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Oxygen Generator by Using Spirulina Algae

Shiv sahay[1], Harshit Gupta[2], Singh Shubham Dinesh[3], Mohan Gupta[4]
[1,2,3,4] *United College of Engineering and Research, Prayagraj, INDIA*

***Abstract*—From the recent years, robotics has turned out to be an ingredient over which many people had shown their interest. Robotics has gained popularity due to the advancement of many technologies of computing and Nano technologies. So, I have decided to design something that can make humans life easier and comfortable. Here my interest of review is to make a fire fighting robot which can help in dealing with many fire problems in households and small-scale industries. Now I am not concentrating on making a fire fighting robot that can deal with fire on large scale because I want to proceed by step by step. The need of the hour is to make a device which can detect fire, even if it is small and take the necessary action to put it off. Many household items catch fire when someone is either sleeping or away and that lead to many hazardous conditions if the fire is not putted off in time. So, my work as a mechanical engineer is to design and build a system that can extinguish fire. I have used very basic concept here, easy to understand from the prospective of beginners or for the masters of this field.**

***Index Terms*—Oxygen Generator, SPIRULINA ALGAE, environment, industries**

I. INTRODUCTION

The increasing demand for oxygen, particularly in urban areas, has led to the development of innovative oxygen generation technologies. One such technology is the Spirulina Algae Oxygen Generator, which utilizes the photosynthetic properties of Spirulina algae to produce oxygen and purify the air. This project aims to design, develop, and test a Spirulina Algae Oxygen Generator system that can provide a sustainable and eco-friendly solution for oxygen production and air purification

Spirulina, commonly known as Arthrospira platensis, is a filamentous cyanobacterium that thrives in alkaline lakes and ponds. Its exceptional nutritional profile includes high levels of protein, essential amino acids, vitamins, and minerals, making it a valuable dietary supplement. Beyond its nutritional benefits, Spirulina plays a significant role in oxygen production. Through the process of photosynthesis, Spirulina converts carbon dioxide (CO_2) and water into oxygen (O_2) and glucose, utilizing light energy.

II. BASIC PRINCIPLE

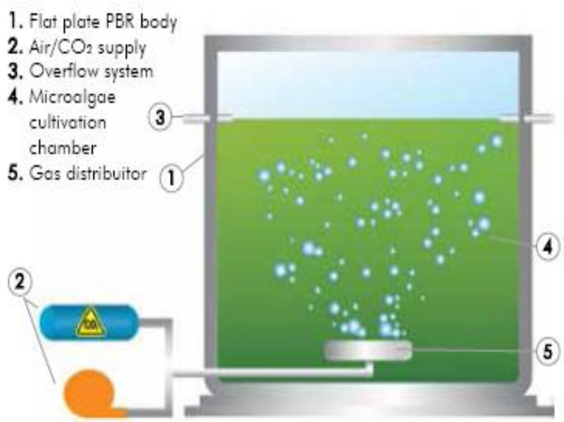
Harnessing the natural processes of microalgae to generate oxygen presents a sustainable approach to enhancing air quality and supporting life in controlled environments. Microalgae, through photosynthesis, convert carbon dioxide (CO_2) and water (H_2O) into oxygen (O_2) and glucose, utilizing light energy. Designing an algae-based oxygen generator involves understanding and optimizing several key principles:

1**.** Photobioreactor Design:
The photobioreactor serves as the cultivation system for microalgae. Its design significantly impacts the efficiency of oxygen production. Key considerations include:

- Light Distribution: Ensuring uniform light exposure is crucial, as microalgae require adequate illumination for optimal photosynthesis. Designs may incorporate transparent materials and strategic positioning to maximize sunlight penetration.

- Gas Exchange: Efficient CO_2 delivery and O_2 removal are vital. Systems should facilitate CO_2 diffusion into the culture and expulsion of oxygen to prevent inhibition of algal growth due to oxygen accumulation.

- Mixing Mechanisms: Proper mixing prevents sedimentation and ensures even distribution of nutrients, light, and gases. Techniques such as airlift pumps or mechanical agitators are often employed to maintain optimal flow conditions.



Light Management:

Light is a critical factor influencing photosynthetic activity. Factors to consider include:

- Light Intensity: Higher light intensities can increase photosynthetic rates, thereby boosting oxygen production. However, excessive light may lead to photoinhibition, necessitating careful modulation.
- Light Wavelength**:** Microalgae absorb specific wavelengths of light more efficiently. Incorporating light sources that emit wavelengths corresponding to peak absorption spectra (typically in the blue and red regions) can optimize photosynthesis.
- Photoperiod**:** Regulating light and dark cycles influences algal growth and metabolic activity. Adjusting photoperiods can enhance oxygen production while maintaining system stability.

