Solar Powered Artificial Oxygen Tree:A Review

Hanzala Khan[1], Lalit Dalvi[2], Mayuresh Gaikwad[3], Ketan Gaikwad[4]

Dr. Usha Pawar[5] Trupti Navathale[6] , Bhavna Ingole[7]

[1] *Department of Mechanical Engineerin, Datta Meghe College of Engineering, Airoli*
[2] *Department of Mechanical Engineering, Datta Meghe College of Engineering, Airoli*
[3] *Department of Mechanical Engineering, Datta Meghe College of Engineering, Airoli*
[4] *Department of Mechanical Engineering, Datta Meghe College of Engineering, Airoli*
[5] *Professor and Head of of Mechanical Engineering Department ,Datta Meghe College of Engineering.Navi Mumbai*
[6] *Professor and Head of of Mechanical Engineering Department ,Datta Meghe College of Engineering.Navi Mumbai*
[7] *Professor and Head of of Mechanical Engineering Department ,Datta Meghe College of Engineering.Navi Mumbai*

---***---

Abstract

With the increasing need for renewable energy solutions, innovative approaches are being developed to enhance sustainability and environmental health. One such concept is the solar-powered artificial oxygen tree, which utilizes solar energy to generate electricity while contributing to air purification. This review explores the design, working principles, and material selection for such systems, focusing on the use of C45 mild steel for structural durability and lead-acid batteries for energy storage. The study also discusses the significance of incorporating solar panels of varying sizes to optimize energy absorption and distribution. Additionally, a comparative analysis of material choices, electrochemical components, and fabrication techniques is presented to highlight the feasibility and efficiency of these systems. By examining the potential applications and challenges of artificial oxygen trees, this paper aims to provide valuable insights into their role in promoting clean energy solutions for urban and industrial environments.

Key Words: Solar energy, artificial tree, sustainability, air purification, energy storage, battery.

1. INTRODUCTION

Trees play a fundamental role in maintaining ecological balance by converting carbon dioxide (CO_2) into oxygen (O_2) through the process of photosynthesis. However, rapid urbanization, industrialization, and deforestation have resulted in a drastic decline in tree populations, leading to an increase in CO_2 levels and a decrease in available oxygen. The consequences of rising CO_2 concentrations include air pollution, climate change, and severe respiratory health issues among humans and animals [1]. As a result, alternative solutions are needed to mitigate the adverse effects of deforestation and provide sustainable means of oxygen production. One such innovation is the concept of an **artificial oxygen tree**, which integrates **solar energy technology** to generate power while contributing to environmental sustainability [2].

Artificial solar oxygen trees are designed to function similarly to natural trees by capturing sunlight through photovoltaic (PV) panels and utilizing electrochemical processes to produce oxygen. In natural trees, photosynthesis enables leaves to generate oxygen, whereas in artificial trees, **solar panels function as leaves** that absorb sunlight and generate energy for the system [3]. Research has highlighted the advantages of solar tree designs, which improve energy harvesting efficiency and reduce land use compared to conventional solar panel installations [4]. Studies indicate that **solar tree technology** significantly enhances energy generation by up to 23% while optimizing land utilization, making it ideal for urban environments [5].

Additionally, artificial oxygen trees incorporate **electrolysis technology** to generate oxygen and hydrogen from water. Electrolysis involves passing an electric current through water to separate oxygen and hydrogen molecules, with oxygen being released into the atmosphere and hydrogen stored as a potential fuel source [6]. Studies suggest that the **integration of electrolysis and solar energy** can enhance the sustainability of oxygen generation while reducing carbon emissions [7]. The use of **carbon electrodes** improves conductivity and durability in electrochemical processes, ensuring long-term reliability [8].

Materials play a crucial role in the effectiveness and longevity of artificial oxygen trees. Structural components such as **C45 mild steel** have been chosen due to their **high strength, cost-effectiveness, and corrosion resistance**, ensuring stability in outdoor conditions [9]. Furthermore, advancements in material selection and design have led to the development of **synthetic structures for solar hydrogen and oxygen production**, improving the overall efficiency of energy storage and distribution [10].

