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Integrated Smart Coco Peat Moisture-Controlled Drying and Compression System with Automated Density Regulation

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Abstract
Coco peat, which comes from the processing of coconut husks, has become increasingly important as a green and sustainable material for growing plants in modern farming and gardening. It is commonly used in seedling nurseries, hydroponic setups, and soil improvement because it holds water well, allows good air flow, and can break down naturally. However, the usual ways of processing coco peat often involve doing things by hand, like drying and pressing it into blocks. These manual methods can lead to problems such as uneven moisture levels, inconsistent block density, and lower quality products. These issues can make it harder to store, transport, and meet the standards needed for exporting to other countries. Because of this, there is a need for a more efficient and automated processing system to boost productivity and ensure a more uniform product. This study introduces an Integrated Smart Coco Peat Moisture Controlled Drying and Compression System with Automated Density Regulation. The goal is to improve the efficiency and consistency of processing coco peat. The system combines moisture sensing technology, controlled drying methods, and an automated compression unit all in one.. Depending on the moisture levels detected, the drying part of the system automatically adjusts heating and airflow to remove excess water and reach the right level of dryness. Here, a motor-driven hydraulic or mechanical press compacts the material into blocks of standard size. The system also has an automated density control feature that uses pressure feedback and control algorithms to keep the density consistent during compression. By combining sensing technology, automation, and controlled processing, The proposed system provides a scalable and affordable solution for the coco peat industry, making it possible to produce standardized products that are suitable for large-scale farming and export. In the end, this smart processing method supports the sustainable use of resources and brings technological progress to the processing of agricultural by-products.

***Keywords**: Coco Peat Processing, Moisture Control, Automated Drying, Density Regulation, Sensor-Based System.*

1. Introduction
Coco peat is a natural and eco-friendly material obtained from coconut husk, and it is widely used in agriculture, horticulture, and hydroponic farming. It has excellent water retention ability, good aeration properties, and supports healthy plant growth. Due to the increasing demand for sustainable farming practices, coco peat has become an important growing medium across the world. However, the raw coco peat collected after processing contains high moisture content and low density, which makes it

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difficult to store, transport, and use efficiently. In traditional methods, coco peat is dried using sunlight, which depends on weather conditions and takes a long time. This method also leads to uneven drying, contamination, and poor quality output. Similarly, manual or conventional compression techniques do not provide uniform density, resulting in inconsistency in packaging and reduced market value. These drawbacks create a need for a smart and efficient system that can automate the drying and compression process. To overcome these issues, this study proposes an Integrated Smart Coco Peat Moisture-Controlled Drying and Compression System with Automated Density Regulation. The system uses sensors to continuously monitor moisture and temperature levels, while a heating unit and blower help in controlled drying. A microcontroller processes the sensor data and controls the system automatically.In addition, a compression unit with pressure sensing mechanism is used to maintain uniform density of coco peat blocks. The system ensures better quality, reduces processing time, and minimizes human effort. By integrating drying and compression into a single automated system, the proposed model improves efficiency, reduces losses, and supports modern agricultural needs [1].

2. Methodology Of The System

Using smart sensors and a microcontroller, the suggested system combines automated compression of coco peat with moisture-controlled drying. A drying chamber is filled with raw coco peat, and temperature and moisture sensors are used to continuously check the conditions. To guarantee even drying, the microcontroller analyzes this data and uses a relay module to control the blower and heating element. The system stops drying and moves the material to the compression unit once the required moisture level is reached. The coco peat is compressed into blocks using a mechanical or hydraulic press. To maintain constant density, a load cell or pressure sensor keeps an eye on the applied force. This process guarantees uniform compression, effective drying, less manual labor, and higher-quality products.

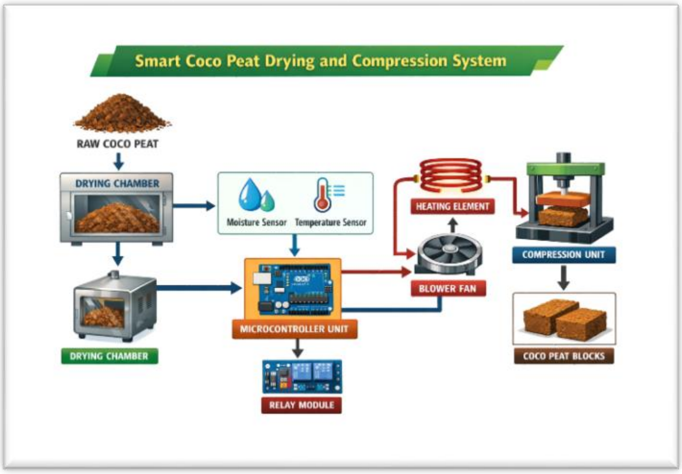

Figure 1 **Block diagram of the proposed smart coco peat Drying and compression system**

3. Design Of The System

3.1. Module for Sensing

Temperature and moisture sensors are included in this module to keep an eye on the drying conditions of the coco peat.

