FORM 2

THE PATENTS ACT 1970

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THE PATENT RULES 2003

COMPLETE SPECIFICATION

(SEE SECTIONS 10 & RULE 13)

1. **TITLE OF THE INVENTION**

IOT BASED PHOTO BIOREACTOR

2. **APPLICANTS (S)**

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2. **PREAMBLE TO THE DESCRIPTION**

COMPLETE SPECIFICATION

The following specification particularly describes the invention and the manner in which it is to be performed

FIELD OF THE INVENTION

The present invention relates to an Internet-of-Things (IOT) based photo bioreactor (PBR) to provide the best possible light exposure to artificial photosynthetic algae in a controlled environment.

BACKGROUND OF THE INVENTION

In artificial Photosynthesis mechanism, algae produce biomass by reacting with light energy from LED lights and chlorophyll.

Photobioreactors for spirulina algae are chambers in which artificial photosynthesis is performed using an artificial light source and nutrients in a controlled environment. The spirulina algae absorb carbon dioxide and releases oxygen, improving biomass for a variety of purposes such as biofuel, fertilisers, and bio plastics.

In the existing art, there is a problem in measurement of carbon-di-oxide and PH. The present invention aims to provide a photo bioreactor (PBR) designed to solve the limitations of open systems. In the proposed PBR, evaporative cooling is used. Evaporative water losses and algal productivity are influenced by PBR design and climate as proposed in the present invention.

The present invention provides the solution to the existing problems by providing the proposed photo bioreactor with low harvesting cost, low evaporation loss and no contamination risk.

OBJECTS OF THE INVENTION

The main object of the present invention is to propose a photo bioreactor (PBR) to solve the limitations of open systems.

Another object of the present invention is to provide a photo bioreactor (PBR) where evaporative cooling is used.

Another object of the present invention is to provide a photo bioreactor (PBR) where evaporative water losses and algal productivity are influenced by PBR design and climate.

SUMMARY OF THE INVENTION

The present invention relates to a photo bioreactor (PBR) to grow micro plants like Spirulina using nutrients and artificial photosynthesis mechanism which resembles sunlight. The main function of photo bioreactor is to absorb carbon footprints and to convert into biodegradable/bio-fertilizer and also to increase the oxygen content. The development of energy-efficient microalgae growth systems is essential due to the great potential for algae-based products in a variety of applications like Carbon Neutral Technologies, Water and Effluent treatment technologies.

The proposed PBR is based on the Internet-of-Things (IoT) technology for parameter monitoring and control, allowing for remote operation of the entire system without any intervention.

In an aspect, the present invention involves artificial photosynthesis mechanism. The proposed invention provides enhancement of growth of algae and carbon neutrality.

BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS

The accompanying drawings are included to provide a further understanding of the present disclosure and are incorporated in and constitute a part of this specification. The drawings illustrate exemplary embodiments of the present disclosure and, together with the description, serve to explain the principles of the present disclosure.

Fig 1 illustrates the Isometric Front & Side View of cubical shaped Photobioreactor(1) where it includes liquid sensors like a Dissolved Oxygen sensor(2), TDS(Total

Dissolved Solids) Sensor(3), NPK (Nitrogen, Potassium and Phosphorous) Sensor(4), Turbidity Sensor(5), pH Sensor(6), and Lights(7) connected to the IoT Platform.

Fig 2 illustrates the. Isometric Top View of cubical shaped Photobioreactor(1) where it includes liquid sensors like Dissolved Oxygen sensor(2), TDS(Total Dissolved Solids) Sensor(3), NPK (Nitrogen, Potassium, and Phosphorous) Sensor(4), Turbidity Sensor(5), pH Sensor(6), and Lights(7) connected to the IoT Platform.

Fig 3 illustrates the Hardware architecture of the IoT system where all the liquid sensors are connected to the microcontroller.

Persons skilled in the art will appreciate that elements in the figures are illustrated for simplicity and clarity and may have not been drawn to scale. Throughout the drawings, it should be noted that reference numbers are used to depict the same or similar elements, features, and structures.

DETAIL DESCRIPTION OF THE PRESENT INVENTION WITH REFERENCE TO THE ACCOMPANYING DRAWINGS OF PREFERRED EMBODIMENTS

In the following description, numerous specific details are set for thin order to provide a thorough understanding of embodiments of the present disclosure. It will be apparent to one skilled in the art that embodiments of the present disclosure may be practiced without some of these specific details.

Features that are described and/ or illustrated with respect to one embodiment may be used in the same way or in a similar way in one or more other embodiments and/ or in combination with or instead of the features of the other embodiments.

The terms and words used in the following description and claims are not limited to the bibliographical meanings but are merely used to enable a clear and consistent understanding of the invention. Accordingly, it should be apparent to those skilled in the art that the following description of exemplary embodiments of the present invention are provided for illustration purpose only and not for the purpose of limiting the invention.

If the specification states a component or feature “may”, “can”, “could”, or “might” be included or have a characteristic, that particular component or feature is not required to be included or have the characteristic.

As used in the description herein and throughout the claims that follow, the meaning of “a,” “an,” and “the” includes plural reference unless the context clearly dictates otherwise. Also, as used in the description herein, the meaning of “in” includes “in” and “on” unless the context clearly dictates otherwise.

It should be emphasized that the equations used in the specification are only for computation purpose. The use of any and all examples, or exemplary language (e.g. “such as”) provided with respect to certain embodiments herein is intended merely to better illuminate the present disclosure and does not pose a limitation on the scope of the present disclosure otherwise claimed. No language in the specification should be construed as indicating any non-claimed element essential to the practice of the present disclosure.

