Investigation on Thermal Properties of Natural Composites for Thermal Insulation

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Abstract— The environmental issues are gaining an increasing interest worldwide. The world's population is much more aware of the importance of sustainability and the need for a proper conduct to protect the environment .The evaluation of thermal properties of new materials is quite important. For several of their engineering applications in microscopic or macroscopic structures for instance, we need to know how they are able to dissipate heat. This is because natural fiber composites have low weight, density, and cost. They have low zero toxin rating easy to reuse and dispose with significant health benefits. This work investigates the thermal insulation properties of agricultural waste made into composites. The same is true for those systems suitable for the recover or storage of energy. Besides this necessity of measuring the thermal properties of new component materials, the study and development of relevant experimental methods is quite important for researchers and students of engineering too. Here then, we propose a method that allows the students to have an experimental approach to the problem of thermal transport.

Key words: Natural Composite Material, Agricultural Waste, Thermal Conductivity, Thermal Resistivity

I. INTRODUCTION

A composite material is a material made from two or more constituent materials with significantly different physical or chemical properties that, when combined, produce a material with characteristics different from individual components. Energy demand in building can be significantly reduced with the use of thermal insulation. The use of thermal insulation in walls and roofs can reduce the demand for air conditioning thereby reducing the cost of cooling and pollution of the environment. The evaluation of thermal properties of new materials is quite important. For several of their engineering applications in microscopic or macroscopic structures for instance, we need to know how they are able to dissipate heat. The same is true for those systems suitable for the recover or storage of energy. Besides this necessity of measuring the thermal properties of new component materials, the study and development of relevant experimental methods is quite important for researchers and students of engineering too. Here then, we propose a method that allows to have an experimental approach to the problem of thermal transport.

II. OBJECTIVES OF PAPER

Investigation on following thermal properties of natural composites for thermal insulation

1) Thermal conductivity (K)
2) Thermal resistivity (r)

III. PROBLEM STATEMENT

To reduce cost of thermal insulating material by using the agricultural waste (Rice Husk, Bagasse and Corncob) as natural composite thermal insulating material.

IV. MATERIAL USED

The material used in this study are agricultural wastes which are Rice Husk, Bagasse and Corncob as shown in figure respectively

Fig. 4.1: Material used before Processing Rice husk, Bagasse, Corncob

V. METHODOLOGY FOR COMPOSITE MATERIAL

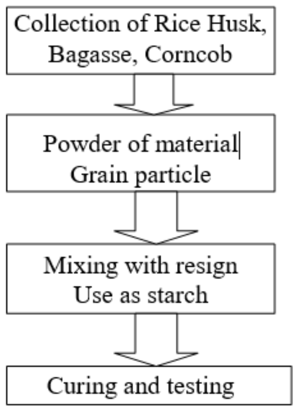

Fig. 5.1: Block diagram of methodology of composite material

VI. MATERIAL PREPARATION

The material used in this study are rice husk, bagasse and corncob as shown in fig 4.1. This material converted into grain size by using mixer grinder as shown fig 6.1

Fig. 6.1: Materials after Processing Rice Husk, Bagasse and Corncob

VII. PREPARATION OF NATURAL COMPOSITE MATERIALS

Twelve sample of the materials were prepared as shown in table 7.1. All Samples are mixing of the materials in different percentage.

Sample no	Rice Husk	Bagasse	Corncob	Starch
1	40	20	-	40
2	20	20	20	20
3	60	-	-	40
4	20	-	40	40
5	-	60	-	40
6	-	20	40	40
7	-	40	20	40
8	40	-	20	40
9	-	-	60	40
10	20	40	-	40
11	30	30	-	40
12	20	20	-	60

Table 1:

The samples were prepared into cylindrical shape of thickness (t), radius(R), volume (V).

$$V = \pi R^2 t \ (m^3)$$

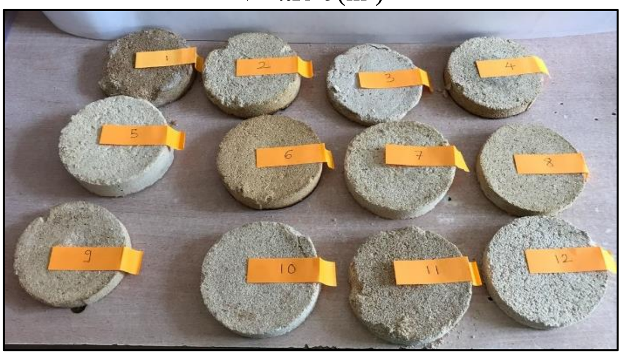

Fig. 7.1: Sample with Different Composites

VIII. DETERMINATION OF THERMAL INSULATION PROPERTY

A. *Determine of Sample Density*

$$\text{Density} = \frac{\text{Mass (Kg)}}{\text{Volume } (m^3)}$$

B. *Determination of Percentage Moisture Content*

Moisture content (g) = wet weight (W_1) – Dry weight (W_2)

$$\text{Percentage of moisture content} = \frac{\text{Moisture content}}{\text{Wet weight}} \times 100$$

C. *Determination of Thermal Conductivity*

Determination of any material for thermal conductivity (K) is measurement of effeteness in conducting heat (7). The method is based on the principle of hot wire in which a heat pulse is supplied to the sample and the increase in temperature recorded by thermocouple. Type K thermocouple was connected to cold and hot ends of the specimen as well as the center to measure the temperature.

