Research on Comparative Analysis of Solar Dryer Designs

MD. Parwej Ali[1], Dr. Sohail Bux[2]

M.Tech scholar[1], Mechanical Engineering, RKDF University
Principal[2],Agnos College of Technology, RKDF University Bhopal (M.P.)

[1]ali1parwej@gmail.com
[2] buxsohail@gmail.com

Abstract Renewable energy is defined as an energy resource base that regenerates in less than a life span excluding depleting the planet's resources. Sunlight, wind, thunderstorms, tidal waves, tides, organic material, as well as difference in temperature stored in the upper mantle all have the benefit of being well almost universally accessible in one pattern or another. In solar drying, energy from the sun will be utilized as the sole or secondary heating source, and air circulation can be induced by prompted or environmental heat exchange.The commodity could've been warmed by passing heated air through it, by comparing it to solar irradiance, or by combining the two methods. This paper primarily mentions the temperature distribution in various solar dryer designs, with the outcomes demonstrating a comparative evaluation of these design features.

Key words: Renewable energy, solar dryer, CAD, FEM, Temperature Distribution.

I. INTRODUCTION

Presently, the globe must highly depend on imports, even subsidising them. Meanwhile, the toxic air they generate has risen tremendously in terms of everything from weather conditions to intellectual wellbeing particulate. Whenever anything goes horribly wrong, like when the Deepwater Horizon drilling rig detonated in 2010, the consequences are disastrous. Since 2011, renewable energy has risen at a quicker speed than all other sources of energy.

Renewables also had a record-breaking year in 2020, with installed power capacity rising by even more than 256 gigawatts (GW), the highest level ever. Wind power now records for even more than 29% of our electricity production, and this percentage is rising rapidly.

Just like every other human influence, all types of energy have an environmental impact. Alternative energy sources will be no different, each has its own set of

trade-offs. Renewable energy, on the other hand, has undeniable advantages over other energy sources, varying from diminished water as well as land use to

reduce harmful emissions, wild places as well as habitat destruction, and no or low greenhouse emissions.

Besides that, the local as well as distributed nature of their operations, as well as technical advances, focus on providing substantial economic and environmental advantages. As of earlier civilizations, food grains have indeed been dried in India's domains by sunlight exposure.

As a direct consequence of mechanization and automation in the twenty-first century, controlled drying of several farm products, including nicotine, lumber, nectarines, resins, and several others, is becoming extremely prevalent, as components retain their flavour and aroma, quality, and attractive appearance, and thus have improved sales possibilities. To eliminate extra hydration, crops, fruits as well as veggies, and fruits are dried in a drying framework.

The solar dryer is made of abundant and cost - effective materials for construction, galvanised iron, brick, as well as particleboard. The topmost layer of the dryer is surrounded by translucent single and then double panels. It's inside the external surface is painted black to absorb radiation from the sun. Since this box is sheltered, the inside thermostat is elevated. The top of the crease has small gaps that allow air to circulate.

The free convection process removes excessive water from strawberries, fruits and veggies, as well as crops placed in containers inside the box inside as the hot air rises. To fill in the gap, fresh air is required.

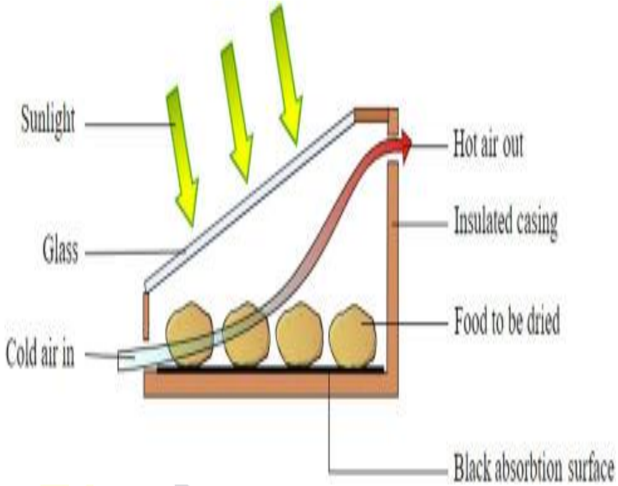

Figure 1 Basic schematic of Solar dryer

Solar dryers have numerous advantages over the traditional expanded evaporation, along with (1) a smaller area of land requisite to dry the same quantity of crop, (2) a significantly higher quality of dried crop due to the absence of insects and pests, (3) a shorter drying timeframe, (4) protection from impulsive rain, and (5) inadequate funding and operational costs.