3.2. Module of Control

Relay circuits are used by an Arduino microcontroller to process sensor data and manage the system.

3.3. Module for Drying

For consistent moisture removal, it has a drying chamber, blower fan, and heating element.

3.4. Module for Compression

Coco peat is compressed into homogeneous blocks with a regulated density using a mechanical or hydraulic press with a load cell.

4. Working Principle Of The System

The suggested system's operation is predicated on using sensors and a microcontroller to continuously monitor and regulate the processing of coco peat. First, the drying chamber is filled with raw coco peat. The temperature and moisture content are continuously measured by the temperature and moisture sensors. The microcontroller receives these values and compares them to predetermined limits. The microcontroller uses a relay module to turn on the blower fan and heating element based on the sensor data. In order to effectively remove moisture, the blower evenly distributes hot air while the heating element generates heat.The system automatically halts the drying process when the required moisture level is attained. After being dried, the coco peat is moved to the compression unit, where it is compressed into blocks using a hydraulic press. To guarantee uniform density, a load cell keeps an eye on the applied pressure. The system improves product quality and offers a productive, automated process with little human intervention [2].

5. Hardware Components

The System consist of several hardware components and they are listed below

5.1.Sensor for Moisture

The moisture content of the coco peat is measured by this sensor.

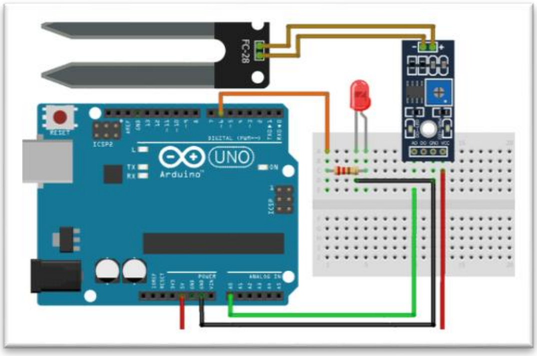

Figure 1 Sensor for moisture

5.2.Sensor of Temperature

To regulate the heating process, it keeps an eye on the temperature inside the drying chamber.

Figure 2 Sensor of Temperature

5.3.The Heating Component

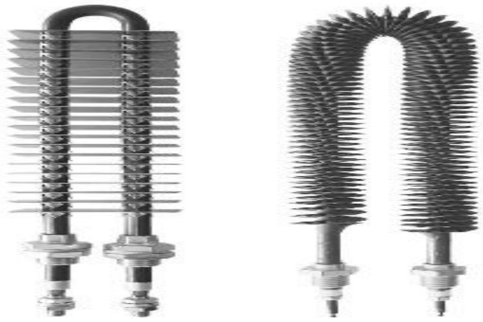

Figure 3 The Heating Component

It produces the heat needed to properly dry the coco peat.

5.4.Blower Fan

Figure 4 Blower Fan

The blower aids in the chamber's uniform hot air circulation.

5.5.Arduino microcontroller

It serves as the primary control unit, handling all operations and processing sensor data.

Figure 5 Arduino microcontroller

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5.6.Module for Relays

Figure 6 Module for Relays

used to turn the blower and heating element on and off in response to control signals [3].

5.7.Hydraulic/Mechanical Press Compression Unit

Figure 7 Hydraulic/Mechanical Press Compression Unit

5.8.Pressure Sensor/Load Cell

In order to guarantee a consistent block density, it measures the applied pressure.

Figure 8 Pressure Sensor/Load Cell

5.9.LCD Screen

shows data in real time, including temperature and moisture content.

5.10. Unit of Power Supply

Figure 10 Unit of Power Supply

supplies all system components with the necessary electrical power.

6. Results And Discussion

The suggested system's prototype was created and tested in various operating environments. The temperature sensor efficiently tracked the drying chamber conditions, and the moisture sensor precisely determined the moisture content of coco peat. In comparison to conventional techniques, the heating element and blower combined to provide uniform drying, lowering the moisture content in less time. In order to avoid overheating and material loss, the system automatically halted the drying process once the required moisture level was reached. The hydraulic press effectively produced homogeneous coco peat blocks during the compression stage. Uniform density was achieved by applying pressure consistently thanks to the load cell. The outcomes demonstrate that the integrated system increases product quality, decreases processing time, and improves drying efficiency. Additionally, automation reduced the amount of manual labor and guaranteed dependable and consistent performance all along the way.

Conclusion

The design and testing of the suggested Integrated Smart Coco Peat Moisture-Controlled Drying and Compression System with Automated Density Regulation went well. Using sensors and a

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microcontroller for real-time monitoring and control, the system successfully combines the drying and compression processes. While the heating element and blower provided consistent moisture removal, the temperature and moisture sensors guaranteed precise drying. The final coco peat blocks had a constant density thanks to the compression unit and the load cell. Both manual labor and process errors were decreased by the automated operation. According to experimental findings, the system outperforms conventional techniques in terms of efficiency, drying time reduction, and final product quality. All things considered, the suggested system provides a scalable, dependable, and affordable solution for contemporary coco peat processing industries.

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