Study of Some Thermal Properties of Insulating Bricks Made from Agricultural Waste

Waghmare Dharaji Uttamrao
PG Student
Department of Mechanical Engineering
Matoshri Pratishthan Group of Institutions, School of Engineering Nanded, India

P. Swaminadhan
Assistant Professor
Department of Mechanical Engineering
Matoshri Pratishthan Group of Institutions, School of Engineering Nanded, India

Abstract

There is a trend in India for the design of dwellings to move away from the traditional, climate responsive architecture towards a style influenced by western architecture. This trend means that buildings are less able to control the internal environment to comfortable conditions without mechanical air conditioning. One technique for reducing the scale of air conditioning is to apply thermal insulation in walls and roofs. Today world is facing challenge of energy crisis. There are many ways of heat energy wastage in the form of heat in heat transfer applications. It is require recovering these waste heats by some means. The present study includes experimental investigation for heat transfer in fire bricks, saving heat energy and increase efficiency of furnace. From experimental data, analysis and comparison of result with industrial fire brick has done. Experimental result of heat transfer rate from fire bricks is compared to thermal analysis. Overall this investigation concludes to saving the heat transfer rate by using agricultural waste.
Keywords: Wastage, Recover, Increase, Transfer, Energy

I. INTRODUCTION

India is one of the agricultural country which produce large amount of by product from agriculture but its fact that large amount of agricultural waste is still not use in proper way. In this project mainly focus on by product of rice husk, pigeon pea, wood and sugarcane bagasse, coconut fiber. Project mainly accommodate the formation of insulating bricks using agricultural by product .In this chaptered are briefly introduced about status of rice husk, pigeon pea , coconut fiber ,wood and sugarcane bagasse in India . Sugarcane bagasse (SB) is residue product in large quantity by sugar industries. In this study to bricks from agricultural waste is taken under study. The heat transfer analysis of bricks less with different waste is decide to carry out experimentally and experimental results is compared with thermal analysis for further analysis. In addition to the energy cost saving on heating, there are several other benefits derived from using the heat energy.

II. EXPERIMENTAL SETUP

In recent years industrial waste materials are filling the landfill and becoming a problem for disposal. This is creating an environmental problem for developing countries which do not have the proper facilities to accommodate or recycle material.

A. *Method for Formation of Brick*

The fundamentals of brick manufacturing have not changed over time. However, technological advancements have made contemporary brick plants substantially more efficient and have improved the overall quality of the products. A more complete knowledge of raw materials and their properties, better control of firing, improved kiln designs and more advanced mechanization have all contributed to advancing the brick industry.

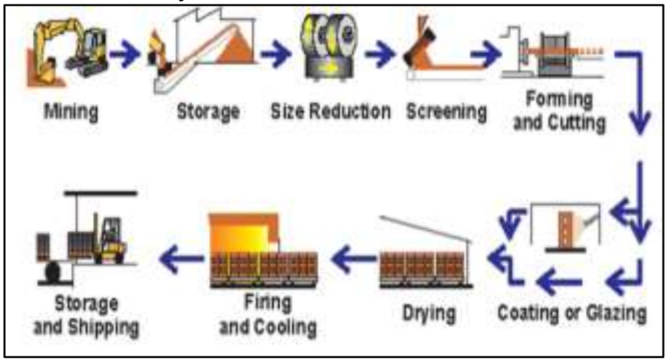

Fig. 1: Flow chart of Manufacturing Process

B. Temperature Testing

The heating element is present between the sole plate and pressure plate. It is pressed hard between the two plates. The heating element consists of nichrome wire wound around a sheet of mica. The two ends of the nichrome wire are connected to the contact strips. The contact strips are connected to the terminals of the iron. There are two reasons for which mica is chosen in the heating material. Mica is a very good insulating material. Besides that mica can also withstand very high temperatures. The entire assembly of mica sheet, nichrome wire and contact strips are riveted together resulting in a mechanically sound and robust construction. There is an asbestos sheet, which separates and thermally insulates the top plate from the heating element.

