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Improve Thermal Effectiveness by Using Spiral Longitudinal Fins inside a Parabolic Trough Solar Collector- a review paper

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Abstract: It can be known from heat transfer science, to enhance the heat transfer which leads to improving the thermal performance, it can be change the one of the two important parameters, first parameter can be considered is the geometry which taken here in this work and the second parameter is to change the working fluid that used to work the system. Swirl generators or turbulators are discussed and evaluated in this article, which deals with one parabolic trough solar collector. In this article, four different schematics of the collector are analyzed.For this objectives, this article had been prepared in order to prepare a comparative literature from the previous researches to analyze the solar energy by using the parabolic trough collector with an absorber pipe with new configurations.

Introduction

Several sectors, including pharmaceuticals and petrochemical products, rely on heat exchangers for the exchange of solar radiation through direct and indirect contact across fluids. There are a lot of solar systems that employ directly touch heating elements. Enhancing the efficiency of solar technologies has become a top priority for scientists and engineers due to the growing significance of solar energy. For both home and power generation uses, a parabolic trough solar collector (PTSC) is among the most efficient forms of solar collectors. Scientists have recently made several attempts to improve the efficiency of this collector type. Hot water (HTF) flows through the receiver tube of the PTSC part, which receives the energy from the sun emitted from it [1-8].

Researchers have come up with a variety of ways to increase the thermal efficiency of this sort of heat exchanger. Heat exchanger amplification techniques were classified among active and passive categories by Berger et al.[9] Passive processes were one of the two types of approaches for improving heat exchange. It signifies that there is no need for extra force whatsoever. There are a number of different approaches that go into this process. These include the use of nano particles as well as helical tubes, treated areas, vortex generators, and displacement increase systems.

Tang et al.[10] tested the heat exchanger's performance. As per their findings, lengthening the vortices fins improves its effectiveness. It was shown that the highest heat rates may be achieved in a round micro - channels if the design parameters are asymmetrical, according to Azari et al.[11]. According to Darzi et al.[12], a wavy tube filled in nano - fluid may boost heat exchange about 330 percent rise in net solution, based on such a laboratory experiment. According to Du et al. [13], the overall performance of the enhanced heat transfer system is improved by roughly 50% when working mathematically on pipe topologies. Based on heat exchange efficiency, Bahiraei et al.[14] investigated the effects of increasing height and decreasing pitch on a triple-tube. According to Abolarin et al.[15], twisting tapes with a high connecting angle are more efficient at transferring heat. There is a rise in temperature along the walls if the wavelength is short, according to the researchers. Checking the thermal performance of corrugated pipes was done by Zhang et al [16]. According to the results, the heat transmission rate was improved by the corrugated pipe. As a result, in a turbulent flow, alternative passive techniques such as turbulators are preferable [17]. Table 1 displays and lists a number of recent studies related to insertion as well as other passively ways for improving heat pipe thermal efficiency.

Table 1. summery for the previous studies.

Details	Result
[18], 2015Pipe with helical corrugation experimentally and numerically	Thermal performance is improved in the pipe with the highest index score.
[19], 2016Maker of vortices, numerically	They found that perforations located at the forefront were more efficient.

