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DNA Samples Processing Using Dry Block Heating System

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Abstract: ***The emerging studies and researches are based on the science platform of samples of DNA which need to perform various experiments for new findings in researches and their implementations. The analysis of DNA samples is carried out in various labs under controlled temperature environment. Barcoding lab and research facility provide barcoding training to researchers and facilities for them to work on their DNA samples and data generation. There is a necessity of maintaining the required temperature for specific amount of time which is favourable for experiment. A need of controlled environment for the various experiments is necessary for having the maximum accuracy in respective researches done with DNA samples. The controlled environment should have the desired specifications which are suitable for carrying out all multiple experiments on the samples which also should have an additional feature of continuously monitoring, controlling as well as agitating. There are many devices which perform same function but the major difference occurs is the cost. In this paper, we are proposing a dry block heating system which is a compact device which provides a wide range of temperature for the various applications carried out in DNA labs. The efficiency of such devices can be calculated according to the uniformity of temperature inside the chamber and the accuracy of the temperature sensor. A variable agitator provides continuous agitations to samples which avoids the formation of the precipitate during the heating of the samples. Micro-tubes are used which are crystal clear and hold the samples in it which are then processed in the device according to individual experiment. This device is mainly useful for the small scale industries which have low capital and can prove beneficial for new researchers.***

Keywords: DNA Processing, DNA Analysis, Barcoding

1. Introduction

In response and learning various developments in the field of science with different countries India is the one of the mega biodiversity hotspots with tremendous biological diversities and the mapping techniques. India being a diverse nation has many challenges in the field of science and the researches regarding the barcoding of DNA. DNA analysis consist of various techniques such as mapping, digitization, correct identification, etc. and applying universally accepted methods on their researches on DNA barcoding which is the need for the proper progress of our nation in this field. Dry block heaters are widely used in various labs as well as medical colleges and hospitals. There is always a demand for its new innovations and versions in the research market. In biology, dry block heater is a device used to grow and maintain microbiological cultures or cell cultures. The dry block heater maintains optimal temperature, humidity and other conditions. Dry block heaters are essential for a lot of experimental work in cell biology, microbiology and molecular biology and are used to culture both bacterial as well as eukaryotic cells. This paper presents the overview of Dry Block Heating System which is used in the DNA processing and other such experiments regarding the DNA samples.In any DNA analysis, the main challenge or the essential need of research is ofusing a correct design in order to ensure optimal results; an incorrect design could result in wrong sequences which may lead to vague process.

2. Present Techniques

There are plenty of Dry block heating systems available in the market in India as well as outside India. The places where dry block heaters are used are DNA labs, medical colleges, hospitals, pathology labs etc. dry block heaters are also used in the poultry industry to act as a substitute for hens. This often results in higher hatch rates due to the ability to control both temperature and humidity. Various brands of dry block heaters are commercially available to breeders.

The simplest dry block heaters are insulated boxes with an adjustable heater, typically going up to 60 to 65 °C (140 to 150 °F), though some can go slightly higher (generally to no more

than 100 °C). The most commonly used temperature both for bacteria such as the frequently used E. coli as well as for mammalian cells is approximately 37 °C, as these organisms grow well under such conditions. For other organisms used in biological experiments, such as the budding yeast Saccharomyces cerevisiae, a growth temperature of 30 °C is optimal.

3. Problems Involve in current systems

The current systems that are available in the market have a larger cost with low range of temperatures. Those industries that need higher ranges have to pay more for their desired system. They provide better efficiency at high cost. And the most important thing regarding the other systems is that they are uncomfortable when handling for longer time and are not compact. That makes it hard for the user to use it repeatedly.

4. Design of Dry Block Heating System

4.1 Overview

Dry block heating system is a chamber in which heating environment is created and controlled by microcontroller and also the chamber is continuously in moving state through a motor to avoid the formation of precipitate which may be formed in various experimentsand can cause formation of unwanted compound.

The heat is created by thermocouples which is working on the phenomenon of Peltier effect which states that when the current across the thermocouple (which comprises of two different metal surfaces) is varied then one metal become cold while the other gets heated up. The heating range is from 1°C to 100°C to remove excess heat an exhaust fan is connected to chamber.

The user should enter the desired temperature and the time for which the temperature should bemaintained. Sensors are attached inside the chamber for continuous monitoring of the temperature. Auto cut-off and buzzer are also provided. A safety covers with a transparent top so that the user can easily monitor the chamber throughout the process

The body of the chamber is always maintained at room temperature so as to avoid any injuries to the user. The heat transfer is also negligible as the Peltier transfers heat on when its surface is in contact.

4.2 Construction of Peltier Module

ThePeltier is the heart of the Dry block heating system as it provides the heating or cooling to the samples present in micro tubes kept on the surface of the Peltier via aluminium block.

