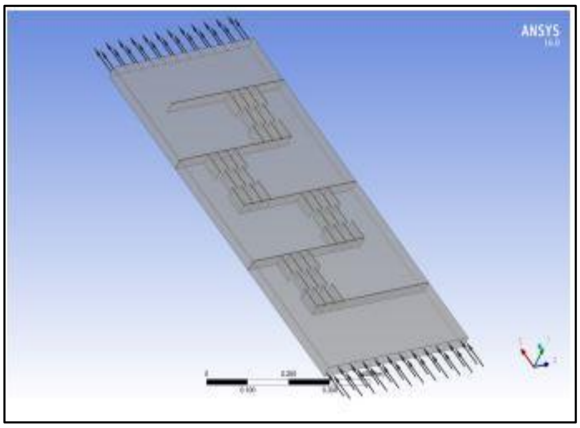

Fig. 12. Sketch for the solar collector [42].

Ameri *et al.*, [40] planned, built and tested a photo/thermal antenna complex in Kerman, Iran (Fig. 10). In the case of forced convection, installing a glass cover on the solar panels reduces the air mass flow rate. However, in the load mode, the installation of the cover glass improves the flow rate of the air mass. Amraoui *et al.,* [41,42] reported the study of convective heat transfer in solar collectors using the CFD that reduces time and cost, Figs. 11 and 12. The temperature of the air exit is compared to experimental results, and there is a satisfactory agreement. Other recent studies have evaluated the performance of some solar channels in the presence of obstacles in various shapes [43-50].

3. Assessment of Forced-Convection Heat Transfer in Heat Exchangers

CFD has been used by Huu-Quan *et al.,* [51] to investigate turbulent forced convection heat transfer within novel two-pipe heat exchangers with flat inner tubes. The overall heat transfer coefficient, thermal efficiency and performance index were improved by about 2.9 percent, 2.7 percent and 16.8 percent, respectively, by using a flat inner tube with an aspect ratio of 0.37. To investigate the heat transfer coefficients of highly porous media within a velocity range of 4 to 90 m/s, Hu *et al.,* [52] used the CFD method to build the open Kelvin model, also known as the field- and column-subtracted models, Fig. 13. According to the results, the pressure drop, heat transfer coefficient and volumetric heat transfer coefficient all increased with increasing CPI (cells per inch) and decreased with increasing porosity. Thermo-hydraulic behavior of toothed heating tubes Bundles as pumps were investigated by Pimsarn *et al.,* [53]. The following are the most important ways to improve convective heat transfer in fluid flow. Heat transfer rate, friction loss and TPI increased with decreasing pitch ratio (PR) and diagonal toroidal switching angle (α). The heat transfer rate and friction factor were increased by 2.2 and 8.8 times over a simple tube, respectively. Over the studied range, the maximum TPI, 1.16, was detected using a serrated ring beam with α = 15° and *PR* = 6.0 at Re = 4000.

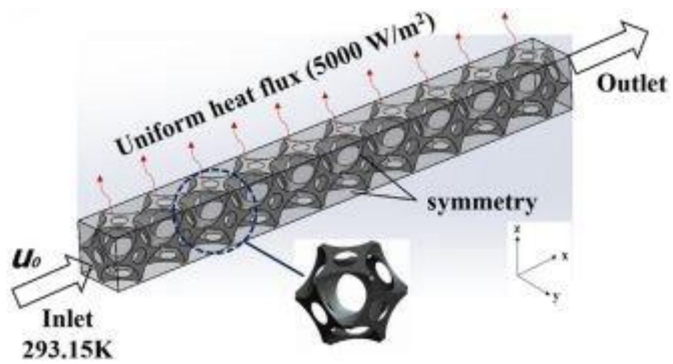

Fig. 13. Computational domain of simulation [52].