[20], 2017Coiling around itself, experimentally	Using a turbulator raised the Nusselt number by 8–32%, according to the research.
[21], 2018elliptical baffles in both x and y direction orientations, numerically and experimentally	At a 15-degree angle, the exchange of heat is at its peak.
[22], 2019Twisted-tapes, numerically	The energy transfer rises as the set of fins increases.
[23], 2019, fixed mixing , numerically	The heat transfer rate of stationary mixing increased by nearly 100 percent.
[24], 2019, microchannel, experimentally	The friction coefficient decreases as the input temperature increases.
[25], 2019 Experimental Heat sinks	At = 20 and $\beta = 0.8$, transfer of energy reached its apex.
[26], 2020 Experimental Automotive radiator	At 0.8 nanofluid, thermal resistance was improved.
[27], 2020 Experimental Triangle tube	Triangular tubing always had the greatest favorable effect on heat exchange rate.
[28], 2020 Numerical Perforated hollow cylinders	Results showed that increasing the perforations ratio reduced flow resistance by up as 86.2%.
[29], 2020 Numerical Microchannels	Water - insoluble modelling may reduce fluid pump power requirements by up to 69% while increasing heat flux by up to 15%.
[30], 2020 Numerical Flexible fins	A heat exchange rates increases as a result of the fins oscillating.
[31], 2020 Numerical Central corrugated insert	The total heat transmission efficiency was found to be between 1.3 and 2.6.
[32], 2020 Experimental Helically corrugated tube	Pitching spacing and roughness height of 3 mm and 1.5 mm were found to have the best cooling efficiency is (2.29).
[33], 2020 Numerical Helical absorber tube	The gains in thermal efficiency and exergy are 1–10% as well as 0.2–3.2%, respectively.
[34], 2020NumericalConical strip inserts	Performed well in the ranges of 0.679–1.107 for total energy conversion effectiveness
[35], 2020NumericalBilateral fins and a helically coiled insert are used to create an absorbers tubes.	Cases using various geometries, tubes with integrated fins, and plain tubes all have 72.26 percent thermal efficiency.
[36], 2021 NumericalComponents that promote turbulence	The highest possible level of thermal efficiency was reached, at 29%.
[37], 2021Inserts for coiled angular strips experimentally	According to the results, the increase in efficiency ranged from 145 to 215 percent.
[38], 2021a helix tube for absorption numerically	By 4–10 percent and 4–5 percent, respectively, thermal efficiency and exergy are improved.
[39], 2021Tubes with helical corrugations numerically	26–176 percent increase in thermal efficiency
[40], 2021Mixed metal foam quasi or fin-shaped design, experimentally and numerically	360 percent increase in performance assessment criteria, 93.3 percent reduction in total entropy production, and 10.2 percent increase in exergetic efficiency are the maximum values for each.

For solar collectors, solar energy is seen as a heat flow. Increasing the thermal performance of an existing system may be achieved by conducting a solar heat transfer device assessment. To improve the efficiency of solar collector heat exchangers, Moghaddaszadeh et al. [41] used two passive approaches. The results show that the usage of nanofluid increased the Nusselt number by 4%. A study by Ghasemi and Ranjbar [42] found that adding nanopar- ticles to a solar parabolic collector increased thermal performance and utilizing Al2O3 or CuO as nanofluid at 3% volume fraction improved heat exchange by 28 and 35%, respectively. Analysis of the thermal analysis of parabolic trough collectors for different geometrical factors such as porosity and fin aspect ratio was carried out by Reddy et al [43]. A 17 percent increase in heat exchange is predicted by their findings.

Conclusions

There has been no prior research on the use of heat transfer improvement of the PTSC using various passive approaches, such as helical fins (Table 1), which is based on the literature review reported in this paper.

