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Design and Development of Furnace for Carbon to Be Used In Supercapacitor

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Abstract— Increasing demand for energy requirement has attracted considerable attention among researchers to develop efficient energy storage. One of the energy storage devices is supercapacitor, has great potential for it's capability to deliver more power than batteries and store more energy than conventional capacitor. For making such Supercapacitors various types of carbon materials like activated carbon, carbon nanotubes, carbon aerogel, carbon derived carbon, graphite, etc are use as a electrode material. To produce this type of carbon special furnaces are required. This furnace has it's own parameters in terms of pressure, temperature, weight, power, dimensions. So it was decided to develop new kind of furnace which can make high quality carbon for energy storage devices such as mainly used for supercapacitor.
Keywords— super capacitor, furnace, energy storage devices.

I. INTRODUCTION

Supercapacitor, is also known as electric double layer capacitor and it is used as energy storage device. The widely used electrode material for supercapacitor are carbon aerogel, carbon derived carbon, carbon nanotubes, etc. Out of these carbon materials, carbon aerogel is highly ultralight material which is obtained from organic gel.To produce this type of carbon special furnaces are required. These furnaces has their own parameters in terms of pressure, temperature, weight, power, dimensions, etc. Conventional furnaces having some issues like, it doesn't fill full inert gasses because of porous gaps developed in the furnaces. As well as it unable to sustain high temperature and high pressure condition. Thus conventional furnaces which are used in labs that are not suitable for producing carbon to be used in Supercapacitor. So this issue is addressed for developing a new kind of furnace suitable for making a carbon for Supercapacitor.

Furnace is equipment to heat material to change their shape like rolling and to change the properties of material. On the basis of generating heat furnace is classified into two types i) Combustion (fuel) type, ii) Electric type. Furnace should be designed in such a way to his goal consume less fuel or electricity and heat as much material as possible in requiring less labour cost. Nowadays, new kind of carbons are producing from biomass such as Jackfruit, Ashoka tree, Neem tree, etc. For this experimentation furnace of high pressure is required in which high temperature is under controlled atmospheric condition. To achieve this goal it was decided to develop electric type cylindrical furnace which can make high quality carbon for energy storage devices such as mainly for Supercapacitor.

This paper is organised as follows : section II deals with characteristics and properties of carbon aerogel. Section III is about development of furnace for Carbon Aerogel. Section IV is about application of developed furnace.

II. CHARACTERISTICS AND PROPERTIES OF CARBON AEROGEL

Biomass is a renewable resource that provided abundant supply supply of waste materials such as empty fruit branch (EFB), wood chips, and bamboo. These waste material traditionally used for the production of charcoals. On the other hand, there is future scope in development of carbon which is produced from plant waste material to make various types of carbons. Carbon materials having highly porous structure such as activated carbon, coke and charcoal are produced by pyrolysis. Pyrolysis is carried out in the muffle furnace which is operated at high pressure and temperature under inert gas atmosphere. Carbon Aerogels are formed from organic gel by pyrolysis method in inert atmosphere. So this issue is addressed for developing a new kind of furnace suitable for making carbon for supercapacitors.

Aerogel is highly porous as well as ultralight material which is derived from gel, in which liquid component of gel has been replaced with gas. Carbon Aerogel have very high porosity surface area ranging 400-1000 m^2/g. They are manufactured from resorcinol – formaldehyde using pyrolysis method. Depending on the density, Carbon Aerogel may be electrically conductive, making composite aerogel paper useful for electrodes in capacitor or deionization electrodes. Due to their extremely high surface

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area, Carbon Aerogel are used to develop supercapacitors, with values ranging upto thousands of farads based on a capacitance density of 104 F/g and 77 F/ cm^3.

III.DEVELOPMENT OF FURNACE

Formation of Carbon Aerogel is carried out in the muffle furnace in the N_2 filled atmosphere. Here this kind of muffle furnace is developed under the guidance of "Madhav Capacitor Pvt. Ltd. Pune". Principle components of this furnace and their importance in the formation of Carbon Aerogel is as follows.

A. Furnace Cylinder

A device which is used for high temperature heating is known as Furnace. Furnace is a device that provides heat to the inner surface of the furnace cylinder through the inert atmosphere. Efficiency of modern furnaces is upto 98% and it is operated without chimney. By taking into consideration of requirement of furnace thermal enclosure of the furnace is designed and constructed. Furnace cylinder is made up with Metal Sheet material having 18 inch guage. Height of the cylinder is 450 mm excluding dishend. With dishend height of the cylinder is 650 mm and inner diameter is 435 mm.

