

Thermal Analysis of Composites to evaluate different properties

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ABSTRACT

The thermal properties of some Agricultural waste (Rice Husk, Bagasse and Corncob) was investigated with the purpose of determining their use as insulators. Using varied composite percentages of each sample wastes at increasing and decreasing quantities to determine best mixtures has assisted in accurate recommendation. The work has explored the potentials for using composite samples of Rice Husk, Bagasse and Corncob as materials for thermal insulation, a solution which offers a reduction in resource use, promote recycle of the wastes, less dependent on toxic chemical types in wood/cellulose based insulators, in addition to reducing energy consumed by altering internal air conditions. The criteria for evaluation include experimental determination of Thermal Conductivities and Specific Heat Capacities for composites samples and other dependable properties.

1. 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. For quite some time many buildings seem not to be habitable due to the uncontrollable environment conditions. Hence the use of artificial air conditioning and the need for cheaper, faster cooling condition around oneself has becomes a necessity. 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 the students to have an experimental approach to the problem of thermal transport.

2. Motivation

The use of inorganic insulating materials may be harmful to human health and body and causes environmental pollution. (Liang and Ho, 2007). The production of these materials will require high energy consumption and the eventual disposal can cause environmental hazard (Panyakaew and Fotios, 2008). Common thermal insulators are fiberglass, rock wool and mineral wool, but they are environmentally hazardous. The small particles from fiber glass and glass wool insulation can cause health hazard and respiratory or skin irritant (OSHA, 2003) most thermal insulation baths contain formaldehyde resin that can cause

asthma (US EPA 2000) cellulose insulation with toxic, fire-retarding chemicals like boric acid have been identified as having the potential for significant health effects (OSHA,1999).

Agricultural wastes such as rice hulls, sugarcane stalks, corn cob have high degree of fibrous content (lingo-cellulosic compound) and can serve as the main ingredient for composite materials making them suitable for manufacturing boards or panels. Bagasse can be made into soft bearch, medium density hardboard or particle boards as well as high density hardboards (26) The aim of this research is to investigate the potential of agricultural waste as thermal insulation materials. An easy way to comply with the conference paper formatting requirements is to use this document as a template and simply type your text into it.

3. Objectives

The investigation of following thermal properties of agricultural waste as thermal insulating material.

- 1) Thermal conductivity
- 2) Specific heat capacity
- 3) Thermal diffusivity

4. Problem Definition

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

5. Methodology

The methodology adapted for the testing of the natural composites is as follows.

1. Collection of Rice Husk Baggas and corncob.
2. Making of powder of the raw materials
3. Mixing with resign such as Starch.
4. Making of mould.
5. Apply load to make specimen compact.
6. Cut the specimen.
7. Test the specimens.

6. Sample Preparation

Samples are prepared as per the methodology by using different composition percentage of materials. The samples were prepared into cylindrical shapes of thickness (t), radius (R) and volume, V given by Equation 1.

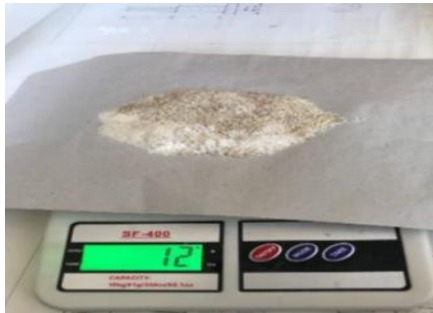


Figure 1: Sample preparation in various %



Figure 2: Samples having different compositions

Table 1 Sample designation

No. Samples	Materials
1	A Rice Husk
2	B <u>Bagasse</u>
3	C Comcob
4	D Rice Husk + <u>Bagasse</u>
5	E Rice Husk + Comcob
6	F Rice Husk + <u>Bagasse</u> + Comcob

S/NO	Samples	Rice husk	<u>Bagasse</u>	Comcob
1	A	100%		
2	B		100%	
3	C			100%
4	D1	70%	30%	-
5	D2	50%	50%	-
6	D3	30%	70%	-
7	E1	70%	-	30%
8	E2	50%	-	50%
9	E3	30%	-	70%
10	F1	50%	40%	10%
11	F2	50%	10%	40%
12	F3	50%	30%	20%