References

[1]. Berger, S.A.; Talbot, L.; Yao, L.S. Flow in curved pipes. Annu. Rev. Fluid Mech. **1983**, 15, 461–512.
[2]. Sheikholeslami, M.; Gorji-Bandpy, M.; Ganji, D.D. Review of heat transfer enhancement methods: Focus on passive methodsusing swirl flow devices. Renew. Sustain. Energy Rev. **2015**, 49, 444–469
[3]. Esfe, M.H.; Saedodin, S.; Wongwises, S.; Toghraie, D. An experimental study on the effect of diameter on thermal conductivityand dynamic viscosity of Fe/water nanofluids. J. Therm. Anal. Calorim. **2015**, 119, 1817–1824.
[4]. Zaboli, M.; Ajarostaghi, S.S.; Noorbakhsh, M.; Delavar, M.A. Effects of geometrical and operational parameters on heat transferand fluid flow of three various water based nanofluids in a shell and coil tube heat exchanger. SN Appl. Sci. **2019**, 1, 1387.
[5]. Kim, K.; Lee, K.S. Frosting and defrosting characteristics of surface-treated louvered-fin heat exchangers: Effects of fin pitch andexperimental conditions. Int. J. Heat Mass Transf. **2013**, 60, 505–511.
[6]. Gao, D.; Wang, Y. Generating high-purity orbital angular momentum vortex waves from Cassegrain meta-mirrors. Eur. Phys. J.Plus **2020**, 135.
[7]. Hobbi, A.; Siddiqui, K. Experimental study on the effect of heat transfer enhancement devices in flat-plate solar collectors. Int. J.Heat Mass Transf. **2009**, 52, 4650–4658.
[8]. Nuntaphan, A.; Vithayasai, S.; Vorayos, N.; Vorayos, N.; Kiatsiriroat, T. Use of oscillating heat pipe technique as extended surfacein wire-on-tube heat exchanger for heat transfer enhancement. Int. Commun. Heat Mass Transf. **2010**, 37, 287–292.
[9]. Dizaji, H.S.; Jafarmadar, S.; Asaadi, S. Experimental exergy analysis for shell and tube heat exchanger made of corrugated shelland corrugated tube. Exp. Therm. Fluid Sci. **2017**, 81, 475–481.
[10]. Tang, L.H.; Zeng, M.; Wang, Q.W. Experimental and numerical investigation on air-side performance of fin-and-tube heatexchangers with various fin patterns. Exp. Therm. Fluid Sci. **2009**, 33, 818–827.
[11]. Azari, M.; Sadeghi, A.; Chakraborty, S. Electroosmotic flow and heat transfer in a heterogeneous circular microchannel. Appl.Math. Model. **2020**, 87, 640–654.
[12]. Darzi, A.A.R.; Farhadi, M.; Sedighi, K. Experimental investigation of convective heat transfer and friction factor of Al2O3/waternanofluid in helically corrugated tube. Exp. Therm. Fluid Sci. **2014**, 57, 188–199.
[13]. Du, T.; Chen, Q.; Du, W.; Cheng, L. Performance of continuous helical baffled heat exchanger with varying elliptical tube layouts.Int. J. Heat Mass Transf. **2019**, 133, 1165–1175.
[14]. Bahiraei, M.; Mazaheri, N.; Rizehvandi, A. Application of a hybrid nanofluid containing graphene nanoplatelet-platinumcomposite powder in a triple-tube heat exchanger equipped with inserted ribs. Appl. Therm. Eng. **2019**, 149, 588–601.
[15]. Abolarin, S.M.; Everts, M.; Meyer, J.P. Heat transfer and pressure drop characteristics of alternating clockwise and counterclockwise twisted tape inserts in the transitional flow regime. Int. J. Heat Mass Transf. **2019**, 133, 203–217.
[16]. Zhang, Y.; Zhou, F.; Kang, J. Flow and heat transfer in drag-reducing polymer solution flow through the corrugated tube andcircular tube. Appl. Therm. Eng. **2020**, 115185.
[17]. Rashidi, S.; Hormozi, F.; Sundén, B.; Mahian, O. Energy saving in thermal energy systems using dimpled surface technology-Areview on mechanisms and applications. Appl. Energy **2019**, 250, 1491–1547.
[18]. Kareem, Z.S.; Abdullah, S.; Lazim, T.M.; Jaafar, M.M.; Wahid, A.F. Heat transfer enhancement in three-start spirally corrugatedtube: Experimental and numerical study. Chem. Eng. Sci. **2015**, 134, 746–757.
[19]. Lu, G.; Zhou, G. Numerical simulation on performances of plane and curved winglet type vortex generator pairs with punchedholes. Int. J. Heat Mass Transf. **2016**, 102, 679–690
[20]. Mashoofi, N.; Pesteei, S.M.; Moosavi, A.; Dizaji, H.S. Fabrication method and thermal-frictional behavior of a tube-in-tubehelically coiled heat exchanger which contains turbulator. Appl. Therm. Eng. **2017**, 111, 1008–1015.
[21]. Aghaei, A.; Sheikhzadeh, G.A.; Goodarzi, M.; Hasani, H.; Damirchi, H.; Afrand, M. Effect of horizontal and vertical elliptic bafflesinside an enclosure on the mixed convection of a MWCNTs-water nanofluid and its entropy generation. Eur. Phys. J. Plus **2018**, 133, 486.