Fig. 2: Temperature Testing

There are many types of thermocouples, each with its own unique characteristics in terms of temperature range, durability, vibration resistance, chemical resistance, and application compatibility. Type J, K, T, & E are “Base Metal” thermocouples, the most common types of thermocouples. Type R, S, and B thermocouples are “Noble Metal” thermocouples, which are used in high temperature applications. Thermocouples are used in many industrial, scientific, and OEM applications. They can be found in nearly all industrial markets: Power Generation, Oil/Gas, Pharmaceutical, Bio-Tech, Cement, Paper & Pulp, etc. Thermocouples are also used in everyday appliances like stoves, furnaces, and toasters.

Thermocouples are typically selected because of their low cost, high temperature limits, wide temperature ranges, and durable nature.

1) Type R Temperature Range:
- Thermocouple grade wire, -58 to 2700F (-50 to 1480C)
- Extension wire, 32 to 392F (0 to 200C)

2) Accuracy (whichever is greater):
- Standard: +/- 1.5C or +/- .25%
- Special Limits of Error: +/- 0.6C or 0.1%

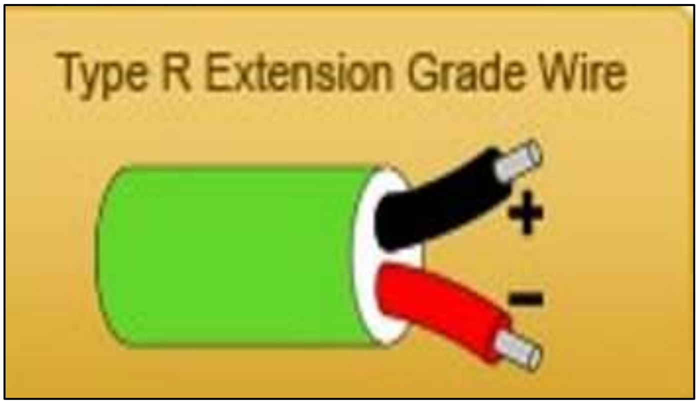

Fig. 3: Thermocouple

III. THERMAL ANALYSIS

A. Introduction to CAD

Computer aided designing (CAD) is widely used in product development phase to reduce design time with high level of accuracy in the work. The success of manufacturing companies depends on their ability to produce high quality products at the lowest cost. This applies to bearing design industries that aims to create designs that are very similar in alternative products and standardized in the sizes. To reduce the development cost, it may be worthy to focus on the design phase of product development, since most of the product cost is committed in the design phase, also the design phase decides the cost associated in the manufacturing phase, any of the mistake in the design phase may result in to very high losses associated in the manufacturing investments. Use of CAD tools take so much of time and are associated with the risk of errors in design.

B. *Designing of Brick using Creo Software*

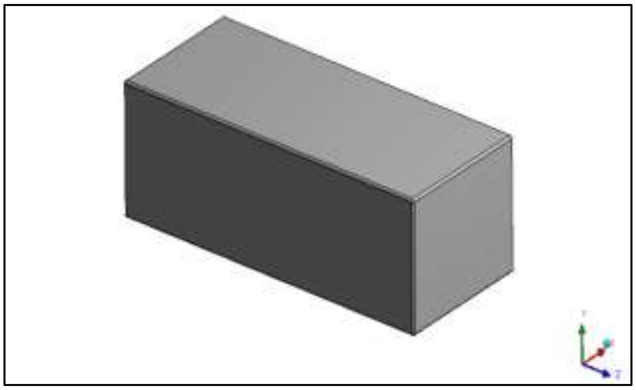

Fig. 4: Creo Model of Brick

C. *Finite Element Analysis*

The finite element method is a simple, robust and efficient method of obtaining a numerical approximate solution for a given mathematical model of a structure. In FEM a structure is divided into small triangles or quadrilaterals (`elements') and the displacement within an element was assumed to be linear in space variables, then the stress is calculated throughout the element and the sum of all the stresses would have to agree with the loading. Hence we obtained a linear combination of displacements equal to the loading, and inverting this system gave the displacements and then the stresses in the structure. When this very practical method is put in a sound mathematical framework, and once that framework was developed, the method could be applied to problems of structural analysis.