SAMPLE	WET WIEG HT (g) W1	DRY WEIGH T (g) W2	%OF MOISTURE CONTENT	VOLUME (m ³)	DRY DENSITY(kg/m ³)	WET DENSITY(kg/m ³)
A (100%R)	41.6	25.7	38.22115385	0.00003768	69.52695698	112.5416891
B (100% B)	46.3	21.9	52.69978402	0.00005275	42.31907609	89.46909695
C (100% C)	38.8	21.1	45.6185567	0.00004019	53.51479058	98.40634475
D1 (70R+30B)	54.9	29.2	46.81238616	0.00005526	53.8606423	101.2653857
D2 (50R+50B)	49.4	22.4	54.65587045	0.00005024	45.4495283	100.2324419
D3 (30R+70B)	49.8	28.2	43.37349398	0.00005275	54.49305689	96.23241961
E1 (70R+30C)	46.4	26.7	42.45689655	0.00004396	61.91338804	107.5948017
E2 (50R+50C)	42.6	19.4	54.4600939	0.00003391	58.31487097	128.0522424
E3 (70C+30R)	50.8	25.1	50.59055118	0.00004270	59.91508195	121.2623969
F1 (33R+33B+33C)	48.1	23.5	51.14345114	0.00005777	41.4621085	84.86499655
F2 (50R+10B+40C)	48.3	22.3	53.83022774	0.00005652	40.21922544	87.11159591
F3 (50R+30B+20C)	50.8	25.1	50.59055118	0.00005652	45.26917303	91.62047768

7. Determination of Thermal Conductivity

The thermal conductivity (κ) of any material is a measure of its effectiveness in conducting heat. Thermal conductivity was determined using heat transfer from the heat source to the sample. Prior to the determination of thermal conductivity, thermal history of individual material was determined. The thermal conductivity tests was conducted in line with the thermal properties of the materials were established using steady-state, one-dimensional condition. 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 centre 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

Where, K is the thermal conductivity (w/m/k), A is the cross-sectional area of the sample (m²), 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).