The thermocouple was connected to 1200 watt heat source, and inserted into the sample at the middle. The temperature was recorded at 30 second intervals and the total time used per sample was 5 minutes. The thermal conductivity was obtained by Equation

$$Q = \frac{KA\Delta T}{\Delta L}$$

Where, K is the thermal conductivity (w/m/k), A is the cross-sectional area of the sample (m^2), ΔL is the distance between the two wires of the thermocouple, ΔT is the temperature (k) And Q is the quantity of heat supplied (Watt).

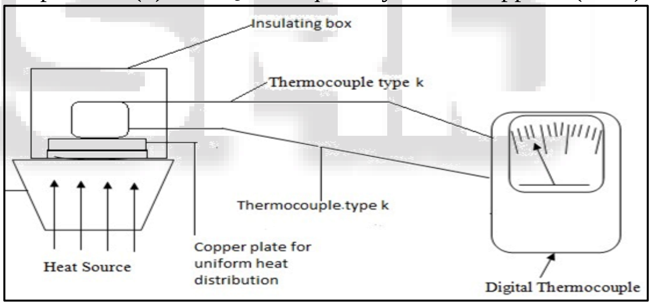

Fig. 8.1: Schematic Diagram of Experimental Setup

Fig. 8.2: Experimental Setup

D. *Determination of Thermal Resistivity*

The resistance of material to flow of heat is thermal resistivity (7). The equation of thermal resistivity is

Thermal resistivity = k^{-1} (mK/W)

IX. OBSERVATION & GRAPH

Here we calculate thermal conductivity & thermal resistivity. We also plot the graph of thermal conductivity and thermal resistivity in various sample.

A. Graph

1) Thermal Conductivity of Each Sample

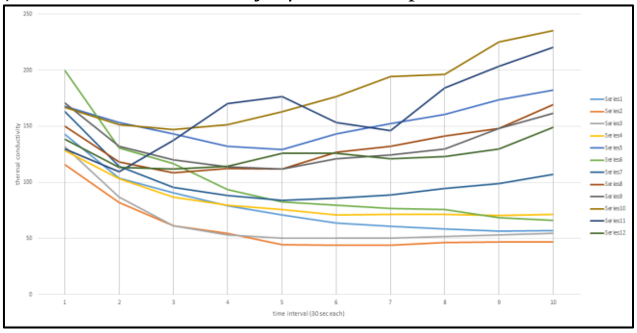

Fig. 9.1: Thermal Conductivity V/S Time

2) Thermal Conductivity of Each Sample

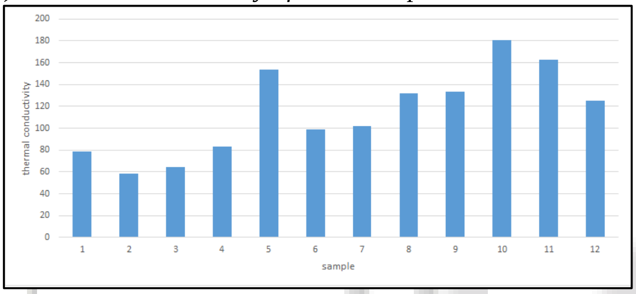

Fig. 9.2: Thermal Conductivity of Samples

3) Thermal Resistivity of Each Sample

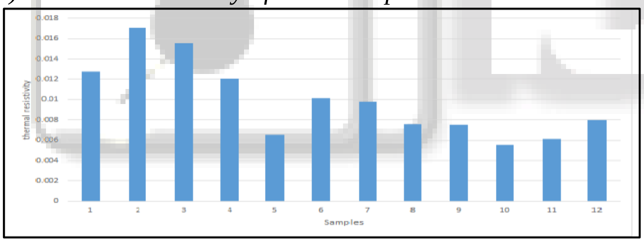

Fig. 9.3: Thermal Resistivity of Sample

X. RESULTS

Sample no	Thermal conductivity	Thermal resistivity
1	78.3112	0.01277
2	58.6152	0.01706
3	64.2350	0.01556
4	82.9045	0.01206
5	153.6731	0.00650
6	98.8655	0.01012
7	101.9653	0.0981
8	131.8455	0.00759
9	133.3414	0.00750
10	180.5044	0.00554
11	162.8111	0.00614
12	125.2343	0.00798

Table 2:

XI. CONCLUSION

From the graph of thermal conductivity, we can conclude that the thermal conductivity of sample no. 5 (20%R+ 40%B+ 40 %S) is maximum and sample no. 2 (20%R+20%B+20%C+ 40%S) is minimum. Thermal resistivity is reciprocal of thermal conductivity. So results of thermal resistivity of samples is opposite to thermal conductivity.

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