1) *Meshing*

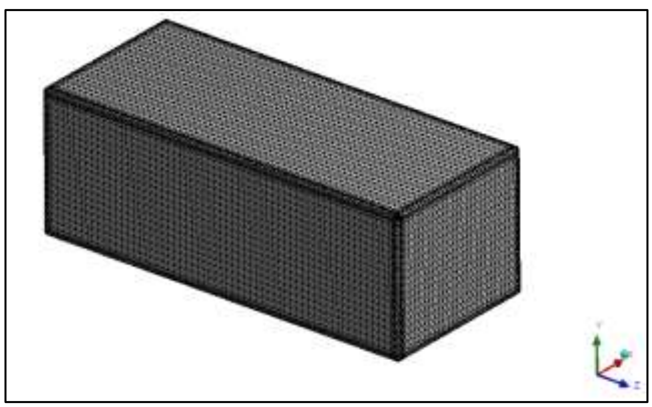

Fig. 5: Meshing of brick

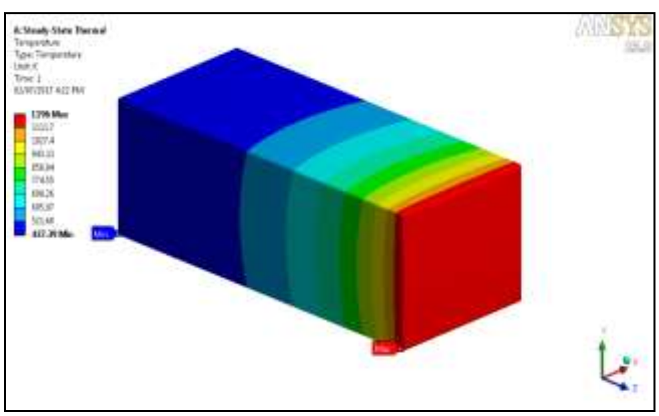

Fig. 6: Temperature Distribution Result

IV. COMPARATIVE ANALYSIS

Insulating fire bricks are soft and light in weight. They can be easily cut by handheld hack saw or any other hand tool like chisel or even drill bit. Color of insulating bricks varies but usually they come in shades from light brown to white, see pictures. In refractory air is the best insulation and this is why insulating firebricks have excellent insulating properties. Their body is made of tiny air spaces similar to honeycomb effect.

Table – 1
Comparison between Bricks (thermal conductivity)

Sample Number	*Contains*	*Thermal Conductivity*
Sample A	*Rice Husk-15gm-1%* *Coconut Shell- 15gm-1%* *Wheat Straw-15gm-1%* *Sugarcane Bagasse- 15 Gm-1%*	*0.01173*
Sample B	*Rice Husk-20gm-2%* *Coconut Shell- 20gm-2%* *Wheat Straw-20gm-2%* *Sugarcane Bagasse- 20 Gm-2%*	*0.01107*
Sample C	*Rice Husk-30gm-3%* *Coconut Shell- 30gm-3%* *Wheat Straw-30gm-3%* *Sugarcane Bagasse- 30 Gm-3%*	*0.0109*
Existing Bricks	*Alumina-37%* *Silica- 61%* *Ferric Oxide- 1.6%*	*0.2*

Table - 2
Comparison of thermal conductivity & Contents

Sample No.	*Inlet Temp.*	*Outlet Temp.*	*Heat Loss*
Sample A	*1045*	*242*	*0.2825*
	1127	*324*	
	923	*120*	
Sample B	*1045*	*222*	*0.2733*
	1127	*303*	
	923	*100*	
Sample C	*1045*	*221*	*0.2693*
	1127	*302*	
	923	*99*	
Existing Bricks	*1045*	*275*	*4.623*
	1127	*374*	
	923	*164*	