Solar dryers having a simple extremely important backflow cost less to construct than renewable energy dryers with a distributed circulatory water system. Even though natural transfer renewable power dryers are susceptible to localised overheating and also have a slow as a whole drying temperature, a solar chimney is commonly used to speed up the rate upon which dry air tries to join by increasing the hydrostatic pressure on the air circulation.

Renewable energy from natural transfer Green - house air conditioning systems are larger than that of most cupboard drying techniques and feature numerous skylights on the edges, that are usually made of plastic. Electrical insulator panels can be drawn over the glazing at night to avoid heat loss offer heat capacity; even so, each of these features are rarely used in practitioners. A solar polytunnel dryer is nicer than a solar drying chamber for large-scale dehydration since it provides you more control so over drying kinetics.

Solar dryers have traditionally been used primarily in agriculture. The aim of drying monoculture crops is to reduce their water content to a level that prevents them from degrading inside a span of time that is considered safe for storage. Evaporative cooling is a two-step process that involves a temperature difference between a heat source and the brand, as well as an elevated heat transfer rate of condensation from the company's inner surface to its outer walls, as well as from the exterior to the atmosphere. For centuries, farmers have dried their crop production in the open air. Solar dryers have recently been used because they are more efficient and effective.

One of the earliest usage of solar energy is to dry food by uncovering it to the sun, that is used to retain fruits and vegetables, apples, fish, and processed meats. Since earlier civilizations, sun radiation has been utilised as the sole supply of energy to dry and preserve all requisite food stuffs, to dry ground bricks for their residences, and to dry fur coats for dressing.

II. LITERATURE REVIEW

(Lamrani et al., 2019) [1] The purpose of this research is to construct a numerical method using TRNSYS systems in order to evaluate the efficacy of an implied photovoltaic power drying for woods. A sun compound parabolic concentrator (CPC) is used to create heat energy, and employee' regularly colorful simulation studies are run utilizing MoroCcan weather data. In a comparing results of both our mathematics experimentation outcome findings, the Mean Relative Error (MRE) and the Root Mean Squared Error (RMSE) are 3.9 % and 0.024 kg/kg, respectfully. The impact of some operational and design criteria on dryness kinematics, as well as the energizing of conventional drying devices, are discussed. The amount of carbon dioxide (CO2) carbon output due to incomplete combustion at the supplementary heating unit is the fºCus of an environmental assessment. The results show that incorporating a solar panel into the dryer system reduces the auxiliary heating element system's power consumption and reduces CO2 emissions by about 34% annually.

(Kuan et al., 2019) [2] In this paper, a measurement simulation for trying to predict the electricity thermal performance compressor supported solar dryer in european environments is proposed. The model is determined by the balance of energy and mass. The energy efficiency of heat pump drying systems, photovoltaic dryers, and heating system assisted solar dryers is compared. The model was conducted in Almaty, Kazakhstan, under four different climatic conditions. When opposed to ordinary solar dryers, the heating system supported photovoltaic dryer seems to be more energy efficient, according to the simulated data. It has also been confirmed that traditional solar dryers are ineffective in continental climates with intermediate temperatures.In 21 hours, the heat exchanger dryer reduces the amount of moisture of bananas (on a wet basis) from about 74 percent to about 19 percent. In 35 hours, the solar dryer diminishes the moisture levels (wet basis) from about 74 percent to about 20 percent. A heat pump facilitated solar dryer's particular humidity harvesting rate and thermal efficiency are approximated to be around 0.6 kg/kWh and 2.72, respectively.

(Lingayat et al., 2020) [3] This study describes the development of an indirect type solar dryer (ITSD) for dried apple and melons. The efficiency of the ITSD was tested, as well as the drying chamber for watermelon and apples slicing. The experimental data were used to compute the deterioration rate, surfaces transfer coefficients, and solution temperature of apples and cantaloupe. According to the results of the trials, the average temperature within the drying cabinet fluctuated over time due to frequent fluctuations in sun activity. The thermodynamics performances of the collection and dryer was 54.5 percent and 25.39 percent, respectfully, while apples drying and 56.3 percent and 28.76 percent, including both, while watermelon dryness. Watermelon water content fell from 10.76 to 0.496 kg/kg db, while apple water content declined from 6.16 to 0.799 kg/kg db. Different variants from previous studies were used to fit the dryer curves. The equilibrium moisture content diffusion coefficient average was calculated and it was 4.28×10^{-9} m2/s and 4.01×10^{-9} m2/s for apple and watermelon, respectively. Mass transfer coefficient is found to be in the range 1.584×10^{-4} to 3.158×10^{-3} m/s for apple and 5.17×10^{-4} to 4.98×10^{-3} m/s for watermelon. The heat transfer coefficients for apple and watermelon were 0.16 to 3.19 W/m2 K and 0.52 to 5.04 W/m2 K, respectfully. Apple and watermelon have activation energies of 17.34 and 18.71 kJ/mol, respective.

