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"A REVIEW ON SOLAR AIR HEATER"

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ABSTRACT

Solar energy is one of the most attractive types of renewable sources with applicability for heating in different scales. Several technologies can be employed for air heating by using solar radiations. The performance of the solar heating systems is dependent on different elements including the type of technology, configuration and operating conditions. In the present work, different solar air heating systems and the factors affecting their performance are reviewed and discussed with focus on the recently published studies in order to cover the contents that have not been considered in the previous review articles.

Key Words: *Soalr energy, heating, radiation, solar air heater.*

I. INTRODUCTION

In present world the prosperity of nation is measured by the energy consumption of that nation, the GDP of country is directly linked with energy consumption. Therefore demand for energy resources is increasing day by day. There are various types of energy resourcesbut mainly they are classified in commercial and non-commercial energy, renewable and non- renewable energy and primary andsecondary energy forms. From renewable point of view solar energy is one of the most convenient forms. It is the energy which iscoming from sun in the form of light and heat. Especially the thermal energy will be further converted into electrical energy. One ofthe most potential applications of solar energy is the supply of hot air for drying of agricultural and heating of buildings to maintain acomfortable environment especially in the winter season. The large magnitude of solar energy available makes it a highly appealingsource of electricity.Solar air heater is one of the basic equipment through which solar energy is converted into thermal energy. A conventional solar airheater generally consist of an absorber plate, a rear plate, insulation below the rear plate, transparent cover on the exposed side, and theair flows between the absorbing plate and rear plate. The value of the heat transfer coefficient between the absorber plate and air is lowand this result in lower efficiency for this reason the surface are sometime roughened in the air flow passage. Fig. 1 shows aconventional solar air heater. There are basically three approaches or methods that can be used to solve a problem of fluid flow andheat transfer. These approaches are: Experimental, Theoretical and Computational (CFD)

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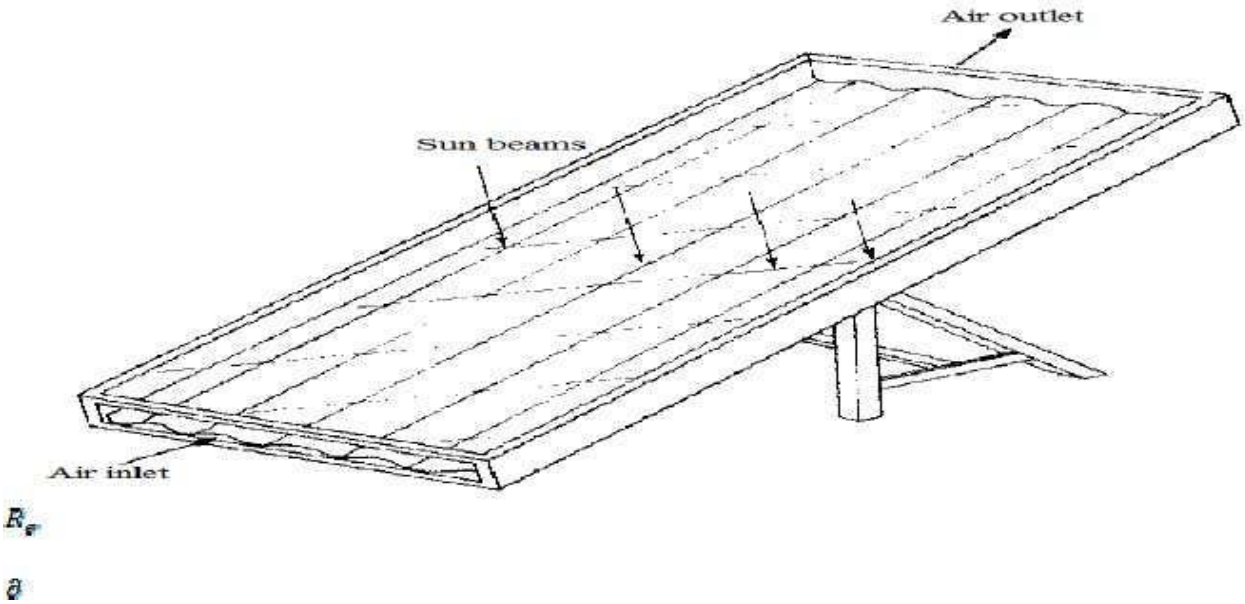