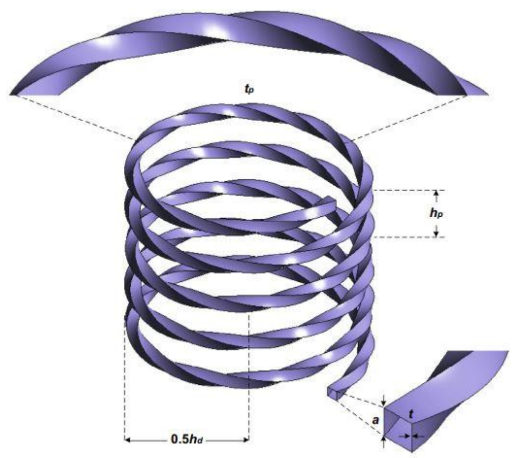

Fig. 14. Helical – twisted tubes [54].

To improve the thermal performance of a coiled-tube heat exchanger, Farnam *et al.,* [54] proposed a coiled structure, Fig. 14. To start, experiments are performed on a smooth helical tube, and the results are validated using the putative correlations of other scientists. For the Reynolds number range tested, the Nusselt number was improved 14.2% and the friction factor increased by 7.7%. It is observed for a model with median levels of design parameters (600 ≤ *Re* ≤ 1200). With a 50 mm diameter helix and a Reynolds number 900, the version with a better performance index of 1.98 was obtained.

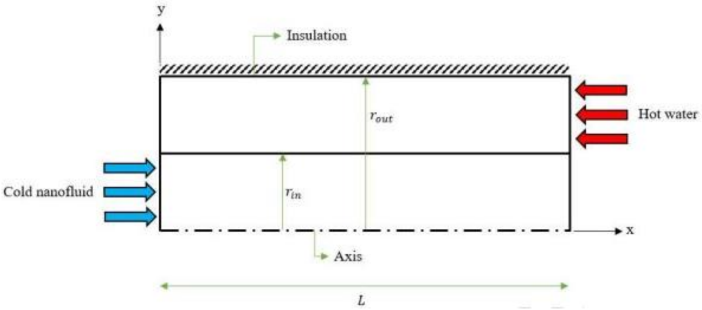

Fig. 15. Minichannel hairpin heat exchanger [57].

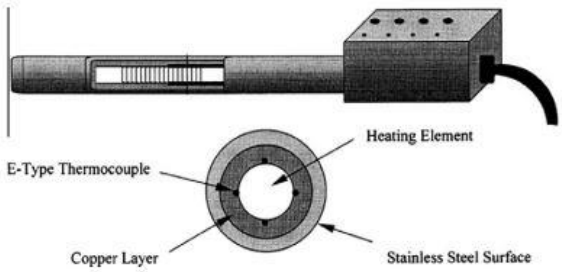

Fig. 16. Details of the heating section [61].

A hybrid digital experimental method for estimating the thermal performance of a heat exchanger was proposed by González *et al.,* [55]. The proposed methodology combines numerical modeling and wind tunnel experimental data to predict the average convective heat transfer coefficient and the overall surface efficiency of the fins. The main results show that at air velocity the average heat transfer coefficient by convection increases, despite the decrease in the overall efficiency of the fin surface. In a point plate heat exchanger, Soman *et al.,* [56] investigated the heat transfer behavior of -Al_2O_3/water nanofluid in turbulent flow. When the heat transfer behavior of the nanofluid was compared with the base liquid (water), it was discovered that with a higher concentration of nanoparticles, an increase in heat transfer occurred. Nusselt number correlations for working fluids have been established for the purpose of determining the heat transfer coefficient. Liu *et al.,* [57] wanted to see a comment on the variation in working fluid temperatures in the inlet affecting the hydrothermal properties of a small countercurrent heat exchanger, Fig. 15. The annular side of the heat exchanger is filled with water, while the side of the tube is filled with a water-based hybrid nano-fluid comprising Fe_3O_4 and carbon nanotubes (CNTs). The results showed that the heat transfer rate, total heat transfer coefficient (except for Reynolds No. 500), heat exchanger efficiency, and PEC all increase with the increase in the difference between the inlet working-fluid temperatures. However, as the inlet water temperature increases, the pumping force decreases.