(Atalay, 2019) [4] The energy and and perhaps appearances of a sun drying able to integrate with a packed bed (TES) as a heat storage medium are presented in this study. The drying chamber of orange slices were studied as a case study. The goal of this research is to assess the packed bed's heat transfer possibilities by choosing to fºCus on electricity usage and entropy generation indicators. Experiments were conducted out twice daily. The results revealed that employing a solar thermal energy with a packed column reduced the moisture content of orange sliced from 93.5 percent to 10.28 percent (in the first trial) and 10.76 percent (in the second experiment) (in the second). Total usable power consumption was found to be 89.892 MJ for one status and 88.11 MJ for the other. The dryer system's power conversion efficiency ranges from 50.18 to 66.58 percent during daylight hours. The drying proCess' exergy efficiency varies between 54.71 and 68.37 % while using stored energy generation. A mathematical model is developed to forecast how well the moisture ratio of reddish sliced will change with time. According to the results of the star, the Modified Freeman and Pabis Model provided excellent specifications for determining the drying behavior of oranges sliced.

(Bhardwaj et al., 2019)[5]The laboratory experiment of an implicit forced convection dryer with sensible heat storage material (SHSM) and phase change material (PCM) in the Himalayan meteorological environment (latitude 30.91 °N) is presented in this paper. Iron scraps mixing with gravel is placed on top of the solar concentrator, with copper tubing containing engine serving as SHSM. In the drying chamber, the Paraffin RT-42 was used as a PCM. Experiments with drying Valeriana Jatamansi (a medicinal herb) were conducted, and the moisture content was reduced from 89 percent to 9 percent. When SHSM and PCM were used simultaneously, the overall drying rate was 0.051 kg/hr, just about double that of 0.028 kg/hr and 0.018 kg/hr, respectively, when no thermoelectric stºCk was used. The dryers time to reach 9 percent saturation was 120 hours, compared to 216 and 336 hours, to between, and decent quality dehydrated root system in addition to the core oil and med chem substances were obtained. Intravenous fluids capacity and total Tend to have stronger were found to be 7.11 and 3.47 percent, including both, in the experimental data, compared to 6.18 and 3.31 percent in the comparison with conventional shade drying. The ordinary energy and exergy efficiency of a solar hoarder without SHSM is 9.8% and 0.14 percent, respectively. SHSM achieves energetic and exergetic efficiency of 26.10 and 0.81 percent, respectively.

(Vijayan et al., 2020)[6]In this study, a reduced ambiguously defined forced convective heat transfer solar dryer with a highly permeable bed heat storage material was developed and tested for drying fenugreek slices throughout Coimbatore's environmental conditions. A solar panel with a surface area of 2 m2, a drying chamber, and a centrifugal blower make up the development setup. The exploratory study of an indirect forced convection dryer with sensible heat storage material (SHSM) and phase change material (PCM) in the Himalayan weather forecasting surroundings (latitude 30.91 °N) is presented in this paper. In the solar panel, iron scrap mixture with granular material is placed on the absorber tube, and brass tubes containing engine oil are used as SHSM.In the drying medium, the Paraffin RT-42 was used as a PCM. Experiments with drying Azadirachta indica Jatamansi (a medicinal herb) were undertaken, and the moisture content was reduced from 89 percent to 9 percent. When SHSM and PCM were used instantaneously, the overarching rate of evaporation was 0.051 kg/hr, almost double that of 0.028 kg/hr and 0.018 kg/hr, respectively, when no thermal storage medium was used and classical shade evaporation was used. The drying time to reach 9 percent saturation was

120 hours, compared to 216 and 336 hours, to between, and decent quality dehydrated taproot in addition to the core oil and med chem substances were acquired. Moisture absorption potential and total Tend to have stronger were found to be 7.11 and 3.47 percent, including both, in the experimental data, compared to 6.18 and 3.31 percent in the comparison with conventional shade drying. The average exergy analysis efficiency of a solar concentrator without SHSM is 9.8% and 0.14 percent, respectively. To force the air, SHSM achieves energy and exergy efficiency of 26.10 and 0.81 percent, respectively.