Fig. 1 Air heater Baffles

II. PROBLEM STANTMENT

The objective of present study is to perform CFD simulation for solar air heater. The results obtained by CFD simulation are been validated with experimental results. The experimental conditions taken for solar air heater, the same has been used for CFD simulation. The overall aim of this work is to understand the flow behaviour and temperature distribution of air inside the solar air heater and compare the outlet temperature of air with experimental results and also will see results with different parameters of solar air heater.

III. LITERATURE REVIEW

(kumar et al., 2022) The spacer length (Spdw), the variable parameter governing the PDWs, has a 100 mm range from 0 mm to 300 mm. The effects of "Spdw variation on the Nusselt number" (Nupdw), "friction factor" (frpdw), and "thermo-hydraulic performance" (pdw) are examined. "The fixed parameters of the PDWs are the relative roughness height of perforated delta-shaped winglets = 0.8," "relative transversal length of perforated delta-shaped winglet = 0.66," and "angle of incidence = 90°." Compared to SAH with a smooth absorber plate, artificially roughened SAH produced 5.17 and 4.52 times better Nupdw and frpdw, respectively. The greatest worth of 3.14 (>1) is reached by ηpdw at the ideal spacer lengthSpdw = 0 mm and Re of 12000. According to Hassan et al.'s research, perforated delta winglets are a great way to increase SAH's heat transmission[1].

Hassan et al. 2021) the research is conducted at four distinct air mass flow Within the flat plate solar air heater, which has two absorber plate levels named C_SAH and CP_SAH, the research is carried out at four distinct air mass flow ratios. The capability of level SAH (F_SAH) is appeared differently in relation to that of C_SAH and CP_SAH. The discoveries uncover that in SP, 1/3 DP, 2/3 DP, and DP conditions, separately, F_SAH accomplishes the most minimal day to day energy effectiveness rates of 52.5%, 55.86%, 54.77%, as well as 56.7%, though CP_SAH accomplishes the best upsides of 67.67%, 69.7%, 71.85%, as well as 70.8%. Also, at 2/3 DP conditions, C_SAH and the CP_SAH arrive at their greatest everyday efficiencies of 70.58% and 71.85%, individually. When compared to F_SAH under the same prior conditions, CP_SAH achieves average daily exergy productivity of 0.78 percent, 0.89 percent, 0.92 percent, and 0.92 percent, respectively.[2]

(Ganesh Kumar et al., 2021) This examination presents another half breed framework which might warm both air and water around a similar time. A forced shot-impacting technique was utilized to smooth the inward surface of the rectangular aluminum pipes inside the air warmers as well as the copper safeguard plate inside the water radiator to

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work on their warm execution. Also, the viability of convective intensity transmission was improved by consolidating nanofluids made out of sun powered glycol (SG) and "multi-walled carbon nanotubes (MWCNTs)". The trial examination was directed to survey the viability of this inventive joined framework over a gatherer area of 2 m2. The SG/MWCNT-based nanofluid was made by adding gum arabic at concentrations of 0.1 and 0.2 by volume percent as a surfactant. The results of the experimental investigation led us to the conclusion that there is a direct correlation between the volume percentage of nanomaterials and collector efficiency. With 0.2 vol % of MWCNT and a mass flow rate of 0.01 kg/s, the solar collector reached a maximum temperature of 18.32 °C, producing an average temperature difference of 14.54 °C. Moreover, a nanofluid in view of 0.2 vol% SG/MWCNTs had the option to accomplish a greatest warm proficiency of 51.03% during a mass stream pace of 0.01 kg/s.[3]