V. RESULT AND DISCUSSION

The utilization of sugarcane bagasse, pigeon pea, wood powder waste into fired clay brick could act as pore former to produce lightweight brick and improved the thermal properties. Furthermore, the calorific value of the sugarcane bagasse, pigeon pea, wood powder also helps to reduce the energy consumption during firing. Even though some of the brick properties such as compressive strength is decreased by the incorporation of the waste, but the waste, but it is still producing adequate fired clay brick. This also provides an alternative disposal method for sugarcane bagasse, pigeon pea, and wood powder

A. *Dry Shrinkage*

The additional of SB, PP wood powder makes the bond between them become weak due to the pores after firing of the fired clay brick. Low-density or light-weight brick have great advantages in firing of the fired clay brick. Low- density or light-weight brick have great advantages in construction including, for example, lower structural dead load, easier handing, lower transport costs, lower thermal conducted, and a higher number of bricks produced per ton of raw materials. Light brick can be substituted for standard brick in most application except when brick of higher strength are needed or when a particular look or finish is desirable for architectural reasons.

B. *Initial Rate of Sanction*

Fiber burn during creates more pores. Pores in the SB, PP, and wood powder brick absorb more water. Therefore a higher percentage of SB, PP will increase IRS. The preferable value of the IRS was 2.93 kg/mm which were control brick.

C. Compressive Strength

It was found that the additional SB, PP and wood powder reduced the strength of the fired clay brick compared to the normal brick as the brick become more porous with a higher percentage of fiber. Generally, the compressive strength value required for load bearing capability of brick. The additional of the SB,PP, wood powder weaken the bond strength between it.

D. Thermal Conductivity

It is found that sugarcane bagasse pea and wood powder improved the value of thermal conductivity. Fibrous material could be additive that could improve the insulation properties. The incorporation of waste will make the brick sufficient for load bearing purposes

E. Result

1) Result of Bricks from Agricultural Waste

Table – 3
Result of Bricks from Agricultural Waste

Sr. No.	Thermal Conductivity (K)	Inlet Temperature (C)	Temperature (^{0}C)	
			Max.	Min.
1	0.01173	1124 ˚C	1124 ˚C	317.28
		1045 ˚C	1045 ˚C	230.88
		923 ˚C	923 ˚C	107.94
2	0.01107	1124 ˚C	1124 ˚C	294.03
		1045 ˚C	1045 ˚C	209.21
		923 ˚C	923 ˚C	84.39
3	0.0109	1124 ˚C	1124 ˚C	298.79
		1045 ˚C	1045 ˚C	204.56
		923 ˚C	923 ˚C	79.73

2) Result of Existing Bricks

Table – 4
Result of Existing Bricks

Sr. No.	Thermal Conductivity (K)	Inlet Temperature (C)	Temperature (^{0}C)	
			Max.	Min.
3	0.2	1124 ˚C	1124 ˚C	374.04
		1045 ˚C	1045 ˚C	275.09
		923 ˚C	923 ˚C	164.39

3) Heat Loss Effect

Table – 5
Heat Loss Effect

Sr. No.	Thermal Conductivity	Heat Loss – watts
1	0.01173	0.2729
2	0.01107	0.2659
3	0.0109	0.2543
4	0.2	4.876

VI. CONCLUSION

Thus we have studied various insulating Bricks made from agricultural waste and it is concluded the rate of heat transfer is reduced for these materials

ACKNOWLEDGMENT

I would like to express my gratitude to all the people behind the screen who helped me to transform an idea into real application I profoundly thank Mr. P. Swaminadhan who has been an excellent guide and also great source of inspection to my work.

I would like to thank our professors of Departments of Mechanical Engineering for their constant encouragement and support in carrying out my project at college. I would like to thank Mr. P. Swaminadhan sir for his technical guidance. I would like to thank all the other staff members, both teaching and non-teaching, who have extended their timely help and eased my task. I would also like to thank to our beloved Dean Dr. Sadhana Chidrawar.