(Sözen et al., 2020) [7] For the developing world, clean renewable energy production is a must. Solar energy is a frequently used renewable energy source that may produce both electricity and heat heat. Solar energy techniques could be employed in various of applications, include space proCess heat.. Three easy and price solar air heating systems were developed and made in this study. A hollow tube heating element is the first type of heater. The 2nd heating element will have the same basic properties as the first, but in the fluid flow, iron blended seamlessly were added to improve thermal contact area. Using Computational Fluid dynamics software, Based on the simulation results, a honeycomb tube-type heaters was developed. Both heater were equipped with a drying chamber, and drying tests were conducted at 3 different air mass flow rates (0.014, 0.011, and 0.009 kg/s). The peak energy thermal performance of an iron matrix model with various heaters was determined to be 74.71 percent. The thermal efficiency of the tube-type heaters was raised by 11% after mesh was added. Furthermore, the iron mesh customized solar aided drier had the highest average energy efficiency of the drying system, at 50.85%.This tubular SAH design, with its simple and expense structure that contains no casing, no protection function, and is manufactured from steel sheet, is promising in terms of sustainable energy hot air creation.

(Ndukwu et al., 2020) [8] The paper will compare an active mix-mode wind-powered fan solar dryer (AWPFS) to a detachable combined non-wind-powered solar drier using pre-treated potato slices (PNWPS).The two dryers were put through their paces with and without the use of glycerol as an energy storage medium. The goal was to demonstrate a non-electric sun 's energy dryer that relied solely on clean energy sources. The dryer was tested at a room temperature of 24–50 °C and a humidity of 10–52 percent. The results show that dry with AWPFS and glycerin takes much less time than drier with just AWPFS or with PNWPS. Dunking the beets in a suitable solvent and blanching for 30 seconds before dry sped up the dryers time compared to other procedures. The dry power conversion efficiency range from 2.846 to 3.686 kWh/kg, whereas electricity consumption was between 4.10 and 4.98 MJ. Exergy efficiency was improved by 25.031 percent to 31.5 percent, while dryer efficacy improved by 25.031 percent to 31.5 percent. Due to Africa's low electricity penetration, this dryer with such a naturally extractor generator will assist crop manufactures in drying their products more efficiently, saving around 15.3–290.4 $ per year at a 10%–100% consumption rate.

(Güler et al., 2020)[9]The present study designed, analysed, assembled, and checked the double indirect solar dryer (DPISD) or a double solar thermal dryer with mesh absorber modification (DPISDMA). The main goal of this research is to use iron meshes to improve thermal efficiency of the double photovoltaic panel. The experimental investigation used specimen of de pescado fruit (Solanum muricatum L.) in two thicknesses. In addition, CFD analysis of both the solar air collection and the drying chamber was performed, as well as quality measurements such as phenolic, antioxidant capacity and flavonoids content Mesh alteration has a positive effect on the collectible efficiency, according to numeric simulations and experiments. DPISDMA had the greatest average dryer efficiency of 23.08 percent for thin sample thickness. Quality evaluations revealed that the trials conducted in DPISDMA produced the best results, with the greatest values of TPC, TFC, and antioxidant activity (p 0.05). The dry information of pepino fruits for several trials was modeled using eight distinct statistical formulas. As a result, the best-fitting kinetics framework for all experimental tests was determined to be the Logarithmic model, which provided the most statistically reliable value systems.

(Vigneshkumar et al., 2021)[10]Solar dryers are crucial in the food industry for maintaining safe to eat items such as granules, veggies, fish, and other foods by removing moisture levels. They have an advantage over outdoor public drying in that they safeguard the food from soot, invertebrates, and other harmful elements. Furthermore, they are said to save more environment for future generations from deterioration. Solar dryers of the indirect type consist mainly of a solar concentrator and a space to place grated zucchini. Their water evaporation rate is high, and the end product performance would be enhanced as well. An implicit based classification natural convection solar evaporator was fabricated in this study, and petroleum distillates was used as a phase different set (PCM) in the solar concentrator to continue improving the solar dryer's performance during the off-sunshine hours. In two cases, particularly regarding, solar dryer without PCM (Plain Dryer) and solar dryer with PCM, control parameters such as water evaporation rate, hydration ratio, and dryer temperature gradient were explored for drying grated zucchini (PCM Dryer). The air flow rate was kept constant at 0.065kg/s, and the evaporator was turned on from 10 a.m. to 7 p.m. The results will be compared, and the impact of combining PCM with the drying system was investigated and presented. The presence of PCM within the solar concentrator significantly increased the drying ambient temperature 2 hours after the solar period, according to the findings. Furthermore, using paraffin, the proportion of total weight of moisture removed from potato slices was increased by 5.1 percent per day.