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

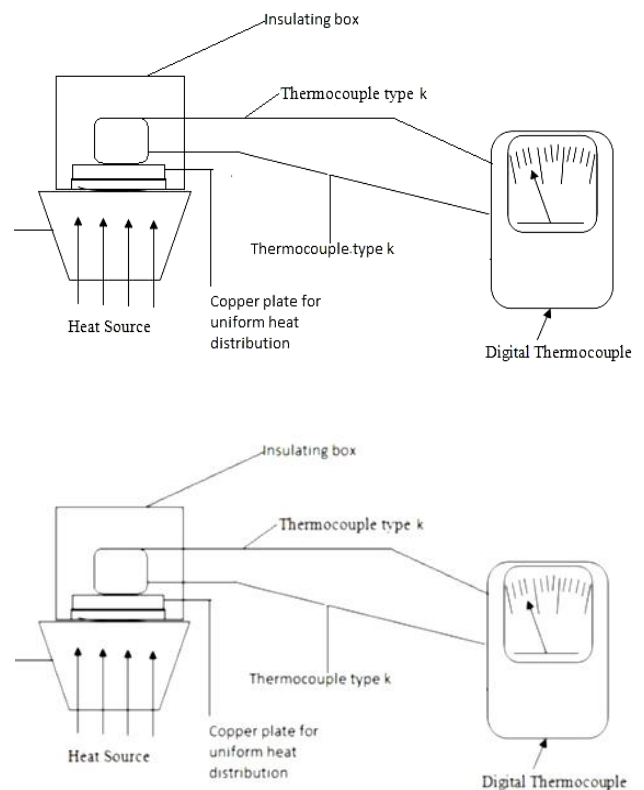


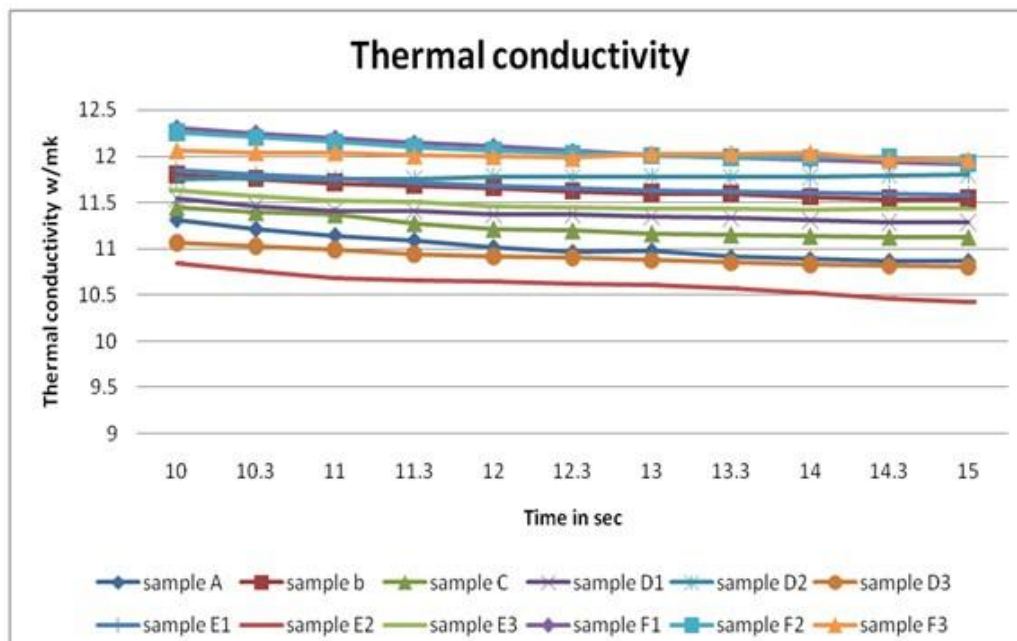
Fig3: Schematic Diagram of Experimental Setup

8. Results and Discussion

The characteristics of thermal conductivity of rice husk given in table. As a result of the loose fibrous nature of rice husk that enhances its conductivity. It is likely that due to uneven nature of the condensed strands that exist in Bagasse resulted in its fair conductivity properties. The properties exhibited by the Corncob were likely to be responsible for its laminated uncondensed fibre that naturally exists. Rice husk with Bagasse has the properties of a loose fibrous nature, coupled with condensed strands that make the material have a fairly stable temperature compared to the other materials For the thermal diffusivity properties fig no 5.3, other than rice husk with bagasse that has a low diffusivity primarily due to its loose woolly structure, other base materials exhibited same trends in their diffusivity. The thermal resistivity indicates

that rice husk with bagasse and corncob has the least resistivity against rice husk with Bagasse, which has a high resistivity among the other materials.

Thermal resistivity is the inverse of thermal conductivity (i.e. at low conductivity there is a corresponding high resistivity). It is observed that Samples D3, E2 have the highest thermal resistivity values in their respective categories, revealing that they have high resistance to heat, which implies that they respond to heat flow slowly. Thermal diffusivity of the samples was obtained by using the slope of the plot of change in temperature against the inverse of time. The diffusivity was obtained which shows that all the samples have low temperature response to heat pulse and the behavior makes them suitable as lagging materials.



9. Conclusion

The following conclusions were drawn from the investigation of thermal insulation properties of biomass composites:

- 1) Rice husk works better (good thermal insulator) when combined with Corncob and at a percentage of 50%.
- 2) The particle size of Rice husk and that of Bagasse helps reduce heat flow, hence they serve as good thermal resistance materials;
- 3) All the samples investigated in this work can withstand a medium temperature range
- 4) of 31oC to 120oC.
- 5) Sample E2 (50%R+50%C), Sample D3(30%R+70%B), can be used for a high temperature application range of above 90oC.

The bases for recommendation as substitute or replacement are considered under these three key qualities. They are resources availability, physical properties, and environmental impacts when using these waste considered (Rice husk, Bagasse and Corncob). The used of these material reduces the risk of environmental pollution. Also we have been able to show that these wastes can be used for the production of panels or broad sheet of required thickness for used as walling materials or thermal resistant materials.

In proving that all samples passed each tests and recommended ranges, it shows that it favors insulation materials for naturally cooled design in sub/tropical region

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