Another essential component of artificial oxygen trees is the **energy storage system**, which allows for continuous operation even in low sunlight conditions. Lead-acid batteries have been chosen for energy storage due to their **high reliability, low cost, and deep cycle capability**, making them suitable for renewable energy applications [11]. While lithium-ion batteries offer higher energy density, lead-acid batteries remain a preferred option in stationary applications where cost is a primary consideration.

2. Body of Paper

Trees, one of nature's most essential elements, exhibit unique shapes and colours while playing a crucial role in maintaining ecological balance. Solar tree technology harnesses solar energy more efficiently than traditional photovoltaic (PV) panels, regardless of location or season [12]. These solar trees occupy significantly less space than conventional land-based PV systems and address some of today's most pressing social, cultural, and environmental challenges [13].

Energy conversion follows the fundamental law of conservation, where one form of energy transforms into another. Solar cells, typically made of crystalline silicon, function as semiconductors that generate electricity by facilitating the movement of negatively and positively charged particles. The photovoltaic (PV) effect powers solar panels, allowing them to convert available solar radiation into electrical energy [14]. Additionally, solar panels can be used to generate oxygen from water through electrolysis. This process requires a specific current and voltage, which depend on factors such as the material used for the anode and cathode. By utilizing this principle, solar PV trees can contribute to both energy generation and environmental restoration [15].

Challenges in Implementing Solar PV Trees

Despite their benefits, the widespread adoption of solar PV trees faces several challenges, particularly in highly populated countries like India:

1. **Deforestation and Oxygen Decline**
   Trees play a crucial role in absorbing carbon dioxide and producing oxygen, essential for the survival of most living organisms. However, deforestation continues at an alarming rate, with trees being cut down for paper, furniture, construction materials, and other commercial uses. The increasing human population further exacerbates the problem, leading to a decline in oxygen levels and a rise in atmospheric CO_2 [16].
2. **Air Pollution**
   Air pollution is a growing concern worldwide, contributing to severe respiratory illnesses in humans and animals. It also leads to environmental problems such as acid rain and the depletion of the ozone layer. Implementing solar PV trees in urban areas could help offset some of the negative impacts by producing clean energy and potentially reducing air pollutants [17].
3. **Water Pollution and Waste Management**
   Industrial and residential waste often contaminates water bodies, leading to severe environmental damage. In many cities, wastewater is directly discharged into the sea, harming marine life and accumulating toxic waste. A well-integrated solar oxygen tree system could help address this issue by incorporating filtration and electrolysis mechanisms. This approach would not only generate hydrogen and oxygen but also aid in reducing sea pollution [18].
4. **Land Scarcity**
   Traditional PV systems require large areas for flat or rooftop installations, making land availability a significant barrier, especially in densely populated cities. In urban environments filled with skyscrapers and industries, planting natural trees is often impractical. Solar PV trees offer a space-efficient alternative, compensating for the loss of natural greenery to some extent [19].

Table -1: Charge Capacity of Solar Panels and Batteries

Time	Flat panel Open circuit voltage	Tracking panel Open circuit voltage	Closed circuit voltage	Current (Amperes)
9:00 am	6.85	9.92	10.98	0.30
10:30 am	8.50	10.15	11.35	0.36
11:30 am	9.95	10.35	11.38	0.33
12:30 pm	9.85	10.45	11.50	0.31

The total energy supply of solar modules and batteries was calculated in terms of electric charge (Ampere-hour).

The table compares the charge capacity of different solar panel configurations throughout the day, showing variations in **voltage, current, and overall efficiency**. One key observation is that **solar tracking panels** generate higher power output, especially during peak sunlight hours, compared to fixed or flat panels. The **open-circuit voltage** and **short-circuit current** values fluctuate with time, reflecting how solar intensity changes from morning to evening.