(P. G. Kumar et al., 2021) A solar air heater is a device that heats air using sunlight to circulate it and use it for ventilation or room heating. Active solar heating technology, which collects and utilizes solar radiation for heating, is represented by these systems. Solar air heaters are frequently used in addition to conventional heating systems in commercial, industrial, and residential buildings to offset the costs of energy and lessen their impact on the environment. A general explanation of how solar air heaters work can be found here. likewise checks out at an exhaustive financial evaluation of DPSAHs in India.[4]

(Baissi et al., 2020) The heat transfer, friction, and thermal improvement factors of a rectangular channel that has been purposefully roughened are studied using two configurations of delta-shaped baffles that are longitudinally curved. Reynolds number (Re) between 2500 and 12,000, relative transversal length (Pt/b) between 0.6 and 1, relative longitudinal length (Pl/e) between 3 and 5, and a single attack angle (= 45°) for the absorber plate and obstacles are all included in the investigation. The heat transfer coefficient (Nu) is 6.94 times higher and the friction coefficient (f) is 45.83 times higher when compared to a smooth channel. As per the review, "punctured longitudinally bended delta-molded confuses (LCD)" show a greatest pace of around 2.26 for "warm upgrade factor (TEF)" [5].

(Khanlari, Güler, et al., In this study, "new parallel-pass SCs with double baffles (PPSCDB), parallel-pass SCs with baffles (PPSCB), and parallel-pass SCs (PPSC)" were designed and evaluated for drying applications. With plus-shaped and perforated baffles, excellent thermal performance can be achieved. The performance of solar collectors has been the subject of both computational and experimental studies. A drying chamber has also been connected to solar air collectors.
The foundation of "celery (Apium Graveolens L.)" was thoroughly dried, and the quality of the dried samples was experimentally evaluated. The preliminaries were completed utilizing air mass stream paces of 0.009 kg/s and 0.011 kg/s. The trial results demonstrate that the mean warm efficiencies of PPSC, PPSCB, and PPSCDB are, individually, 62.10-66.32%, 65.72-69.62%, and 71.12-75.11%. An expansion in mass stream rate brought about the achievement of the greatest momentary proficiency of 84.30% in PPSCDB. Furthermore, there was a maximum discrepancy of 9.5% between the experimental and calculated results[6].

(Khanlari, Sözen, et al., 2020) This exploration researches the plan, manufacture, and testing of "V-groove fourfold pass (V-QPSAH) and V-groove triple-pass (V-TPSAH) sun based air warmers" to get dried out metropolitan sewage slime. In addition, every solar heater incorporates DC-I for conventional drying and DC-II for solar absorbers as separate drying chambers. Numerical and experimental methods have been used in studies of the efficacy of solar air heater-based drying systems. The produced system's potential for use has been revealed by performance testing under various operating conditions. The normal effectiveness of sun oriented air warmers goes from 70.12% to 81.7%, as displayed in the analyses. Additionally, the numerical outcomes concur with the experimental outcomes. The findings of the study suggest that the constructed technologies can dry municipal sewage sludge, which may have multiple applications[7]

(Saravanakumar et al., 2020) The current research focuses on optimizing the parameters and enhancing the energetic performance of a solar air heater with fins and baffles and a roughened ribbed surface in the shape of an arc. The effect of mathematical and functional variables on SAH's exergy proficiency has been explored utilizing a hypothetical system in light of exergy misfortune. The energy and exercise balance equations were calculated with this code, which

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was developed in MATLAB. In terms of critical factors, there are provided variations of exercise degradation and losses. A genetic algorithm has also been used to improve SAH's design and operating characteristics. The findings demonstrate that the suggested SAH can achieve an exergy efficiency of up to 5.2% in ideal conditions. The diagrams plainly show that the ideal boundaries for getting greatest exergy are 8 blades, 0.2 m confuse length, 0.015 m bewilder width, and 0.012 kg/s mass stream rate. The discoveries of the ongoing model's recreations for the proposed SAH were contrasted with models previously distributed in the writing not entirely settled to be comprehensively adequate. [8]