III. METHODOLOGY

Solar Drying is much more innovative replacement for traditional sun drying technique, in which the merchandise is managed to keep in a transparent vessel uncover towards sunlight. The crucial difference among Solar Drying and sun drying would be that Solar Drying necessitates a solar collector, the dehydrating merchandise is not revealed to direct sunlight, and the solar collector could be equipped with a control system.

The green - house solar dryer's design factors are 1.2 x 1.2 x 1.5 m, 0.64 m for the altitude of the side walls from the base, 0.01 m for the air intake gap on four sides of the dryer, and 0.15 m for the mass circulation rate of the fan requirement radius. The roof is enclosed with a poly-carbonate layer, that also allows infrared radiation to enter the dryer. The radiation model is applied to the lºCation of Bhopal, which is lºCated at 23.20°N and 77.22°E, respectively.

With the support of the design module of the Ansys software, a three-dimensional CAD model of a greenhouse sun drying for preliminary design is generated in the current task. The sun dryer's length and width are 1200 mm and its high is 1500 mm, with a 100 mm inlet gap on four sides for hot air and a 150 mm circular fan hole for pumping air within the greener home sun drying.

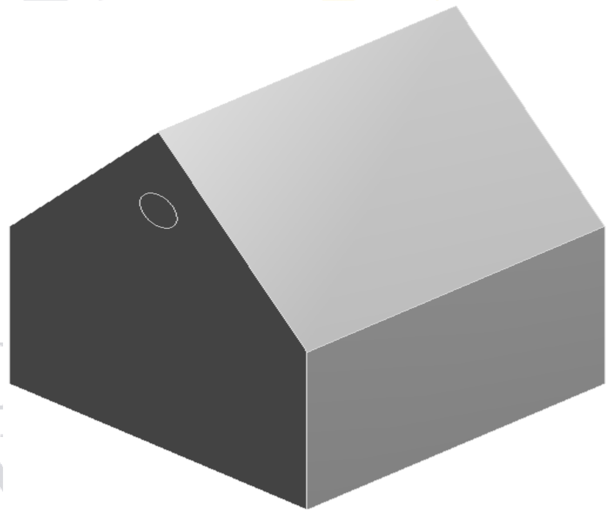

Figure 2Three Dimensional CAD model of greenhouse solar dryer for base design

CAD geometry solar dryer proposed design-2:

With the help of ANSYS workbench's design modules, a three-dimensional CAD model of greenhouse solar dryer design-2 is built. The drying system has a length and breadth of 1200 mm and a height of 1500 mm, with a 100 mm intake gap on four sides for hot air and a 0.02 m opening at the top.

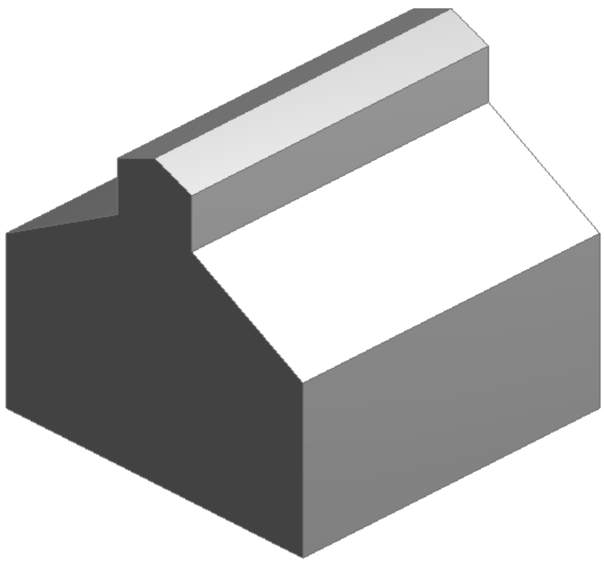

Figure 3Three Dimensional CAD model of greenhouse solar dryer for design-2

With the help of ANSYS workbench's designer module, a three-dimensional CAD model of greenhouses solar distillation design-3 is built. The solar dryer has a length and breadth of 1200 mm and a height of 1500 mm, with a 100 mm intake space on 4 sides for heated air, and a 1 m roof curve.