The present invention aims to transform chemicals into biomass and carbon dioxide from the atmosphere into oxygen. The spirulina algae consume the pollutants from industrial waste and sewage, converting them into biofertilizers.

The photobioreactor (PBR) is a cuboidal tank that contains micro plant such as spirulina, kelp, and other species. LED light strips in multiple colors are installed around the tank's perimeter, where photosynthesis takes place. The photobioreactor receives external supplies of nutrients and carbon dioxide, which it uses to create biomass for the micro plant. To track the parameters such as pH, TDS (total dissolved salts), DO (dissolved oxygen), turbidity, and temperature of the micro plant, water sensors are submerged in the photobioreactor.

A microcontroller that uses an IoT platform to monitor and analyse the micro plant's parameters is connected to the sensors, which improves the micro plant's yield. The existing systems are open-to-air culture systems in which the light and carbon dioxide from the atmosphere reaches only the topmost layer of the system due to which it photosynthesizes only the topmost layer. Our Cuboidal photobioreactor uses an artificial photosynthesis mechanism that contains led lights around the cuboidal walls of the photobioreactor. The light energy released from the photobioreactor is sufficient enough for the photosynthesis of the micro-plant. In our system, the light energy reaches every cell of the micro plant for photosynthesis. This is one step where the yield is increased. Parallel to this the photobioreactor also consists of IoT-based sensors which monitor the parameters like Carbon-dioxide, Green density, Dissolved Oxygen, NPK etc. These sensors monitor the parameters in real-time and notify if there is a change in it. For example, the carbon dioxide level in the micro plant has decreased the sensor notifies the change using the cloud server then the carbon dioxide is supplied externally parallel to this NPK sensor also monitors the nutrient levels in the photobioreactor if there is any decrease in nutrients also supplied to it. This increases the Yield drastically as the Carbon-dioxide and nutrients are supplied to the micro plant in a timely manner.

The user can remotely monitor the parameters by logging in to the central server where the microcontroller's data is uploaded. It also alerts the user when nutrients and CO2 are needed. The quantification of artificial photosynthesis has been first time addressed.

Controlled environmental systems with artificial lighting have been considered to increase production capacity. Light-emitting diode (LED) technology advancements in recent years have huge potential to enhance plant growth and create more sustainable systems. The artificial lighting system will have to provide plants the energy and information they need to grow. To provide the continuous photosynthetic photon fluence required for high productivity, growth chambers frequently use LED lights for this purpose, especially those with enhanced blue and red spectra (i.e. cool

LED white lamps). LED light's spectrum and intensity, however, are not long-term constants. The novelty of the system is that the photobioreactor is under the control of the environment using IoT technology.

The photobioreactor also consists of IoT-based sensors which monitor the parameters like Carbon-dioxide, Green density, Dissolved Oxygen, NPK etc. These sensors monitor the parameters in real-time and notify if there is a change in it. For example, the carbon dioxide level in the micro plant has decreased the sensor notifies the change using the cloud server then the carbon dioxide is supplied externally parallel to this NPK sensor also monitors the nutrient levels in the photobioreactor if there is any decrease in nutrients also supplied to it. This helps the micro plant for better growth and yield in a controlled environment. The output of the algae can be controlled and predicted

The bulk data collected from the sensors for every parameter and the data collected from input parameters like nutrients and Carbon dioxide is being analysed for 2-3 months. The data sets are then sent to a Machine learning algorithm to train a model. The model predicts the growth rate of the algae by quantifying the nutrients and Carbon Dioxide. It also predicts the Required input for the micro plant for the Specific biomass. The proposed system occupies less space.

In interpreting both the specification and the claims, all terms should be interpreted in the broadest possible manner consistent with the context. In particular, the terms “comprises” and “comprising” should be interpreted as referring to elements, components, or steps in a non-exclusive manner, indicating that the referenced elements, components, or steps may be present, or utilized, or combined with other elements, components, or steps that are not expressly referenced.

The present disclosure is not limited to the described embodiments, versions or examples, which are included to enable a person having ordinary skill in the art to make and use the present disclosure when combined with information and knowledge available to the person having ordinary skill in the art and thus it is intended by the appended claims to cover all such modifications and adaptations which fall within the scope of the present subject matter.

ADVANTAGES OF THE INVENTION

- The main advantage of the present invention is that it provides a photo bioreactor with photosynthetic efficiency.
- Another advantage of the present invention is that it provides a photo bioreactor wherein the parameters are monitored through IOT.
- Another advantage of the present invention is that it involves cost effectiveness of algal growth.
- Yet another advantage of the present invention is that it gives high mechanical strength.
- Yet another advantage of the present invention is that it provides high durability or high resistance to weathering.
- Yet another advantage of the present invention is that it provides high translucence and chemical stability.
- Yet another advantage of the present invention is that it is cost effective and easy to maintain.

We claim:

- The Photobioreactor occupies less space than the open culture systems.
- The growth of algae can be predicted and controlled as per the user requirement
- The IoT based parameter monitoring of the photobioreactor increases the yield of the algae.
- The sunlight is completely replaced in a photobioreactor using artificial photosynthesis mechanism with led lights.
- The carbon emissions are neutralized in a photobioreactor through the process of photosynthesis and converted into oxygen.

ABSTRACTs

Photobioreactors for algae(micro-plant) are chambers in which artificial photosynthesis is performed using an artificial light source and nutrients in a controlled environment. The spirulina algae absorb carbon dioxide and releases oxygen, improving bio mass for a variety of purposes such as biofuel, fertilisers, and bio plastics.