I would like to express my thanks and indebtedness to Mr. Mokhede Y.G for their constructive technical advice, constant guidance and encouragement throughout my project work. I am obliged to them being there always whenever I needed them. Last, but not the least, I would like to thank the authors of various research articles and books that were referred to.

REFERENCES

[1] Aeslina Abdul Kadir & Abbas Mohajerani "Bricks: an excellent building material for recycling wastes" , "Proceedings of the IASTED International Conference ,July 4 - 6, 2011 Calgary, AB, Canada Environmental Management and Engineering (EME 2011)
[2] J. K. Author, "Title of chapter in the book," in Title of His Published Book, xth ed. City of Publisher, Country if not Mangesh V. Madurwar, Rahul V. Ralegaonkar, Sachin A. Mandavgane "Application of agro-waste for sustainable construction materials" Elsevier, Construction and Building Materials 38 (2013) 872–878.
[3] Shankar Prasad Shukla "Investigation In To Tribo Potential Of Rice Husk (Rh) Char Reinforced Epoxy Composite"W.-K. Chen, Linear Networks and Systems. Belmont, CA: Wadsworth, 1993, pp. 123–135.
[4] Kumar S., Sangwan P., Dhankhar R. Mor V., and Bidra S. "Utilization of Rice Husk and Their Ash" Research Journal of Chemical and Environmental Sciences Res. J. Chem. Env. Sci., Volume 1 Issue 5 December 2013: 126-129 Online ISSN 2321-1040 CODEN: RJCEA2
[5] Kyauta E.E. Dauda D.M. and Justin E " Investigation on Thermal Properties of Composite of Rice Husk, Corncob and Baggasse for Building Thermal Insulation" American Journal of Engineering Research (AJER) e-ISSN : 2320-0847 p-ISSN : 2320-0936 Volume-03, Issue-12, pp-34-40
[6] Eugenia Obiageli Obidiegwu David Ehigie Esezobor, Johnson Olumuyiwa Agunsoye Ganiyu Ishola Lawal "Enhancement of Insulating Refractory Properties of Selected Nigeria Fire-Clays Using Coconut Shell" Journal of Minerals and Materials Characterization and Engineering,2015, 3, 458-468Published Online November2015in SciRes. http://www.scirp.org/journal/jmmce http://dx.doi.org/10.4236/jmmce.2015.36048
[7] Satta Panyakaew & Steve Fotios "Agricultural Waste Materials as Thermal Insulation for Dwellings in Thailand" Conference on Passive and Low Energy Architecture, PLEA 2008
[8] Mariana Palumbo ,Antonia Navarro ,Jaume Avellaneda ,Ana Maria Lacasta "Characterization of thermal insulation materials developed with crop wastes and natural binders" world SB 14 Barcelona octomber 28-30 2014
[9] Jorge Pinto, Daniel Cruz, Anabela Paiva, & Sandra Pereira "Characterization of corn cob as a possible raw building material" Elsevier Construction and Building Materials 34 (2012) 28–33
[10] Bogdan Bogdanov, Irena Markovska, Yancho Hristov, Dimitar Georgiev "Lightweight Materials Obtained by Utilization of Agricultural Waste" World Academy of Science, Engineering and Technology International Journal of Chemical, Molecular, Nuclear, Materials and Metallurgical Engineering Vol:6, No:4, 2012
[11] Soofia T. Elias-Ozkan, Francoise Summers, Nesen Surmeli and Simos Yannas "A Comparative Study of the Thermal Performance of Building Materials" PLEA2006 - The 23 Conference on Passive and Low Energy Architecture, Geneva, Switzerland, 6-8 September 2006
[12] Lorenza Aviles Trujillo, Neín Farrera Vázquez & Joel Moreira Acosta "Characterization Of A Material Based On Agricultural Waste For Use As Thermal Insulation" Xxx International Material Research Congress
[13] N. Padkho "A new design recycle agricultural waste materials for profitable use rice straw and maize husk in wall" Elsevier Procedia Engineering 32 (2012) 1113 – 1118.