Tahmasebiboldaji *et al.,* [58] described a computer simulation of laminar flow and heat transfer of nanofluids on an array of heat exchanger tubes. To better anticipate the nanofluid flow behavior on tube matrices, a two-stage mixture model was applied. Among all the different tube configurations and Reynolds numbers studied, the square configuration exhibited the highest-pressure drop coefficient as well as the highest fluid consumption. Zamzamian *et al.,* [59] calculated the effect of forced convection heat transfer coefficient on turbulent flow using a double tube and plate heat exchanger. In this study, aluminum oxide and copper oxide were separately synthesized in ethylene glycol. The results showed that when compared with the base fluid, the nanofluids show a significant increase in the convective heat transfer coefficient, ranging from 2% to 50%. Moreover, the results showed that the thermal heat transfer coefficient of the nanoliquid increases with the higher concentration of nanoparticles and the temperature of the nanofluid. Sarafraz *et al.* [60] focused on the forced convection heat transfer coefficient of a biogenerated nanofluid flowing in a circular tube of a heat exchanger. When the volume percentage was one, the heat transfer coefficient improved by up to 67 percent. Peyghambarzadeh *et al.* [61] values the boiling heat transfer coefficients for sub-cooled sub-flow of pure n-heptane and distilled water under different operating conditions, Fig. 16. The vertical ring was heated by a variable heat flow from the inside cylindrical heater in the heat exchanger.

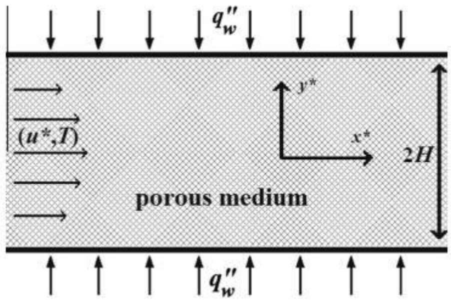

Fig. 17. Diagram of the saturated porous channel [62].

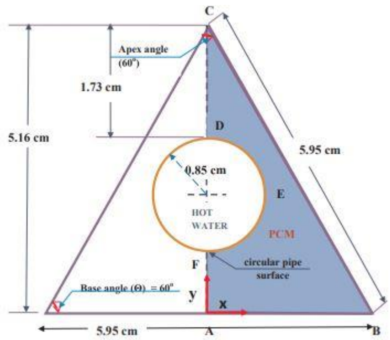

Fig. 18. Irregular shaped double – pipe HE [63].

Dehghan *et al.,* [62] reported the effects of modulating thermal conductivity on forced convection in a parallel plate-channel heat exchanger with a liquid-saturated porous material using turbulence methods, Fig. 17. According to the results, a linear increase in the thermal conductivity of the medium leads to a half-linear increase in the Nusselt number. A two-dimensional transient numerical analysis was conducted by Tabassum *et al.,* [63] to explore the solubility (energy storage) of an impure phase-changing material (paraffin wax) immersed in the annular gap composed of an equilateral tube outer and inner tube carrying a heat transfer fluid, Fig. 18. The results reveal that HTF block temperature has a significant influence on the melting process when compared to the mass flow rate. In a diagonally square channel arranged undulating in ribs, *Boonloi et al.,* [64] explored turbulent forced heat transfer and flow configurations. Heat transfer improvements across the seamless channel were 1.97-5.14 and 2.04-5.27 times for the 30° and 45° angles of attack, respectively. Friction loss estimates of 30° and 45° are about 4.26-86.55 and 5.03-97.98 times higher than that of a smooth square channel, respectively. In a horizontal tube with constant wall temperature, Demir *et al.,* [65] examined numerically induced heat fluxes of nanofluids composed of water with TiO_2 and Al_2O_3 nanoparticles. The numerical results show that embedding nanoparticles in the liquid enhances heat transfer, which is in line with the experimental results that were used to validate the numerical model. For different fin spacing in forced convection, Chen *et al.,* [66] used a finite difference approach, least squares methodology, and experimentally determined temperatures to predict the average heat transfer coefficient and fin efficiency on a vertical circular fin of tube-fin heat exchangers, Fig. 19.