IV. RESULT AND DISCUSSION

Computational fluid dynamic analysis on greenhouse solar dryer for base model:

Temperature distribution inside the solar dryer at 10.00 AM on mid plane, bottom plane and vertical plane:

The temperatures contours diagram at mid-plane at 10 a.m. shows a range of 29.85oC to 47.45oC. At 10 a.m., the maximum temperature at the mid surface is 47.45 oC, with temperatures ranging from 29.85 oC to 47.47 oC in the vertical direction. At 10 a.m., the greatest temperatures on the vertical surface is 47.47°C, with temperatures on the bottom planes ranging from 33.85°C to 42.38°C. As indicated in the diagram below, the maximum temperature at the bottom surface is 42.38 oC:

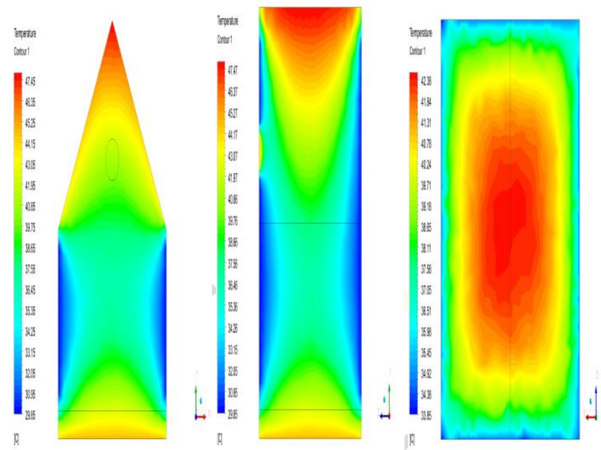

Figure 4 Temperature distribution at mid plane, vertical plane and bottom plane at 10 am.

At 11 a.m., 12 p.m., 1 p.m., 2 p.m., 3 p.m., 4 p.m., and 5 p.m., temperature distribution in all planes was similar, as shown in the graphically

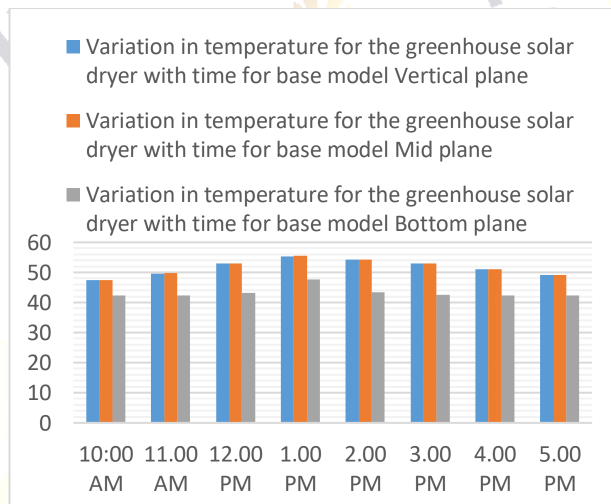

Figure 5 Variation in temperature for the greenhouse solar dryer with time for base model

Figure 5.95 shows that the base model of greenhouses sun drying has a low temperature of 42.38 oC at 10 a.m. on the bottom planes and a max temp of 55.47 oC at 1 p.m. on the vertical direction.

Temperature distribution of solar dryer design 2

Distribution of temperatures The temperatures contours diagram at mid-plane at 10 a.m. shows a range of 29.85oC to 55.64oC. At 10 a.m., the maximum temperature at the mid surface is 55.64 oC, with temperatures ranging from 29.85 oC to 55.64 oC in the vertical direction. At 10 a.m., the maximum temperature at the vertical wall is 55.64 oC, with temperatures at the bottom plane ranged from 30.28 oC to 42.71 oC. The highest temperature at the bottom is 42.71 degrees Celsius.

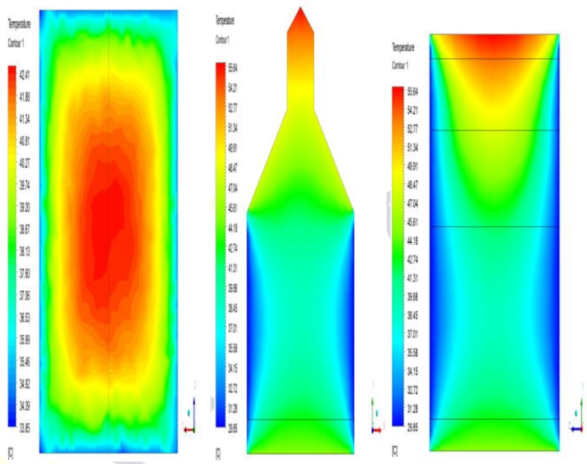

Figure 6Temperature contour inside the solar dryer for design-2at 10 AM on mid plane, vertical plane and bottom plane