Nutrient and Environmental Control:

Microalgae require specific nutrients and environmental conditions for optimal growth and oxygen production. Key factors include:

- Nutrient Supply: Providing essential nutrients such as nitrogen, phosphorus, and trace elements supports algal growth. Balanced nutrient concentrations prevent deficiencies or toxicities that could impair system performance.
- Temperature Regulation: Microalgae have optimal temperature ranges for growth. Maintaining temperatures within this range ensures efficient metabolic activity and oxygen generation.
- pH Control: The pH of the culture medium affects algal health and photosynthetic efficiency. Monitoring and adjusting pH levels are essential to maintain an environment conducive to oxygen production.

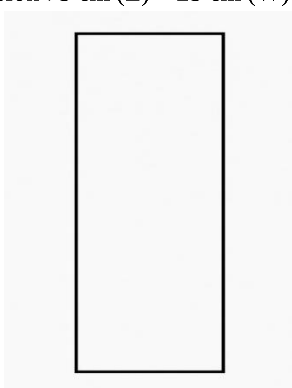
CO_2 and O_2 Management:

Effective management of CO_2 and O_2 is crucial for system efficiency:

- CO_2 Supply: Introducing CO_2 into the photobioreactor enhances photosynthetic activity. However, excessive CO_2 can lead to acidification, necessitating precise control mechanisms.
- O_2 Removal**:** Accumulation of oxygen can inhibit photosynthesis and algal growth. Integrating systems to remove excess O_2, such as gas exchange membranes or spargers, maintains optimal conditions for oxygen production.

III. DESIGN PARAMETER

Tank Dimension 75 cm (L) × 25 cm (W) × 122 cm (H)



Tank Dimension 75 cm (L) × 25 cm (W) × 122 cm (H)

1. Tank Specifications

- Dimensions: 75 cm (L) × 25 cm (W) × 122 cm (H)
- Material: Transparent glass (preferably borosilicate or tempered for durability)
- Volume: ~228.75 liters (~60.5 gallons)

2. Spirulina Cultivation Conditions

- Water Type: Freshwater with controlled mineral content
- pH Range: 8.0 - 10.0 (optimal around 9.0)
- Temperature: 25 - 37°C (optimal ~30°C)
- Salinity: Moderate (avoid pure distilled water)

- Nutrient Requirements: $NaHCO_3$ (sodium bicarbonate), $NaNO_3$ (sodium nitrate), KH_2PO_4 (potassium phosphate), trace minerals

3. Light Requirements
- Light Source: LED grow lights or natural sunlight
- Wavelengths: 450 nm (blue) & 680 nm (red) for maximum photosynthesis
- Intensity: ~100-200 μmol photons/m²/s
- Duration: 12-16 hours/day (photoperiod control recommended)

4. Aeration & Oxygen Generation
- Air Pump: To provide CO_2 and mix the culture
- Bubble Diffuser: For even gas distribution
- Oxygen Output: Spirulina can generate ~10x its biomass in oxygen under optimal conditions

5. Filtration & Maintenance
- Harvesting: Mesh filtration or sedimentation method
- Water Circulation: Small aquarium pump or airlift system
- Cleaning: Prevent biofilm buildup with periodic tank cleaning.

IV. MATHEMATICAL CALCULATION TO PRODUCE OXYGEN

1m^3=1000 liters of water
Volume = 75 cm (L) × 25 cm (W) × 122 cm (H) =228.75 liters of water

We filled up 200 litres of water to grow Algae 2KG of Sprulina Algae to produce 2.67 kg of Oxygen. To estimate how much oxygen (O_2) is produced by 2 kg of Spirulina algae, we can use the following formula based on photosynthesis efficiency:

Formula:

O2 produced = (C/Biomass ConversionFactor)×O2 Production Factor

Key Assumptions:

1. Photosynthesis Reaction:

$$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$$

For every 1 g of carbon fixed into biomass, roughly 2.67 g of O_2 is released.

