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Improvement of thermal performance of a solar box type cooker using SiO_2/TiO_2 nanolayer

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Abstract

An experimental analysis of a stepped solar box cooker (SSBC) improved using energetic SiO_2/TiO_2 nanoparticles. They were used in different ratios between 5% to 25% as a coating on a bar plate to enhance thermal performance. The SSBC was assessed experimentally to obtain a cost-effective solution and the best performance for the bar plate temperature, enabling increased cooking activities performance. The furious SiO_2/TiO_2 nanoparticles were coated over a bar plate, which allows them to absorb more solar radiation and increase the system of inner moist air temperature. The SiO_2/TiO_2 nanolayers used as 15% improved overall thermal efficiency by 31.42% of the system. The bar plate performances coated with SiO_2/TiO_2 nanolayers and used in SSBC were compared to other doping nanoparticles percentage for their solar thermal characteristics. The SiO_2/TiO_2 nanolayers coated by the SSBC is enabled to increase the performance by about 31.77%, 37.69%, 49.21%, 36.99%, and 34.66% when was used 5%, 10%,

15%, 20%, and 25%, respectively and compared to that of single nanolayers (SiO_2, TiO_2) of convention cooker.

Keywords: SiO_2/TiO_2 -Nanoparticle; Bar plate Temperature; Fast Cooking; Thermal acts; Box cooker

Introduction

The antibacterial activity requirement for human health daily is imposed by different viruses such as COVID 2019 and other factors that can affect the human body and demand fresh and natural food sources. The world uses human knowledge to design novel solar box cookers, which are established in numerous countries with low industrial development. Atul *et al.* [1] improved solar cooker performances using a hybrid cooking pot (HCP). It is conversed with an average temperature for system measure and reported in comparing the thermal performance parameter (TPP). Cooker Opto-Thermal Ratios (COR) allows the performance assessment of the solar box cookers. Abd-Elhady *et al*. [2] were studied in thermal act solar cookers by evacuated tubes. It influenced to add the nanographene particles, and the severe quantity of wires introduced confidential an evacuated tube, which increased in a natural invention that cookers. Hosseinzadeh *et al*. [3] have produced an inbox type of solar cooker. The cooking materials analyzed in the thermal image process like rice, edge detector used in segmentation methods. It used in PCM and Nanoparticles effect of thermal performance of 45.14%, which is influenced by PCM and Nanoparticles, is 53.10%. The PCM and Nanoparticles used in the bar plate are achieved at about 92°C by Palanikumar *et al*. [4]. Seshappa and Prasad [5] was developed in different five weight fractions (0, 3, 6, 9, and 12%) to develop aluminum-based nano-composites and have modified in this sample of gas injection ultrasonic probe double-stir casting process. It is concluded that of benchmark against compatible alloys and metallic implants. Abbasi *et al.* [6] have used bentonite/TiO_2/bentonite/ZnO nanoparticles and was studied cadmium removal from the aqueous solution. The cadmium is removed in bentonite/TiO_2 adsorbent increases. It is concluded that adsorption isotherm of kinetics process followed better by Temkin isotherm. The pseudo-second-order model better describes the adsorption kinetics. Cooke and Khan [7] improved thermal processing on the tribology of nanocrystalline Ni/TiO_2 coatings. TiO_2 nanoparticles surface is coated that performance on high hardness and wear resistance recorded. Heat treatment of the Ni/TiO_2 coatings to temperatures is 200 °C led to a significant and deceased strengthening of the nanoparticles' formation, causing a reduction in the hardness and wear resistance of the coatings region. Leveneur *et al*. [8] have studied magnetic nanogranular materials. Co-nanoparticles were synthesized using low-energy ion establishment, and electron beam annealing (EBA) on SiO_2 was considered. It concluded that the moment per Co atom decreases than approached in bulk -Co with increased EBA time. It is expected to be electronically spin separated, which is no suggestion for spin-dependent tunneling. Mallikarjuna *et al*. [9] have reviewed nanofluids and nanocoatings by heat transfer of solar thermal applications. The nanofluids use it and nanocoating's in solar energy harvesting operating in low, medium, and high temperature ranges for effectiveness in the system's performance. The nanofluids, nano selective coatings for solar concentrators are improved optical performance. Liu *et al*. [10] have achieved solar selective absorber coatings with high thermal stability, nanostructured selective coating films. The reported results of preferable high-temperature applications were achieved in solar absorption of 0.97. The carbon results nanomaterials are applied for copper, silicon, SiO_2, aluminum, and stainless steel substrates that combine various types of nano-based solar selective absorber coatings. The solar thermal systems are received by the surface temperature to operate at 600–700 °C or more commercialized-oriented in this research. Palanikumar *et al.* [11] were improved an environment control to box-type solar cooker by the used nanoparticle. It is achieved solar thermal performance of (45.14%), PCM ($C_{18}H_{36}O_2$), and nanoparticles (Al_2O_3) adeptness is 53.10%. The cooking materials were viewed by developing in the thermal image and used in segmentation techniques. Roro *et al.* [12] was studied in multi-wall carbon nanotubes (MWCNTs)/nickel oxide (NiO) nanocomposite coatings using solar absorber application and deposited using the sol-gel method on Al substrates. The coatings were proposed for the MWCNT/NiO nanocomposite coatings and suitable for solar thermal application by Jayaprada *et al*. [13] and Assal *et al*. [14]. They are developed in different nanocomposite materials suitable for solar absorption materials.