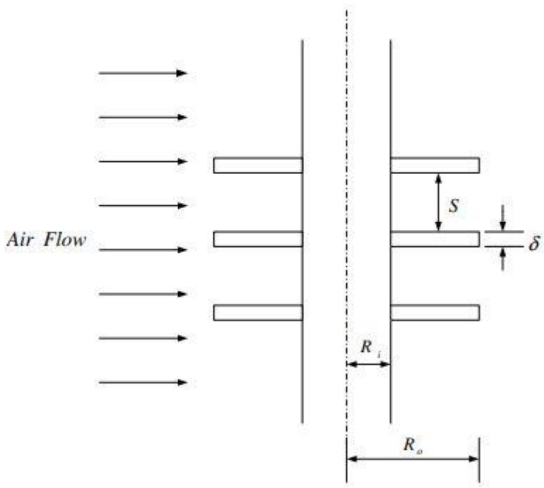

Fig. 19. One – tube annular – finned tube HE [66].

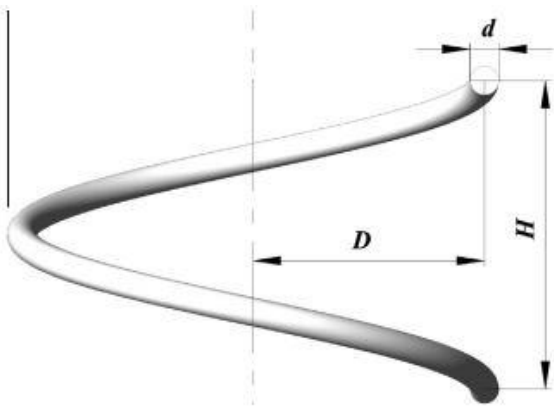

Fig. 20. Schematic of the helical pipe [67].

Shi *et al.,* [67] explored the second law of thermodynamics for entropy analysis generates in a rotary helical tube heat exchanger with laminar convective flow and input dimensionless properties such as heat exchanger duty, heat flow, heat transfer, and low friction pressure, Fig. 20. In a nuclear fuel storage vault, Mishra *et al.,* [68] investigated forced convective heat transfer from fuel and sub-assemblies to air. The air flow was increased and, as a result, a decrease in the temperature of the hot spots was achieved by adding slots for the connected channels. Muzychka *et al.,* [69] studied heat transfer through matrices of circular and non-circular channels of finite size and the constraints of a constant pressure drop. It has been shown that the ideal duct dimensions are independent of the matrix structure, making it an ideal building component. Acikgoz *et al.,* [70] used a machine learning method to predict the heat transfer coefficients of a radiator wall of a cooling system with mixed and forced convection. For all heat transfer coefficients, the results of the computational solution were compared with the target data within a 5% deviation region, and the results were evaluated. Performance factors were identified, and the accuracy of estimation of numerical models was accurately tested. In addition, several techniques have been recently adopted in many studies by providing the channels of heat exchangers with baffles and fins in various shapes and directions [71-80].

4. Conclusions

This document is a detailed review of the literature of the various research studied on this topic. Thus data from experimental and numerical studies using several type and hypotheses for different type solar collector and heat exchanger geometries are brought together. This paper reviews experimental and numerical studies implemented on forced thermal transfer in solar collectors and heat exchangers, including both traditional and novel approaches. The research work carried out for two application of forced convection. First, forced-convection in solar receivers and second for heat exchangers. Various parameters, such as, wind speed, solar radiation intensity, the type of it walls and so on should all be examined before employing for both systems. The thermal performance of the collector and heat exchanger was found to be poorer as a result of low convective heat transfer from the absorber plate to the air, according to the findings of this study. The heat transfer coefficient has been significantly improved by artificial rib roughness on the underside of the absorber. We ended this research by identifying the many applications for solar collectors and heat exchangers, including electronic component cooling, house heating and cooling, transpiration cooling, agricultural food material drying, and cold storage performance.

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