(Touili et al., 2020) The reason for this paper is to dissect the green hydrogen creation produced in Morocco through water electrolysis utilizing different sun oriented energy frameworks and climatic circumstances. A PEM electrolyzer has been used to reproduce the functional periods of 4 sun oriented power plant designs, each with an ostensible limit of 100 MWe and utilizing a particular innovation (fixed PV, 1-pivot following PV, 2-hub following PV, and Stirling Dish). A three-year moving average of high-quality meteorological data collected in situ at five distinct locations served as the simulation's inputs to ensure accuracy. From a technological point of view, the findings indicate that the 1 axis tracking PV system is the most economically viable technology for the production of green hydrogen in Morocco in nearly all locations. The fixed PV system has the lowest LCOH2 (5.8 $/Kg) and the Stirling Dish is the most efficient (12%), but the 2 axis tracking PV system has the capacity to generate the most hydrogen (4500 Tons/year). Moreover, with a LCOH2 of 5.57 $/Kg, when contrasted with 5.96 $/Kg in Southern Spain and 6.51 $/Kg in South Africa, Morocco might be viewed as an exceptionally serious area with regards to green hydrogen age, especially for PV innovation. [9]

(A. Kumar & Layek, 2019) A stochastic analysis is used in this study to numerically optimize the energetic and exergetic efficiencies of a solar air radiator with an absorber plate with contorted rib irregularity. The evaluation of these efficiencies considers both plan boundaries as well as the temperature increment boundary. The purpose of the experimental study was to investigate the response of twisted rib roughness to various geometric configurations in terms of temperature. This behavior was evaluated using correlations between the Nusselt number and the friction factor, and the findings were compared to those of smooth plates and previous studies. The exergetic efficiency criteria for temperature increase parameters and insolation were used to define the ideal roughness parameters. The mathematical setup described by an overall pitch harshness of 8, a rib direction point of 60°, a curve proportion of 3, as well as temperature climb boundaries of 0.0125 m2 K/W brought about the best increments of 1.81, 1.79, and 1.81 times, separately, in warm, compelling, as well as exergetic efficiencies when contrasted with a level plate. At greatest, the distinctions between the exploratory and recreation discoveries are under 6%, which is viewed as inside an OK reach. In addition, the current method simplifies the process of creating a design plot using the roughness parameter without requiring a significant financial investment in actual experiments and addresses the investigation of novel artificial roughness with the goal of improving the thermal performance of solar air heaters. [10]

(Hu et al., 2019) Numerical and experimental research were carried out on the collector, which had five compartments separated by four barriers. The way performance was improved was made clear by studying flow and heat transfer. Warm proficiency is essentially influenced by the width of the principal chamber, though pressure misfortune is not really impacted, as indicated by the reenactment results. The thermal efficiency of the model with equally spaced baffles increases by up to 16.90% when the first chamber has a width of 200 millimeters and total dimensions of 2000 millimeters, 1000 millimeters, and 120 millimeters. This value contrasts with the model with equally distributed baffles in the 1.8–5.5 103 Reynolds number range. The proportion of the advancement of the test contraption to the mathematical model was 1:0.5. After evaluating three distinct operating conditions and four distinct collection types, the method's efficacy was demonstrated. According to the results of the experiments, the first-chamber narrowing method improves thermal efficiency at rates ranging from 9.73 percent to 16.10 percent, showing that it has a fairly consistent effect on optimization. Regardless of changes in size, this strategy demonstrates a certain degree of adaptability and stability. 11]

(Abuşka, 2018) In this study, the thermal performance of a new absorber plate with a conical surface was compared to the thermal performance of a flat absorber plate in a conventional solar air heater with a single front pass. The investigations were directed outside under controlled conditions with three mass stream rates: 0.04, 0.08, & 0.10 kg/s.