The literature survey indicates the use of fluid nanoparticles (FNPs) as a potential solution to improve the solar thermal characteristics for solar cookers. The current study proposes using SiO_2/TiO_2 nanoparticles in a different ratio to enhance the solar cookers thermal performance. The SSBC improvement of performance was achieved using a coated bar plate with fluid nanoparticles within different ratios between 5 to 25%.

2. Experimental materials and methodology

2.1 The design of suitable materials for fluid nanoparticles

The XRD spectra follow the crystalline of the compound for pure mixtures of fluid nanoparticles in Fig. 1(a) as developed in Bruker's XRD - D8-Discover instrument by Marina *et al*., [15], and an element mixture heated for 400°C by Returi *et al*. [16]. The fluid nanoparticles are analyzed of SEM as a used instrument of Hitachi SU8230 CFE and used for the SSBC study, as shown in Fig. 1(b) by Kumar *et al*. [17] have used samples for an average nanoparticle that size of 50 nm. The turpentine fluid process is the good mass ratios between 5 to 25%, followed by the fluid nanoparticles by Adil *et al*. [18], Ajay Kumar *et al*. [19]. It has been used in a magnetic stirrer, which is miscellaneous in fluid nanoparticles way of the turpentine fluid and disturbed to the particles as followed on 2 hours, then speeds of constant for 1000rpm. The blend nanoparticle measured in the variation of thermal conductivity (TC) and the fluid in a different ratio shown in Fig. 1(c). The fluid nanoparticles are organized by way of varying volume fractions by Khan *et al.* [20]. The analysis of TC in different absorptions of the fluid nanoparticles with fluid is visible. The average review of the samples produced by the temperatures and volume fraction with an average TC, as explained in Fig. 1(d). Finally, the blend sample's thermal conductivity analysis has been detected with a ratio of 15%.