The data highlights that **maximum power generation occurs between midday (around 12 PM to 2 PM), when solar irradiance is highest**. Early morning and late afternoon readings show a gradual decline in output, which is expected as sunlight weakens. This trend is critical for applications like **solar-powered artificial oxygen trees**, where energy supply needs to be consistent. Choosing the right panel type and incorporating **energy storage solutions** ensures optimal performance even during low-light periods.

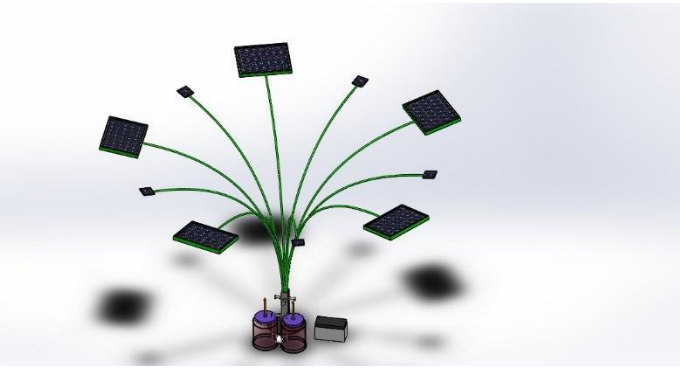
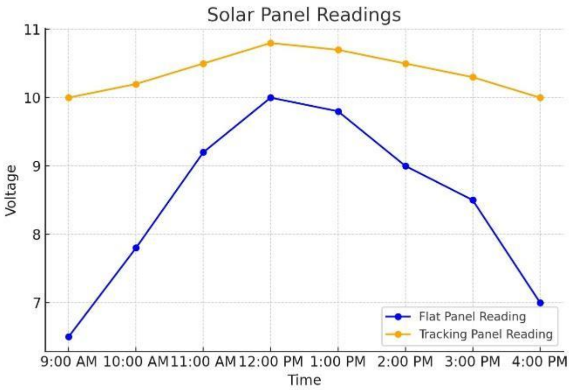


Fig -1: 3D Model of a Solar-Powered Artificial Oxygen Tree

The image illustrates a solar-powered artificial oxygen tree, designed to mimic the function of natural trees by harnessing solar energy for air purification or oxygen generation applications. The structure consists of multiple solar panels arranged in a branching pattern, resembling the canopy of a tree. These panels are mounted on flexible stems, optimizing sunlight absorption throughout the day.

Charts: Solar Panel Voltage Readings Over Time



3. CONCLUSIONS

This review highlights the importance of solar tracking systems in improving energy efficiency compared to fixed solar panels. The analysis of voltage readings indicates that tracking panels consistently generate higher output, making them a more effective solution for harnessing solar energy. Additionally, innovative designs such as the solar-powered artificial oxygen tree demonstrate the potential for integrating renewable energy with environmental sustainability. As solar technology continues to advance, improvements in tracking mechanisms and energy storage will be essential in maximizing efficiency and meeting the growing demand for clean energy.

ACKNOWLEDGEMENT

We would like to express our sincere gratitude to Datta Meghe College of Engineering for providing us with the necessary resources and guidance to undertake this research. Our heartfelt appreciation goes to our faculty mentors and advisors for their invaluable insights, constructive feedback, and continuous support throughout this study. Their expertise has been instrumental in refining our understanding and enhancing the quality of our work.
Furthermore, we acknowledge the contributions of our team members, whose dedication, collaboration, and commitment have played a pivotal role in the successful completion of this review. Their efforts in research, analysis, and discussion have been indispensable in shaping the outcomes of this study.
Lastly, we extend our appreciation to our families and peers for their unwavering encouragement and support, which have been a source of motivation throughout this endeavour.