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The mean warm productivity inside conelike and level safeguard not entirely settled to be 63.2-57.2% for 0.04, 71.5-61.7% for 0.08, as well as 74.6-64.0% for 0.1 kg/s, individually. Sunlight based air warmers with funnel shaped surfaces had the best warm effectiveness in all cases. The conical and flat absorber plates have been calculated to have average exergy efficiencies of 19.3–16.1% for 0.04, 15.1–11.5% for 0.08, and 12.5–9.2% for 0.1 kg/s, respectively. While contrasting cone shaped safeguard plates with level ones, a huge improvement in warm proficiency was found. The tapered shape further develops wind stream over the safeguard plate, increments surface region, decreases dead surface in the channel, and causes diminished shadowing. [12]

(Allouhi et al., 2018) To investigate the effects of various nanoparticles in the working fluid on PTCs operating at medium and high temperatures, this study presents a "one-dimensional mathematical model." The outcomes show that the nanofluid imperceptibly works on the PTC's warm effectiveness, which is the main revelation. The utilization of nanofluids is the most appropriate to high working temperatures, which additionally increment the overall increases of provided energy. Also, it is found that amplifying exergetic effectiveness is of more prominent importance than expanding lively proficiency. A maximal exergy productivity of around 9.05% is achieved through the "CuO based nanofluid". When 5 percent Al2O3 is added to the base fluid, the maximum relative increase in daily thermal energy provided is 1.46 percent. Guaranteeing the most proficient administration of the working conditions permits the PTC to accomplish its full enthusiastic and exergetic potential. [13]

(Ghiami and Ghiami, 2018) In the exploratory examination, the exergy and viability of two assortments of bewilder prepared safeguard plates were contrasted and those of unequipped plates inside the presence of a PCM unit. The bewilders utilized in confounded safeguard plates are excited plates that are stacked in a stunned or successive example. The input, PCM, and exit temperatures were monitored and compared at each of the three air mass flow rates—0.017 Kg/s, 0.014 Kg/s, and 0.009 Kg/s. The first and second laws of thermodynamics were utilized in order to ascertain the exergy and energy efficiencies. The study's findings demonstrated that, across a range of air mass flow rates, a SAH equipped with a baffle performed the best, while an unequipped SAH performed the worst. Results showed that grouping organized perplex prepared SAH had the most elevated energy proficiency of 26.78% at a mass stream pace of 0.017 kg/s, though unequipped SAH had the least effectiveness of 14.30% at a similar mass stream rate. Exergy effectiveness went from 4.86 to 20.47 % across all examples. [14]

(Hassan & Abo-Elfadl, 2018) examines the effects of different absorber plate configurations on the efficiency of double-pass SAH systems with two input ports. For each configuration under consideration, the effects of varying air flow percentages through the inlet apertures are also investigated. There are four potential plans for the safeguard plate: "(1) a flat plate, 2) a pin-finned plate, 3) a corrugated, and 4) a corrugated-perforated plate. The approaching air is additionally assessed at four rate focuses: (i) 0% passes through the top inlet and 100% passes through the bottom (0%Up); ii) 33.3 percent pass through the top and the rest pass through the bottom (33.3%Up); iii) 66.7 percent pass through the top and the rest pass through the bottom (66.7 Up); and iv) 100% pass through the top (100 percent Up). This percentage is looked at across a variety of absorber plate configurations, all of which operate at the same total incoming mass flow rate of air. A solar simulator is used for nighttime measurements, while solar flux is used for daytime observations. The discoveries show that for all setups under study, raising the upper air rate brings down the safeguard plate temperatures and builds SAH proficiency. The absorber plate with a flat surface has the lowest efficiency, whereas the corrugated-perforated pin fin has the highest efficiency. The level plate setup of the SAH accomplishes a maximal viability of roughly 70% at 100 percent Up, while the pin finned safeguard plate accomplishes roughly 79% at a similar level. The effectiveness of the creased finned arrangement at 100 percent Up is roughly 82%, while the productivity of the folded punctured finned safeguard plate at 66.7% Up is around 83%. The solar simulator study provides efficient values that are extremely close to the actual ones, ensuring that the results will be accurate. The cost study indicates that the corrugated perforated finned absorber plate with a 66.7% efficiency has the lowest cost (0.021 $/kW.h), while the flat plate design for 0% UP flow has the highest cost of energy (0.025 $/kW.h). 15]