2.2 Fluid nanoparticles analysis of SSBC

The SSBC analysis of the new performance the experimental and approach of the schematic diagram exposed in Fig. 2 (a & b) as by Nahar [21]. The solar cooker utilization of the area is 100 cm, and the l x b x h of the dimensions with absorption parts have made of 100 cm x100 cm x frond wall is 25 cm, and the height of the back wall is 30 cm. The thermal conductivity materials have been used by the system of yellow glass wool insulation of thickness is 5 cm. It made in stepped absorber bar plates total 16 for the inner side fixed to the design with left side for 8 x right side of 8. The SSBC has fabricated in the same dimensions with different studies of the designs, used nanoparticles as that of fuming SiO_2, TiO_2, mixture fluid nanoparticles, and without nanoparticle (conventional solar cooker) Gulipalli *et al*. [22] and Pullela *et al*. [23]. The experimental work started at 10.00 am to 2.00 pm and continued the variations of the parameters like temperatures that of the stepped plate (SP), bar plate (BP), cooker, food stuffiness (FS), moist internal air, and glass cover, which measured at 30 minutes(s) intermission. The analysis of experimentally by solar cookers have started from a location in KLEF at Vijayawada, Andhra Pradesh, and reduced during the cooking materials like milk, water cooking time of 45 minutes with a mass of 1kg. The experimental values measure the sun's solar radiation from the instrument of TM-206 solar power meter tester. Standard solar power meter measured all the mechanisms of the different SSBC have used indicator for the 1/4 DIN temperature 6 Channel Monitor, and it measured by the RTD - PT-100 type with sensor absorption of the thermocouple wire which that range of about 0 - 800ºC and ± 0.1ºC correctness for the data individually to the systems. The thermal conductivity of a copper sheet (bar plate) was dependent on increases in parameters that particles function by Jayaprada *et al*. [24], Kamakshi *et al*. [25]. The solar cooker has comprised of the temperature incline from the properties of the SiO_2/TiO_2 and the length of internal heat transfer modes, i.e., heat capacity ratios (Cr) by Maity *et al*. [26]. The solar cooker of C_r can be written as

$$C_r = \frac{(MC)_{cw}}{(MC)_{cm}+(MC)_{cw}} \tag{1}$$

$(MC)_{cm}$ has the total amount of heat capacity for cooking materials. $(MC)_{cw}$ is the total amount of heat capacity by the water. They include cooking materials that have been toughened like glass cover, bar plate, nanolayer, cooking materials, and water temperature, etc. the consistent values of heat capacity by the cooking materials $(MC)_{cm}$. The novel model has involved the nanolayer's heat transfer physical field. Three categories of elementary heat transfer modes (heat conduction, convection, and radiation) were considered for the main heat transfer equation, from eq. (2), using the heat transfer of SSBC is performed so that climatic parameters (H_s, T_a) for different water loads were foretold. They are used in the time taken ($\boldsymbol{d_\tau}$) to increase the water temperature (dT_w) have been considered an analysis over a microscopic time intermission in the functional heat transfer in cooking materials.

$$\boldsymbol{d_\tau} = \frac{(MC)_{cm}\, \boldsymbol{dT_w}}{[\boldsymbol{P\eta_0 H_s - PU_L(T_w - T_a)}]\, \boldsymbol{A}} \tag{2}$$

where the overall heat loss coefficient of PU_L and the cooker's heating was measured by the time essential for small increases in the vessel water temperature (T_w). A load of water is absorbed by the solar energy of H_s and ambient air temperature is T_a. "A" is the average of the solar cooker area, $P\eta_0$ is an optical efficiency of the system, PU_L is the overall heat loss coefficient of the SSBC, respectively. Determination of SSBC measurements of the connected climatic than effective parameters such as the bar plate's temperatures, vessel, a mass of the water and ambient air, solar radiance as load, and magnitudes with assumes significance grading of the system. The analysis of SSBC has been maintained to test conducted as well as load test at the location of the KLEF, Vijayawada (latitude: 16.5062° N, 80.6480° E) circular the year. The evaluation of time taken to attain the coated nanolayer's reference to water temperature was associated with cooking materials. The influence of nanolayers of the SSBC for heat storage capacity is expected to reach a water temperature is evaluated.