[22]. Noorbakhsh, M.; Zaboli, M.; Ajarostaghi, S.S. Numerical evaluation of the effect of using twisted tapes as turbulator with variousgeometries in both sides of a double-pipe heat exchanger. J. Therm. Anal. Calorim. **2020**, 140, 1341–1353.
[23]. Kwon, B.; Liebenberg, L.; Jacobi, A.M.; King, W.P. Heat transfer enhancement of internal laminar flows using additivelymanufactured static mixers. Int. J. Heat Mass Transf. **2019**, 137, 292–300.
[24]. Ho, C.J.; Hsieh, Y.J.; Rashidi, S.; Orooji, Y.; Yan, W.M. Thermal-hydraulic analysis for alumina/water nanofluid inside a minichannelheat sink with latent heat cooling ceiling—An experimental study. Int. Commun. Heat Mass Transf. **2020**, 112, 104477.
[25]. Liu, H.L.; Qi, D.H.; Shao, X.D.; Wang, W.D. An experimental and numerical investigation of heat transfer enhancement in annularmicrochannel heat sinks. Int. J. Therm. Sci. **2019**, 142, 106–120.
[26]. Ramalingam, S.; Dhairiyasamy, R.; Govindasamy, M. Assessment of heat transfer characteristics and system physiognomiesusing HYBRID nanofluids in an automotive radiator. Chem. Eng. Process. Process. Intensif. **2020**, 107886.
[27]. Qi, C.; Fan, F.; Pan, Y.; Liu, M.; Yan, Y. Effects of turbulator with round hole on the thermo-hydraulic performance of nanofluidsin a triangle tube. Int. J. Heat Mass Transf. **2020**, 146, 118897.
[28]. Nakhchi, M.E.; Esfahani, J.A. Numerical investigation of heat transfer enhancement inside heat exchanger tubes fitted withperforated hollow cylinders. Int. J. Therm. Sci. **2020**, 147, 106153.
[29]. Rahbarshahlan, S.; Esmaeilzadeh, E.; Khosroshahi, A.R.; Bakhshayesh, A.G. Numerical simulation of fluid flow and heat transferin microchannels with patterns of hydrophobic/hydrophilic walls. Eur. Phys. J. Plus **2020**, 135, 157.
[30]. Jamesahar, E.; Sabour, M.; Shahabadi, M.; Mehryan, S.A.; Ghalambaz, M. Mixed convection heat transfer by nanofluids in a cavitywith two oscillating flexible fins: A fluid-structure interaction approach. Appl. Math. Model. **2020**, 82, 72–90.
[31]. Benabderrahmane, A.; Benazza, A.; Hussein, A.K. Heat transfer enhancement analysis of tube receiver for parabolic trough solarcollector with central corrugated insert. J. Heat Transf. **2020**, 142.
[32]. Akbarzadeh, S.; Valipour, M.S. Experimental study on the heat transfer enhancement in helically corrugated tubes under thenon-uniform heat flux. J. Therm. Anal. Calorim. **2020**.
[33]. Chakraborty, O.; Das, B.; Gupta, R.; Debbarma, S. Heat transfer enhancement analysis of parabolic trough collector with straightand helical absorber tube. Therm. Sci. Eng. Prog. **2020**, 20, 100718.
[34]. Amani, K.; Ebrahimpour, M.; Akbarzadeh, S.; Valipour, M.S. The utilization of conical strip inserts in a parabolic trough collector.J. Therm. Anal. Calorim. **2020**.
[35]. Khan, M.S.; Yan, M.; Ali, H.M.; Amber, K.P.; Bashir, M.A.; Akbar, B.; Javed, S. Comparative performance assessment of differentabsorber tube geometries for parabolic trough solar collector using nanofluid. J. Therm. Anal. Calorim. **2020**, 142, 2227–2241.
[36]. Saedodin, S.; Zaboli, M.; Ajarostaghi, S.S.M. Hydrothermal analysis of heat transfer and thermal performance characteristics in aparabolic trough solar collector with Turbulence-Inducing elements. Sustain. Energy Technol. Assess. **2021**, 46, 101266.
[37]. Vasanthi, P.; Reddy, G.J.C. Experimental Investigations on Heat Transfer and Friction Factor of Hybrid NanofliudEquiped withAngular Twisted Strip Inserts in a Parabolic Trough Solar Collector under Turbulent Flow. Int. J. Innov. Sci. Eng. Technol. **2021**, 8, 315–336.
[38]. Chakraborty, O.; Roy, S.; Das, B.; Gupta, R. Effects of helical absorber tube on the energy and exergy analysis of parabolic solartrough collector-A computational analysis. Sustain. Energy Technol. Assess. **2021**, 44, 101083.
[39]. Akbarzadeh, S.; Valipour, M.S. The thermo-hydraulic performance of a parabolic trough collector with helically corrugated tube.Sustain. Energy Technol. Assess. **2021**, 44, 101013.
[40]. Peng, H.; Li, M.; Hu, F.; Feng, S. Performance analysis of absorber tube in parabolic trough solar collector inserted withsemi-annular and fin shape metal foam hybrid structure. Case Stud. Therm. Eng. **2021**, 101112.
[41]. Sheikholeslami, M.; Farshad, S.A. Nanofluid flow inside a solar collector utilizing twisted tape considering exergy and entropyanalysis. Renew. Energy **2019**, 141, 246–258.
[42]. Moghaddaszadeh, N.; Esfahani, J.A.; Mahian, O. Performance enhancement of heat exchangers using eccentric tape inserts andnanofluids. J. Therm. Anal. Calorim. **2019**, 137, 865–877.
[43]. Ghasemi, S.E.; Ranjbar, A.A. Thermal performance analysis of solar parabolic trough collector using nanofluid as working fluid:A CFD modelling study. J. Mol. Liq. **2016**, 222, 159–166.