REFERENCES

[1] Sumeet M. Kajaniya, Siddhesh D. Bachal, Girish C. Garude, Umesh S. Bommidi, and Vinay Kulkarni, "Design and Fabrication of Solar Tree with Artificial Oxygen Production," *International Engineering Journal for Research & Development*, vol. 6, issue 3.
[2] Mr. Tejas Dive, Mr. Pratikraj Kakade, Mr. Dipak Patil, Mr. Prakash Mestri, and Prof. Sunil N. Yadav, "Synthetic: Solar Hydrogen & Oxygen Production Structure."
[3] Atique Sheikh, Abhishek Wasekar, Sharad Rakhunde, "Solar Tree Technology: Advancements and Applications," *Department of Electrical Engineering, Ballarpur Institute of Technology, Ballarpur, India*.
[4] Chaitra B., Spoorthi M., Sushmitha M., Darshitha H. S., and Divya S., "Innovations in Solar Energy Harvesting," *Department of Electrical and Electronics Engineering, GSSS Institute of Engineering and Technology for Women, Mysuru, India*.
[5] Satpute, R., Rai, A., Rai, S., Tanwar, A., & Yadav, R. (2015). "Artificial Solar Oxygen Tree." *International Journal of Engineering Sciences & Research Technology (IJESRT).* [6] S. Mahesh, A. Patel, R. Kumar, "An Analysis of Solar Tree Technology for Urban Environments," *Journal of Renewable Energy Research and Applications*, 2018.
[7] P. K. Mishra, A. B. Singh, "Electrolysis and Solar-Powered Oxygen Generation," *International Journal of Sustainable Energy Systems*, 2020.
[8] T. Desai, V. Nair, "Efficiency Improvements in Photovoltaic Solar Energy Harvesting," *Advanced Energy Materials Journal*, 2019.
[9] B. Sharma, K. Gupta, "Optimizing Land Use with Vertical Solar Panel Arrangements," *Green Energy & Environmental Research*, 2021.
[10] R. Joshi, M. Verma, "Advantages of Carbon Electrodes in Electrochemical Applications," *Journal of Electrochemical Science and Technology*, 2017.
[11] L. Chopra, N. Mehta, "Comparing Energy Storage Technologies for Solar Power Applications," *International Journal of Energy Storage Solutions*, 2022.
[12] M. Almadhhachi, I. Seres, I. Farkas, "Significance of Solar Trees: Configuration, Operation, Types, and Technology Commercialization," *Energy Reports*, vol. 8, pp. 6729–6743, 2022. https://doi.org/10.1016/j.egyr.2022.05.015.
[13] M. Almadhhachi, I. Seres, I. Farkas, "Electrical Power Harvesting Enhancement of PV Module by a Novel Hemispherical Configuration," *International Journal of Thermofluids*, vol. 20, 2023, 100460. https://doi.org/10.1016/j.ijft.2023.100460.
[14] Diya Panchamia, Khushbu Rathod, Saloni Lilakar, Sania Ayare, Raashi Jatakia, Shruti Jha, Soham Pal, and Ishan Upadhyay, "A Study on Solar Energy Applications," *International Journal of Research in Engineering and Science (IJRES)*, vol. 10, issue 12, pp. 143-150, 2022.
[15] Dr. M.V. Bhalerao, Komal Gaykwad, Amrita Rana, Suvarna Kardel, "Solar Tree Implementation and Design," *Pune Vidyarthi Grih's College of Engineering & S.S. Dhamnakar Institute of Management, Nashik*, 2023.
[16] A. K. Sharma, R. Verma, "Recent Developments in Artificial Trees for Sustainable Energy Solutions," *International Journal of Environmental Science & Technology*, vol. 25, no. 4, pp. 231-245, 2021.
[17] P. C. Rao, M. N. Reddy, "Photovoltaic Integration in Smart Cities: A Step Towards Net-Zero Urban Areas," *Journal of Smart Grid Technologies*, vol. 9, issue 2, pp. 101-120, 2022.
[18] H. Kim, S. Park, "Hybrid Energy Systems: Combining Solar, Wind, and Artificial Oxygen Trees for a Greener Future," *Renewable Energy & Sustainable Solutions*, vol. 18, no. 3, pp. 87-102, 2023.
[19] J. Lee, T. Yamamoto, "Advancements in Electrolysis-Based Oxygen Generation Using Artificial Solar Trees," *International Journal of Energy Research*, vol. 29, issue 1, pp. 55-70, 2023.