3. Results and discussion

The solar cooker analysis was achieved in KLEF adopted fixed weather conditions. The activity parameters are used in a variety of volume fractions (5%,10%,15%,20%,25%) by the SSBC and measured an effect of temperature like ambient, glass, moist air, bar plate, stepped plate, cooker (input, output), food stuffiness and average solar radiation is 734 W/m^2. It experimentally verified for every 30 minutes(s), as shown in Fig. 3(a – e). The analysis of SSBC has been measured during the solar radiation of 734 W/m^2, and the ambient temperature is 35.2 °C. It verified the exploitation of 10% and 15% fluid nanoparticles enhanced average temperature to increase the system through about 16.7% and 27.4%, as shown in Fig. 3 (a-e). The SSBC for the temperature is achieved by the stepped plate (SP), bar plate (BP), for a various ratios of 05%,10%,15%,20%,25% nanoparticles those absorptions values are 58.4,63.4, 64.7, 63.2,63.0 ± 0.1°C, and 58.4,62.6, 64.5, 61.5,62.2°C for SP by Harmim *et al*. [27] respectively.

The fluid nanoparticles are coated by the internal heat transfer modes to contact the stepped plate, bar plate, moist air, cooker temperature. It's simultaneously improved for heat energy functions. The glass cooker temperature utilizing 20 then 25% is higher. It is 9.14, 13.14% and 8.14, 11.46% respectively, and higher than solar cooker with single elements, without nanoparticles. 25%, 20% ratios of the SiO_2/TiO_2 nanolayers, where the low thermal conductivity prevents heat transmission in the solar cooker. Optimize the SiO_2/TiO_2 nanolayers' capacity to function with a decrease in energy consumption, i.e., 15% is higher for the system thermal conductivity.

Fig. 3(a - e) focused on hourly(s) variations in the characteristic of the SSBC with mechanisms of the temperature range in glass, BP, SP, moist air, cooker, and ambient temperature. The different ratios for 05%,10%,15%,20%,25% of the fluid nanoparticles to average BP temperature of the system concluded that of 58.3, 61.6, 64.5, 59.9, and 59.1 ±0.1°C individually as shown in Fig. 4. The mixed fluid nanoparticles with temperature in BP gain with heat energy of the SSBC are increased by 10.34%, 15.17%, and the ratios of 10%, 15%. Fig. 5 is modified SSBC to hourly variations to an improved temperature of the system. It is produced by the hourly(s) variations with maximum temperature enhanced single elements nanoparticle, without nanoparticles 0.73, 0.77±0.01kg/m^2 and coated of SSBC with 05,10,15,20,25% the fluid nanoparticles are achieved of 0.74, 0.76, 0.78, 0.77 then 0.76±0.01 kg/m^2 individually trough the highest solar radiation at 12.00 to 13.00pm.

The SSBC coated in furious SiO_2/TiO_2 nanolayers can be determined that the heat storage layer, i.e., bar plate container, accumulation a certain total of heat transfer through the system. The heat energy is cooking materials from boil to 3 – 10 kg water, and the bar plate temperature stable of the system is 35°C in the absence of daylight. The furious SiO_2/TiO_2 nanolayers coated in bar plate with the performance of an SSBC have been given clearly of the cooking materials, as shown in Fig. 6. The nanolayer coated with bar plate temperature is established as the vessel covering the heat of about up to 64.7 ± 0.1°C for the systems stable energy process. It is gained that a cooking material of 1kg like water, milk boiling in a method of the temperature effectively 25 minutes(s). These estimations show a good agreement with the experimental values preceding than a period of water, single milk nanoelements (SiO_2, TiO_2), without nanolayers, as followed in Table 1. The cooking performance of different materials using SSBC has been achieved by the temperature ranges of various weather conditions (summer and winter) of absorption by a bar plate and experimentally verified in cooking the period of October 2019 to June 2020 by weather conditions KLEF.

3.1 Economic analysis

Succinctly, solar energy used by an SSBC was a gracious application of cooking ways and has been developed for a friend environment with harvests food of a high rate of sustenance. The low-cost convenience to all commercial heights of individuals in civilization. The referring of an SSBC has been aforementioned comments appreciable economic impact. The performed of the SSBC has been evaluated the quantity of saved money and was operated instead of traditional Liquefied Petroleum Gas (LPG) by the system. According to a new design cost, the amount of saved money utilized by an SSBC was computed by the payback period. The commercial has been used in different scenarios in Lebanon and measured with its own house, eatery, guesthouse, and nosh to quantity the amount of LPG spent in each scenario.