B. Flange

A Flange is an external or internal rim for strength. Flange is also made up with Metal Sheet material having 20 mm thickness and also there is provision for groove to suit thick rope of 12 mm diameter.

C. Pressure Guage

There are various techniques developed for the measurement of pressure and vaccum. Instrument which is used for the measurement of pressure is known as pressure guage. A vaccum guage is used to measure the pressure in vaccum. Carbon aerogel is formed carbon cluster at 2-2.5 atmospheric pressure. Pressure guage is fitted on the top of dishend. Pressure guage having rating 20 PSI.

D. Safety Valve

Safety valve is used for the safety of the furnace from excessive pressure in the furnace cylinder. Safety valve could be a pressure relief valve releases a substance automatically from which the furnace cylinder, when the pressure or temperature exceeds present limits. For avoiding the excessive pressure in the furnace thermometer is fitted on the top of furnace.

E. Thermometer

A device which is used for the measurement of temperature is known as thermometer. A thermometer has two main parts, temperature sensor in which some physical change occours with temprature. Measurement of temperature of the furnace is carried out using thermometer which is fitted on the top of the furnace.

F. Heating Element

A ceramic heater as consumer product is a space heaters that generates heat using a heating element of positive temperature coeficient. This furnace is heated with ceramic heaters. Each heaters has rating of 1500 Watt. Total 9 heaters are connected in star manner for getting 500-600 ^{0}C temperature of the furnace.

G. Insulation Covering

For avoiding the heat goes in the environment insulation is required, for this ceramic covering is provided at the outside of the cylinder of the furnace.

H. Instrumentation and Control

Furnace is equipped with control panel for controlling the temperature of the furnace.

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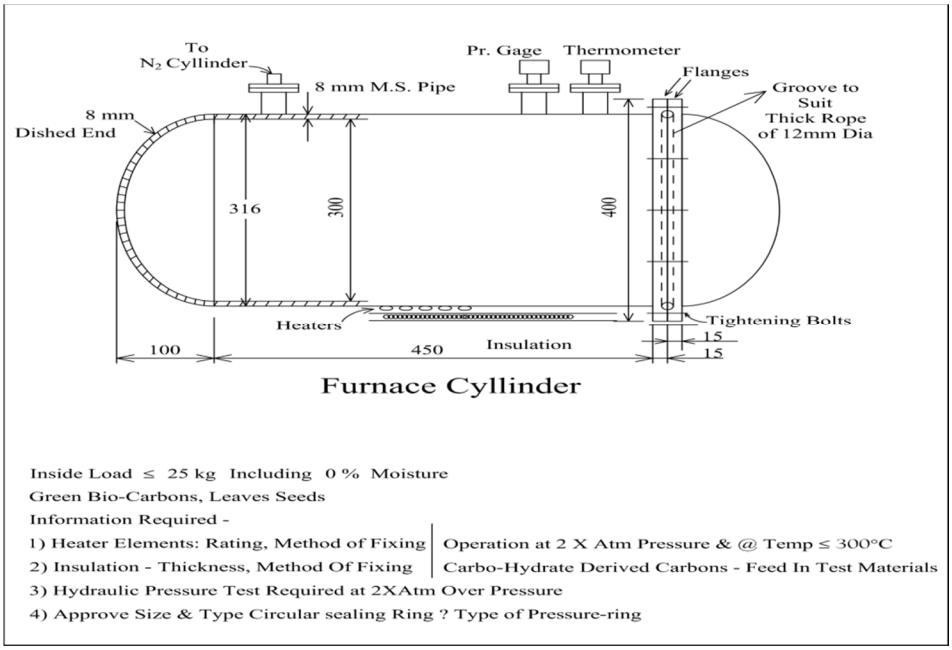


Fig 1. Furnace of Cylinder

IV. APPLICATION

The carbon which are producing from this furnace is used for making Supercapacitor. Supercapacitors are used for power back up in UPS application. If supercapacitor combine with battery then uninterruptible power supply system can be developed and also life span of batteries can be extended. Electrodes are made up by porous carbon which are used for making electrode assembly. By using these electrode assembly, brakish water can be converted into normal water by capacitive deionization method. This water can be used for agricultural purpose. Capacitive deionization uses electric generation, teherby wiping off chances for the need to handle chemical waste streams. Also by using this furnace carbon can make from waste materials like empty fruit branch, wood chips, bamboo, ashoka trees, neem trees,etc.