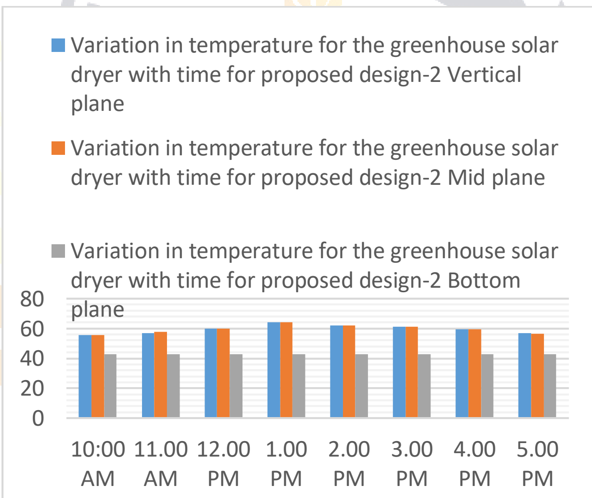

Figure 7Variation in temperature for the greenhouse solar dryer with time for proposed design-2

The temperature for proposed design-2 varies from 42.71oC at 10 a.m. on the bottom plane to 64.41oC at 1 p.m. on the mid and vertical planes, with the maximum temperature observed at 1.00 p.m. due to maximum radiation falling on the top of the sun drying, as shown in the graph as shown in figure no. 5.96.

Temperature distribution of solar dryer design 3

The temperature contour map at 10.00 AM shows temperatures ranging from 29.85oC to 59.23oC. The greatest temperatures at the middle level is 59.23 oC, with temperatures ranging from 29.85 oC to 58.30 oC in the vertical plane at 10.00 a.m. The greatest temperatures at the middle area is 58.30°C, with temperatures ranging from 32.62°C to 42.87°C at 10.00 AM. The maximum temperature at the bottom is 42.87 degrees Celsius.

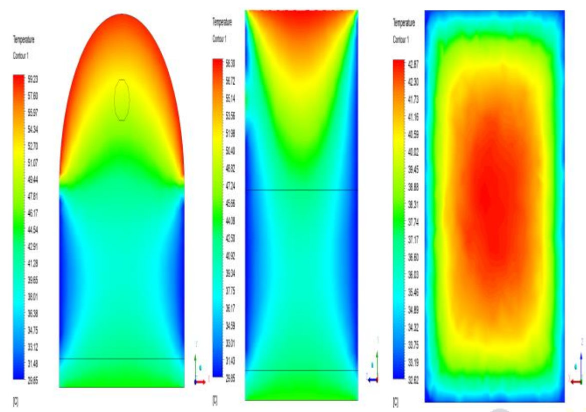

Figure 8 Temperature contour inside the solar dryer for design-3 at 10.00 AM on mid plane, vertical plane and bottom plane

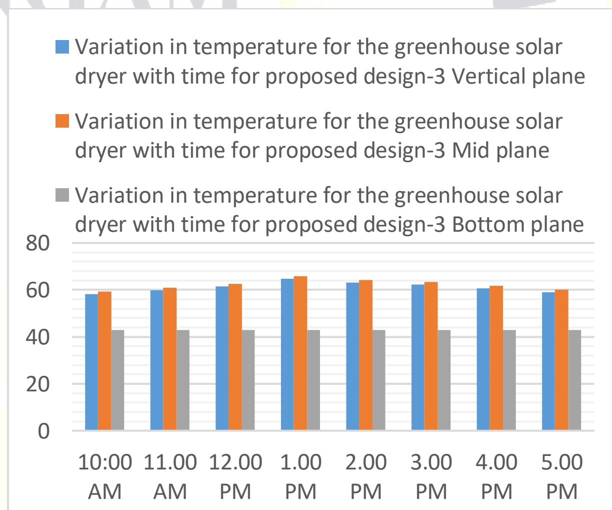

Figure 9Variation in temperature for the greenhouse solar dryer with time for proposed design-3

The temperatures for suggested design-3 varies from 42.87oC at 10 a.m. on the bottom plane to 65.89 oC at 1 p.m. on the mid plane, with the maximum temperature observed at 1.p.m. due to maximum radiation falling on the top of the sun drying, as illustrated in the graphs presented in figure no. 5.97.

Temperature distribution of solar dryer design-4

The temperatures contour diagram at 10.00 AM shows temperatures ranging from 29.85oC to 73.77oC. At 10.00 AM, the maximum temperature at the mid surface is 73.77 oC, with temperatures ranging from 29.85 oC to 73.82 oC in the vertical plane. At 10.00 AM, the maximum temperature at the mid level is 73.82 oC, with temperatures ranging from 30.25 oC to 66.04 oC at the bottom plane. The maximum temperature at the bottom is 66.04 degrees Celsius.