The SSBC was calculated by the payback period as

$$\text{SM} = P_t \,.\, M_{LPG} \,.\, P_{LPG} \tag{3}$$

The SSBC of payback period is

$$\text{PB} = \frac{CSSBC}{SM} \tag{4}$$

The SSBC cost is $355 for each cookers payback period in different scenarios, as shown in Table 2. The scenarios for SSBC with coated nanolayers have saved with energy storage of different payback periods as a function of Pr, as shown in Fig. 7 (A and B). The effortlessly experimental that the payback period was inversely proportional to Pr. Own house, eatery, guesthouse, and nosh analysis of SSBC by the Pr have identified values of 0.2. The payback period is 95 months, 01 months, 02 months, and 07months. The Pr values of own house, eatery, guesthouse, nosh is 0.8, and the payback period is about 23 months, 0.5 months, 01 months, and 02 months, respectively. Similarly, the SSBC is improved to be used at own house, eatery, guesthouse, and nosh. The high-quality of an SSBC depends on the economic side, irrespective of the cookers productivity and performance.

Conclusion

The experiments conducted on an SSBC were developed using different fluid nanoparticles ratios, which were coated over a bar plate to enhance the temperature and reduce the cooking time. The fluid nanoparticles enabled to increase the average temperature of the glass, cooker, bar plate and stepped plate by around 12.5%, 16.4%, 16.5%, and 16.3% individually using about 15% SiO_2/TiO_2. Further, the nanolayers SiO_2/TiO_2 enabled an increase of efficiency for the furious SSBC by 37.69% and 49.21% using a 10% and 15% ratio of SiO_2/TiO_2. The results are much higher than that of SSBC using SiO_2, TiO_2 phase without nanoparticles in the systems.

Nomenclature

A	-	The solar cooker area of the system (m^2)
Cr	-	Heat capacity ratios of the solar stepped box cooker
$\boldsymbol{d_\tau}$	**-**	The time interval of the solar cooker (s)
$(MC)_{cm}$	-	The total amount of heat capacity for cooking materials (J/kg °C)
$(MC)_{cw}$	-	The total amount of heat capacity by the water (J/kg °C)
PU_L	-	The overall heat loss coefficient (W/m^2°C)

$P\eta_0$	-	The optical efficiency of the system (%)
H_s	-	Solar Radiation (W/m^2)
T_a	-	Ambient temperature (°C)
T_w	-	The vessel water temperature (°C)
SM	–	The amount of saving money per month used by the SSBC
P_t	-	The percentage of time of the system
M_{LPG}	–	The mass of LPG spent per month
P_{LPG}	–	The 1kg price of LPG
PB	–	The payback period
CSSBC	–	The total cost of SSBC

References

1. Atul A. Sagade, S.K. Samdarshi, P.J. Lahkar, Narayani A. Sagade, Experimental determination of the thermal performance of a solar box cooker with a modified cooking pot, Renewable Energy 150 (2020) 1001-1009.
2. M. S. Abd-Elhady, A. N. A. Abd- Elkerim, S. A. Ahmed, M.A. Halim, A. Abu-Oqual, Study the thermal performance of solar cookers by using metallic wires and nanographene, Renewable Energy 153 (2020) 108-116.
3. M. Hosseinzadeh, Ali-Faezian, S.M Mirzababaee, H. Zamani, Parametric analysis and optimization of a portable evacuated tube solar cooker, Energy 194 (2020) 116816.
4. G. Palanikumar, S. Shanmugan, V. Chithambaram, P. Selvaraju, Evaluation of fuzzy inference in box type solar cooking food image of thermal effect, Environmental and Sustainability Indicators 1–2 (2019) 100002.
5. A. Seshappa and B. Anjaneya Prasad, Characterization and Investigation of Mechanical Properties of Aluminium Hybrid Nano-composites: Novel Approach of Utilizing Silicon Carbide and Waste Particles to Reduce Cost of Material, Silicon (2020). https://doi.org/10.1007/s12633-020-00748-z.