V. CONCLUSIONS

The electrode material used for supercapacitor are activated carbon, carbon nanotubes, carbon aerogel, carbon derived carbon, graphite. These electrode materials having properties like highly porous, high surface area, high electric conductivity, low cost, etc. Such type of carbon is developed by heating process at various atmospheric pressure under controlled environment. For this special furnace is required, conventional furnaces are not useful for making such types of carbons. So in this presented paper describes development of furnace fully and it can be used for making Supercapacitor, batteries, water filters, furtilizers, etc.

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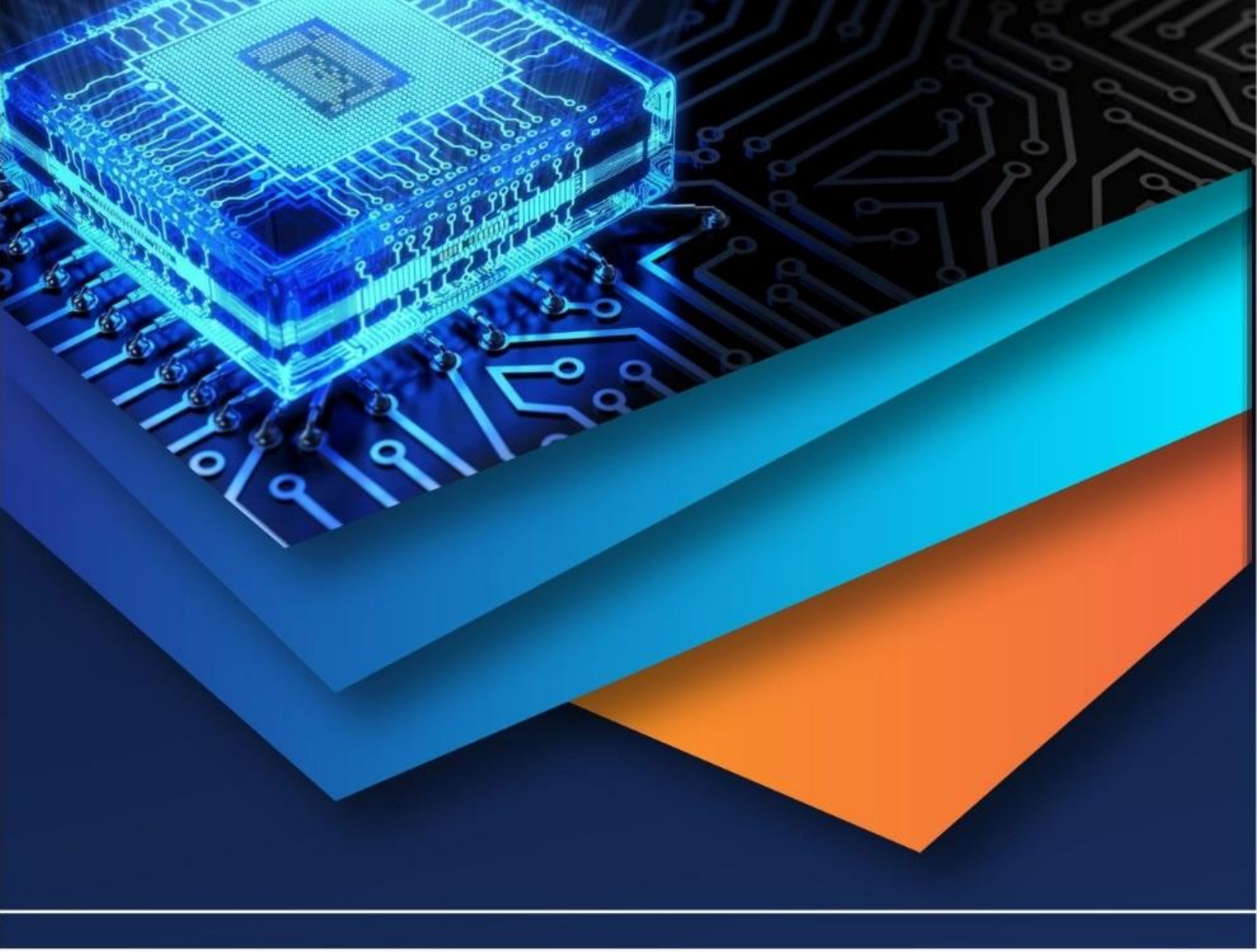
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