The construction of Peltier module (thermoelectric module) consists of an array of Bismuth Telluride semiconductor pellets. They are doped so that one type of charge carrier is either positive or negative and carries the majority of current. The pairs of P/ N pellets in a Peltier module are connected in such a way that they are connected electrically in series, but thermally in parallel. Metalized ceramic substrate provides the platform for the pellets and the small conductive tabs that connect them.

A Peltier element consists of a pair of p-type and n-type semiconductor elements bonded together with a metal electrode. An electric current flows from the n-type to the p-type semiconductor when a DC voltage is applied as the flow of current from anode to cathode, whereby for the p-type semiconductor heat transfers in the direction reverse to the flow of current, while for the n-type in the forward direction, thereby the heat is absorbed at the upper electrode where the current flows from the n-type to the p-type, making the metal electrode a heat absorber. This process is a kind of heat pump, and can constitute a very effective cooling system in case the heat-dissipating side can sufficiently dissipate the heat.

A thermoelectric cooler is a special type of semiconductor that functions as a heat pump. By applying a low-voltage, high-current, DC power source, heat will be moved in the direction of the current (+ to –). The heat is pumped from one side of the module to the other, so that one face will be cold while the opposite face will be heated, and the effect is reversible. This is also known as the Peltier Effect.

Peltier Effect is the phenomenon used in the thermoelectric refrigeration, with the rate of reversible heat absorption. When current passes through the junction of the two different types of conductors, it results in a temperature change. The Peltier module is made of with nickel-plated copper conductors to electrically connect the thermoelectric pellets with each other. The copper diffuses into the thermoelectric material which will decrease the performance of the system and so to avoid this, a plating of nickel acts as a barrier to copper.

Thermoelectric systems are highly reliable provided they are installed and used in an appropriate manner. The specific reliability of thermoelectric coolers tends to be difficult to define though because failure rates are highly dependent upon the particular application. Thermoelectric modules that are at steady state (constant power, heat load, temperature, etc.) can have mean time between failures (MTBFs) in excess of 200,000 hours. However, applications involving thermal cycling show significantly worse MTBFs, especially when TE coolers are cycled up to a high temperature. With thermal cycling, a more appropriate measure of reliability is not time but rather number of cycles.

4.3 Advantages

Thermoelectric modules have no moving parts and do not require the use of chlorofluorocarbons. Therefore they are safe for the environment, inherently reliable, and virtually maintenance free. They can be operated in any orientation and are ideal for cooling devices that might be sensitive to mechanical vibration. Their compact size also makes them ideal for applications that are size or weight limited where even the smallest compressor would have excess capacity. Their ability to heat and cool by a simple reversal of current flow is useful for applications where both heating and cooling is necessary or where precise temperature control is critical.

Thermoelectric coolers are used for the most demanding industries such as medical, laboratory, aerospace, semiconductor, telecom, industrial, and consumer. Uses range from simple food and beverage coolers for an afternoon picnic to extremely sophisticated temperature control systems in missiles and space vehicles.

Dry block heating system permits lowering the temperature of an object below ambient as well as stabilizing the

temperature of objects above ambient temperatures. A thermoelectric cooler is different from a heat sink because it provides active cooling unlike a heat sink which provides only passive cooling.

4.4 Disadvantages

1. As the heat load increases, the advantages that thermoelectric cooling offer in comparison to compressor systems diminishes. When evaluating on the basis of heat load alone, a compressor system will likely be more cost effective when the heat load is greater than approximately 200 W.
2. Moisture should not be allowed to enter the inside of a thermoelectric module in order to prevent both a reduction in cooling performance and the possible corrosion of module materials.

4.5 Applications

The Dry block heating system can perform various experiments in the field of science for example DNA extractions, DNA analysis, Melting point determination, Boiling point determination, Immunoassays, Enzyme reactions, Enzymatic processes, Enzyme activity studies, In situ hybridization, Blood-urea-nitrogen determinations, Nucleic acid hybridization, Coagulation studies, Biochemical processes, Incubation and activation of cultures, Blood examinations, Fertile ground processing, Restriction digest and Denaturation.The Peltier module developed is large-sized and high-powered as well as provided with sufficient durability against rapid cooling and heatingoperations besides on-off control, it is applicable to a wide range of applications. It is expected that the module will expand its application fields taking advantage of such features.

5. Conclusion

Dry block heaters today play a vital role in all the researches done in branches on Biology field like Vertebrates, Land Plants, Fungi, Human and Veterinary Pathogens and Zoonoses, Agricultural and Forestry Pests and their Parasitoids, Pollinators, Fresh Water Bio-Surveillance, Marine Bio-Surveillance, Terrestrial Bio-Surveillance etc.,

It is possible to remove more heat than the amount of power input it takes to move that heat. It passes energy (heat/cool) only when it is in contact with the material avoiding air gap. Thus, the system can obtain the desired output with maximum accuracy and efficiency by using a Peltier device the only factor that is to be considering while building this system is the cost, which will increase according to the size of the system.

6. Future Scope

Preparing the same system with low cost and to reduce the rise and fall time of temperature with more wide scale of temperature.

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