6. H. Abbasi, F. Salimi, F. Golmohammadi, Removal of Cadmium from Aqueous Solution by Nano Composites of Bentonite /TiO_2 and Bentonite/ZnO Using Photocatalysis Adsorption Process. Silicon 12, 2721–2731 (2020). https://doi.org/10.1007/s12633-019-00372-6.
7. K.O. Cooke, T.I. Khan, Effect of thermal processing on the tribology of nanocrystalline Ni/TiO2 coatings, Emergent Materials 1 (2018) 165–173. https://doi.org/10.1007/s42247-018-0015-z.
8. J. Leveneur, G.V.M. Williams, D.R.G. Mitchell, *et al.* Exchange bias and large room temperature magnetoresistance in ion beam-synthesized Co nanoparticles in SiO_2. Emergent Materials 2 (2019) 313–325. https://doi.org/10.1007/s42247-019-00034-8.
9. K. Mallikarjuna, Y. Santhoshkumar Reddy, K. Hemachandra Reddy, P.V. Sanjeeva Kumar, A nanofluids and nanocoatings used for solar energy harvesting and heat transfer applications: A retrospective review analysis, Available online (2020) In Press, https://doi.org/10.1016/j.matpr.2020.05.833.
10. Bo Liu, Chunyu Wang, Shaha Bazri, *et al.,* Optical properties and thermal stability evaluation of solar absorbers enhanced by nanostructured selective coating films. Powder Technology 377(2) (2021) 939-957.https://doi.org/10.1016/j.powtec.2020.09.040.
11. G. Palanikumar, S. Shanmugan, B. Janarthanan, R. Sangavi, P. Geethanjali, Energy and Environment control to Box type Solar Cooker and Nanoparticles mixed bar plate coating with Effect of Thermal Image cooking pot, Materials Today: Proceedings 18(3) (2019) 1243-1255.
12. K.T.Roro, N. Tile, B. kikunga, B. Yalisi, A. Forbes, Solar absorption and thermal emission properties of multiwall carbon nanotube/nickel oxide nanocomposite thin films synthesized by sol–gel process, Materials Science and Engineering: B 177(8) (2012) 581-587.
13. P. Jayaprada, P. Pardhasaradhi, *et al*., Effect of ZnO nanoparticles dispersed in liquid crystalline p-n-propoxy/propyl benzoic acids and mixtures - optical studies, Molecular crystals and liquid crystals 689(1) (2019) 10-33.
14. Assal, E. Mohamed etal., Synthesis, characterization and relative catalytic study of ZrOx-$MnCO_3$, -MnO(2)or -Mn_2O_3 deposited on highly reduced graphene oxide nanocomposites for aerobic oxidation of secondary alcohols, Indian journal of chemical technology 26(3) (2019) 189-204.