2. Carbon Content in Spirulina:
   - Spirulina is ~50% carbon by dry weight.

3. Calculating Oxygen Production for 2 kg Spirulina:
   - Carbon in 2 kg Spirulina = 50% of 2000 g = 1000 g of carbon
   - O_2 produced = 1000 g × 2.67 g O_2/g carbon
   - O_2 produced ≈ 2670 g (or 2.67 kg) of oxygen

Final Formula:

$$O_2\ (kg) = 1.335 \times \text{Spirulina Mass (kg)}$$

So, for 2 kg of Spirulina, the oxygen produced would be:

$$1.335 \times 2 = 2.67 \text{ kg of } O_2$$

V. ANALYSIS

SWOT Analysis:

Strengths:

1. Renewable and Sustainable: Algae oxygen generators use algae, a renewable and sustainable resource, to produce oxygen.
2. Low Energy Requirements: Algae oxygen generators require minimal energy to operate, making them a cost-effective solution.
3. High Oxygen Production: Algae oxygen generators can produce high levels of oxygen, making them suitable for various applications.

Weaknesses:

1. High Initial Investment: Setting up an algae oxygen generator can require a high initial investment in equipment and infrastructure.
2. Limited Scalability: Algae oxygen generators can be difficult to scale up to meet large oxygen demands.
3. Dependence on Light: Algae oxygen generators require light to produce oxygen, which can limit their use in low-light environments.

Opportunities:

1. Growing Demand for Oxygen: The demand for oxygen is growing, particularly in industries such as healthcare and aerospace.
2. Increasing Focus on Sustainability: There is an increasing focus on sustainability and renewable energy, which could drive adoption of algae oxygen generators.

3. Government Incentives: Governments may offer incentives for companies and individuals to adopt sustainable technologies like algae oxygen generators.

Threats:

1. Competing Technologies: Other oxygen generation technologies, such as cryogenic distillation or pressure swing adsorption, may compete with algae oxygen generators.
2. Regulatory Challenges: The regulatory framework for algae oxygen generators may be unclear or lacking, which could create uncertainty and barriers to adoption.
3. Public Perception: Algae oxygen generators may be perceived as unconventional or unproven, which could affect public acceptance and adoption.

Cost-Benefit Analysis:

Benefits:

1. Renewable and Sustainable: Algae oxygen generators use algae, a renewable and sustainable resource, to produce oxygen.
2. Low Energy Requirements: Algae oxygen generators require minimal energy to operate, making them a cost-effective solution.
3. High Oxygen Production: Algae oxygen generators can produce high levels of oxygen, making them suitable for various applications.

Costs:

1. High Initial Investment: Setting up an algae oxygen generator can require a high initial investment in equipment and infrastructure.
2. Maintenance and Operating Costs: Algae oxygen generators require regular maintenance and have operating costs, such as energy and labor costs.
3. Limited Scalability: Algae oxygen generators can be difficult to scale up to meet large oxygen demands.

<u>RESULT</u>

Primary Results:

1. Oxygen Production: Algae oxygen generators produce oxygen as a byproduct of photosynthesis.
2. Carbon Sequestration: Algae oxygen generators sequester carbon dioxide from the atmosphere, reducing greenhouse gas emissions.
3. Air Purification: Algae oxygen generators purify the air by removing pollutants and toxins.

Secondary Results:

1. Improved Air Quality: Algae oxygen generators improve air quality, particularly in urban areas, enhancing the quality of life for residents.
2. Increased Food Security: Algae oxygen generators increase food security by providing a sustainable source of oxygen for aquaculture and agriculture.
3. Job Creation: Algae oxygen generators create jobs in the algae cultivation and harvesting industries.

Environmental Results:

1. Reduced Greenhouse Gas Emissions: Algae oxygen generators reduce greenhouse gas emissions by sequestering carbon dioxide.
2. Conserved Water Resources: Algae oxygen generators conserve water resources by using wastewater or seawater as a nutrient source.
3. Protected Biodiversity: Algae oxygen generators protect biodiversity by providing a habitat for algae and other aquatic organisms.

Economic Results:

1. Cost Savings: Algae oxygen generators can provide cost savings by reducing the need for traditional oxygen generation methods.
2. New Revenue Streams: Algae oxygen generators can create new revenue streams for companies and individuals involved in the algae industry.
3. Increased Property Values: Algae oxygen generators can increase property values by providing a sustainable and unique feature.

VI. CONCLUSION

In conclusion, the algae oxygen generator project has demonstrated the feasibility and potential of using algae to generate oxygen. The project has shown that algae can be used to produce oxygen through photosynthesis, and that this oxygen can be used to support various applications, including air purification, water treatment, and life support systems.

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