(R. Kumar et al., 2018) Placing the supplied rib over the absorber plate can improve the efficiency of the solar air heater (SAH). The use of a forward-chamfered ribbed absorber plate is the subject of this study. The "rib aspect ratio (e/w)" and "rib chamfered height ratio (e′/e)" are two newly defined roughness metrics that have an impact on the

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performance of triangular ducts. The commercial ANSYS program is used to model the SAH within a predetermined Reynolds number (Re) range of 4000–17000. The relative roughness height (e/D) has a range of 0.018 to 0.043, the e/w has a range of 0 to 1.0, and the e′/e has a range of 0.24 to 1.5. The ribbed inside surface of the duct is heated by an ongoing heat flow of 1000 Wm-2. After constructing a "three-dimensional model of SAH" for the analysis, the outcomes are simulated using a finite volume method. A comparison of the predicted and actual outcomes is used to confirm the numerical method; a solid correspondence is seen between the "Nusselt Numbers (Nu)" as well as "Grinding Element (f)". The values of f and Nu change significantly when the roughness and Re parameters are changed. At a Re value of 17000 for e/w values of 1.5, e/D values of 0.043, and e′/e values of 0.75, respectively, the most significant rise in Nu occurs, with a magnitude of 2.88. When the e/D value is 0.043, which is approximately 3.52 times greater than the friction penalty for a duct without ribs at a Re value of 4000, the friction penalty increases most. Numerically predicted outcomes are used to establish a generalized correlation between f and Nu. [16]

(Poongavanam et al., 2018) In this study, we experimented with a surface-modified solar air heater to learn about its laminar flow heat transfer rate and frictional properties. The inside surface of the rectangular duct was shot-blasted using pressurized shot-blasting equipment to a roughness that matched the "V-corrugated absorber plate." The friction factor and the parameters that have an effect on the Nusselt number were the subjects of the discussion. The results procured were then differentiated between traditional safeguard plates as well as a changed shot-impacted safeguard plate working under similar stream conditions. The results of the experiment show that "V-corrugated shot blasted absorber plates" have a higher "Nusselt number and friction factor" than "conventional absorber plates." Also, the results showed that the "Reynolds number on the thermal performance factors" is mostly influenced by the friction factor at the beginning of the trials, while the thermal performance factor usually goes down as the Reynolds number goes up later. [17]

(Ravi & Saini, 2018) The results of an experimental study on the friction factor and heat transfer in counterflow "double pass solar air heater (DPSAH)" ducts with "discrete multi-V-shaped" and staggered rib roughness on two broad heated plate surfaces are the subject of this paper. The relative staggered rib pitch (p′/p) ranges from 0.2 to 0.8, the relative staggered rib size (r/e) ranges from 1 to 4, and the relative roughness width (W/w) ranges from 5 to 8. These qualities are covered by the examination. The mathematical factors of harshness and ideal stream values not entirely settled and completely portrayed. The Nusselt number (Nu) has expanded up to 4.52% to match that of a smooth twofold pass channel; by and by, the grating component (f) has expanded up to 3.13 times that of a smooth conduit. The greatest ascent in Nu and f is connected with the rib boundaries r/e = 3.5, p′/p = 0.6, and W/w = 7. Experimental data have yielded additional correlations between Nu and f. [18]

IV. CONCLUSION

- Solar air heaters are applicable for thermal comfort and drying in a clean and cost-effective way.
- Performance of different types of solar heaters is highly dependent on weather and operating conditions.
- Specifications of the components such as the material of insulation of absorber influence the performance.

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