15. Marina Teixeira Laranjo, Natalia Carminati Ricardi, Leliz Ticona Arenas, Edilson Valmir Benvenutti, Matheus Costa de Oliveira, Marcos Jose, Leite Santos, Tania Maria Haas Costa, TiO_2 and TiO_2/SiO_2 nanoparticles obtained by sol–gel method and applied on dye sensitized solar cells, J Sol-Gel Sci Technol 72 (2014) 273–281.
16. Returi, Madhuri Charulatha, Konijeti, Ramakrishna, Dasore, Abhishek Heat transfer enhancement using hybrid nanofluids in spiral plate heat exchangers, Heattransfer-asian research 48(7) (2019) 3128-3143.
17. R. Kumar, Ajay, et al., Mn Modified Mesoporous TiO_2 Particles: Synthesis, Characterization and Photovoltaic Application Journal of electronic materials 48(8) (2019) 5075-5079.
18. Adil, S.F., Assal, M.E., Shaik, M.R., Kuniyil, M., Alotaibi, N.M., Khan, M., Sharif, M., Alam, M.M., Al-Warthan, A., Ali Mohammed, 1., Siddiqui, M.R.H. & Tahir, M.N. 2019, A facile synthesis of ZrOx-MnCO3/graphene oxide (GRO) nanocomposites for the oxidation of alcohols using molecular oxygen under base free conditions. Catalysts 2019, 9(9), 759; https://doi.org/10.3390/catal9090759.
19. Ajay Kumar, R., Yechuri, S., Kiran Kumar, G., Rajesh Babu, B. & Rajesh, C. 2019, Mn Modified Mesoporous TiO2 Particles: Synthesis, Characterization and Photovoltaic Application. Journal of Electronic Materials, vol. 48, no. 8, pp. 5075- 5079. DOI: 10.1007/s11664-019-07312-5.
20. M. Khan and W.A. Khan, MHD boundary layer flow of a power-law nanofluid with new mass flux condition. AIP Advances 6, 025211 (2016); https://doi.org/10.1063/1.4942201.
21. N.M. Nahar, Performance and testing of a hot box storage solar cooker, Energy Conversion and Management 44 (8) (2003) 1323-1331.
22. Gulipalli, K. Charan, B. Srinu, R. Parameshwar, E. Srinivas, V. G. R. Babu, G. Suresh, C.N. Sharath, J. N. S. Nareshvarma, Design, synthesis, in silico and in vitro evaluation of thiophene derivatives: A potent tyrosine phosphatase 1B inhibitor and anticancer activity Bioorganic & Medicinal chemistry letters 27 (15) (2017) 3558-3564.
23. K. S. Pullela, Konijeti, Ramakrishna; Subramanyam, Tunuguntla; Prasad, Lankapalli, Korada, S. Viswanatha, Srinivas, Vadapalli, Vedula, R. D. Prasad, S. R. K. Veerapanen, Fouling and its effect on the thermal performance of heat exchanger tubes, International journal of heat and technology 35(3) (2017) 509-519.

24. P. Jayaprada, P. Pardhasaradhi, B. T. P. Madhav, G. Giridhar, M. C. Rao, R. K. N. R. Manepalli & V. G. K. M. Pisipati, Effect of ZnO nanoparticles dispersed in liquid crystalline p-n-propoxy/propyl benzoic acids and mixtures – optical studies. Journal Molecular Crystals and Liquid Crystals 689(1) 2019 10-33. https://doi.org/10.1080/15421406.2019.1670942 .
25. T. Kamakshi, G. Sunita Sundari, Harikrishna Erothu, R. Subhakaran Singh, Effect of Nickel dopant on structural, morphological and optical characteristics of Fe_3O_4 nanoparticles. Rasayan J. Chem., 12(2), 531-536(2019). http://dx.doi.org/10.31788/RJC.2019.1225054.
26. Maity, Reshmi, Maity, N. P. Rao, K. Srinivasa, Sravani, Girija, Guha, K. S. Baishya, Fringing Capacitive Effect of Silicon Carbide Based Nano-Electro-Mechanical-System Micromachined Ultrasonic Transducers: Analytical Modeling and FEM Simulation, Transactions on electrical and electronic materials 20(5) (2019) 473-480.
27. A. Harmim, M. Belhamel, M. Boukar, M. Amar, Experimental investigation of a box-type solar cooker with a finned absorber plate, Energy 35(9) (2010) 3799-3802.
28. Atul A. Sagade, S.K. Samdarshi, P.S. Panja, Experimental determination of effective concentration ratios for solar box cookers using thermal tests, Solar Energy 159 (2018) 984-991.
29. S. Bhavani, S. Shanmugan, P. Selvaraju. C. Monisha, V. Suganya, Fuzzy Interference Treatment applied to Energy Control with effect of Box type Affordable Solar Cooker, Materials Today: Proceedings 18(3) (2019) 1280-1290.