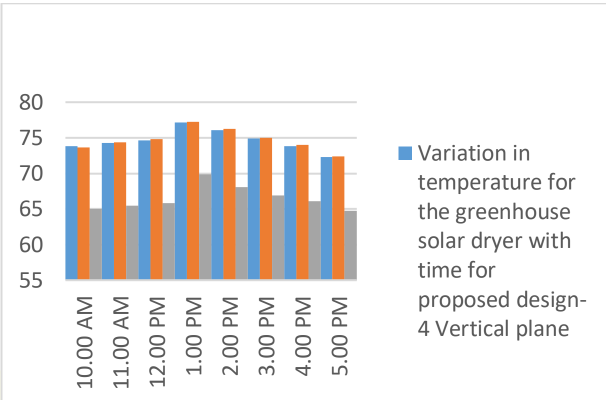

Figure 10 Variation in temperature for the greenhouse solar dryer with time for proposed design-4

It has been observed from above graph shown in figure no. 5.98 that for proposed design-4 the temperature vary from 64.81$^{\circ C}$ at 10 am on bottom plane to 77.36 $^{\circ C}$ at 1.00 pm on mid planeand also maximum temperature observed at 1.pm due to maximum radiation fall on the top of the solar dryer.

V. CONCLUSION

For the temperature change inside the dryer, a computational fluid dynamics assessment was conducted on four distinct designs of greenhouse solar dryers. To acquire the best findings, this analysis has been conducted on the warmest day of the year (May 21st). For a better knowledge of temperature profile, three separate planes were considered: vertical, mid, and bottom. The greenhouses sun dryer's geometric dimensions are 1.2 x 1.2 x 1.5 m, 0.65 m for the elevation of something like the side panels from of the ground, 0.01 m for the inlet space on four sides of the drying, and 0.15 m for the mass flow rate of the fan provision diameter. The roof is covered with a polycarbonate sheet, which allows thermal energy to enter the dryer. The radiated model is applied to the location of Bhopal, which is located at 23.25°N and 77.33°E, respectively.

References

[1] Mahela, O. P., &Shaik, A. G. (2017). Comprehensive overview of grid interfaced solar photovoltaic systems. Renewable and Sustainable Energy Reviews, 68(July 2015), 316–332. https://doi.org/10.1016/j.rser.2016.09.096

[2] Kottayil, S. K., & Engineering, E. (2014). A Grid Interfacing Scheme for Renewable Energy Sources. Pestse, 0–3.

[3] Kasa, S., Ramanathan, P., Ramasamy, S., & Kothari, D. P. (2016). Electrical Power and Energy Systems Effective grid interfaced renewable sources with power quality improvement using dynamic active power filter. INTERNATIONAL JOURNAL OF ELECTRICAL POWER AND ENERGY SYSTEMS, 82, 150–160. https://doi.org/10.1016/j.ijepes.2016.03.002

[4] Member, S. (2018). Harmonics and Mitigation Techniques through Advanced Control in Grid-Connected Renewable Energy Sources : A Review Xiaodong Liang Chowdhury Andalib-Bin-Karim. 9994(c). https://doi.org/10.1109/TIA.2018.2823680

[5] Meral, M. E., &Inci, M. (2019). Virtual Park-based control strategy for grid- connected inverter interfaced renewable energy sources. https://doi.org/10.1049/iet-rpg.2019.0144

[6] Prakash, O., &Shaik, A. G. (2016). Comprehensive overview of grid interfaced wind energy generation systems. Renewable and Sustainable Energy Reviews, 57, 260–281. https://doi.org/10.1016/j.rser.2015.12.048

[7] Meegahapola, L. G., Member, S., Bu, S., & Member, S. (2020). Review on Oscillatory Stability in Power Grids with Renewable Energy Sources : Monitoring , Analysis , and Control using Synchrophasor Technology. https://doi.org/10.1109/TIE.2020.2965455

[8] Gunaruwan, L. (2018). Reactive Power Management in Renewable Rich Power Grids : A Review of Grid-Codes , Renewable Generators , Support Devices , Control Strategies and Optimization Algorithms. 3536(c), 1–33. https://doi.org/10.1109/ACCESS.2018.2838563

[9] Bajaj, M., & Singh, A. K. (2019). Grid integrated renewable DG systems : A review of power quality challenges and state - of - the - art mitigation techniques. September. https://doi.org/10.1002/er.4847

[10] Meegahapola, L., Laverty, D., & Jacobsen, M. (2017). Synchronous islanded operation of an inverter interfaced renewable rich microgrid using synchrophasors. https://doi.org/10.1049/iet-rpg.2017.0406