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MANUFACTURE AND ANALYSIS OF THERMOPHYSICAL PROPERTIES OF THERMAL INSULATION FOR PIPES.

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ABSTRACT. *Thinking about the growing search for materials that can improve the efficiency of thermal insulations, and that do not cause aggressions to the environment, we decided to use the leaf of the carnauba as an alternative reinforcement in composites of thermal insulation. The composite is formed by natural fibers of leaves of the carnauba, that possesses good physicochemical properties to work as a thermal insulation and the minerium kaolin,that is characterized for being chemical inert and possesses low thermal conductivity.Tests were made to evaluate the thermal properties such as conductivity and resistance on a pressed block of pure kaolin , then there were made composites in formulations of 10%, 30% and 50%, this value indicates the percentage of the fiber mass of the carnauba powder per total mass of the composite, these variations were made so the tests could reveal how the increase of carnauba affected the thermal properties of the insulation.*

Keywords: Natural Fiber, Kaolin , Thermal insulation composite.

1. INTRODUCTION

When a system is higher or lower than room temperature, there will be exchanges of heat(Incropera , 2008), which may change its temperature and still result in a loss of energy. To reduce such effects, it is used a low thermal conductivity material layer on the surfaces of trade.The focus of the study of natural fibers is partly because composites formed of natural fibers can replace other synthetic materials, these materials are widely used in various fields of industry, be it automotive, aerospace and even in construction. Natural fibers have characteristics that make them very likely to be used in several fields, among these characteristics have low density, high strength, good mechanical properties and low processing costs.

The carnauba (Copernicia prunifera) is a typical plant in the Brazilian northeast, it develops in areas with clay soils and alluvial river banks, able to survive on flooded or dry places and with high salinity levels. The cerífero powder on the leaves acts as a protective film avoiding excessive water loss that occurs in environments with long periods of drought and low relative humidity (Mitra Mobin, 1999).

The other material used to form the composite was the kaolin, which term is used to denote a rock containing kaolinite. Kaolin is a material formed by a group of hydrated aluminum silicate, kaolinite and halloysite, followed by diquita and nacrita. In addition, kaolin always contains other substances as impurities from traces up to the range of 40-50% by volume, consisting, in general, quartz, mica, feldspar, iron oxides (Luiz; Chaves,2000).

Kaolin is a mineral well that presents a wide range of industrial applications, due to their technological characteristics as it is: chemically inert,soft and non-abrasive,white or almost white (whiteness) ,has coverage capacity when used as a pigment, for reinforcing load applications,has a low thermal conductivity and electrical (LUZ & DAMASCENO 1993).

Another very important factor is that Brazil is one of the countries that produce most of the kaolin in the world. Both the kaolin as carnauba are materials found in abundance in the region where the research was conducted, the study aims to then study an alternative form of thermal insulation that can stimulate the local economy, thus generating more income and exploitation of natural resources they abound in the Northeast region.

2. MATHERIALS AND METHODS

The kaolin is a rock made up of a group of hydrated aluminum silicate, kaolinite and halloysite presenting generally white color due to the low iron content (LIMA, 2010).

Fig.1. Kaolin

The obtained kaolin did not have any kind of treatment that could modify the results, being used in the state that was obtained by the local company.

Natural products derived from carnauba straw, have been considered for thermal insulation purposes, since they are lightweight, flexible, inexpensive, abundant and have a structure "micrographic" characterized by many voids, which induces greater thermal resistance to flow heat (Santos D, 2006).

Fig. 2 Carnauba leaf

First, straw research was done, it found itself with a large accumulation of impurities and a lot of carnauba powder.

The straw was placed at rest on the ground, to be resected by the sun , then was beaten in open atmosphere for the release of the powder, however, there were still found large quantities of powder between the leaves, to prevent even this very small amount of material remained deposited in the straw to interfere in the results , a wash was performed in tap water without adding any chemicals, so that did not occur damage to the straw structure.

Carnauba straw was then milled in a knife mill to be in the form of powder. This powder was then mixed with the kaolin, into three proportions, until a homogeneous appearance was achieved.

This mixture was divided in three proportions as it follows:

- 90% Kaolin and 10% powdered carnauba fiber.
- 70% Kaolin and 30% powdered carnauba fiber.
- 50% Kaolin and 50% powdered carnauba fiber.

The proportions were made to get an idea of how they would behave the thermal characteristics while decreasing a ratio of a material and rise to another, and how this could affect the applicability to the desired situation.

For the type of manufacturing process, pressing was chosen, and three blocks for each proportion as shown above , were manufactured to be used for the experiments. A machine called "KD2 PRO" was used to acquire the results, the blocks made were about 4 cm height , 6 cm long and 6 cm wide.

The blocks were drilled so a sensor could be inserted in the faces of the blocks to acquire the results.

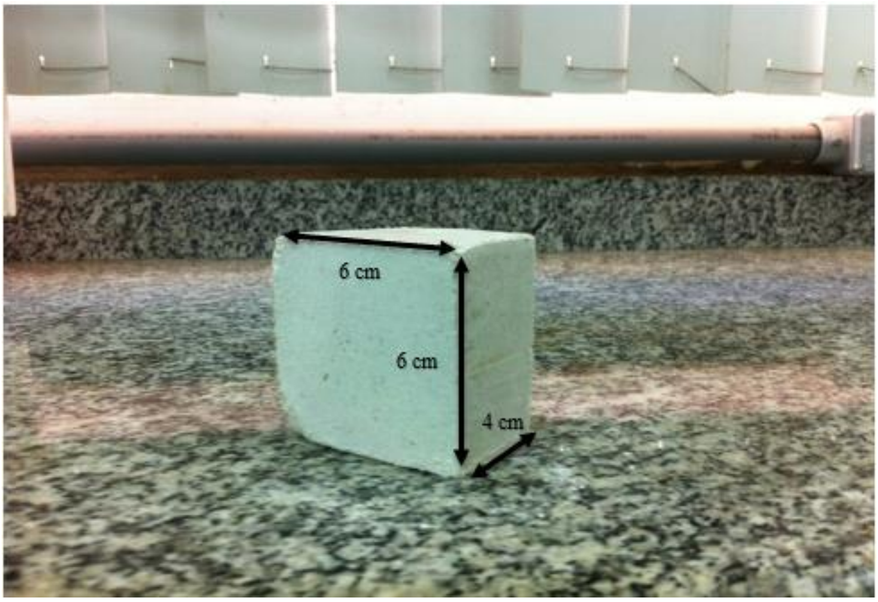

Fig. 3 Block manufactured for the tests.

3. RESULTS AND DISCUSSIONS

For each proportion there were made three blocks, each one was tested with the same conditions and using the same machine, to prevent further damage to the blocks, only five faces were drilled to acquire the results.

The following tables show the average results for each proportion, as long as the average result for each face of the blocks.

Tab. 1 – Proportion1, made of 90% kaolin and 10% carnauba.

Proportion 1	Temperature º Celsius	Thermal conductivity $W/_{m.K}$	Thermal resistance $K.cm/_{W}$	Error
Face 1	27,31	0,235	425,8	0,0025
Face 2	27,93	0,221	453,0	0,0023
Face 3	28,06	0,305	327,5	0,0018
Face 4	27,99	0,289	345,8	0,0021
Face 5	27,75	0,239	417,7	0,0038
Average	**27,80**	**0,257**	**393,3**	

Tab. 2 – Proportion 2, made of 70% kaolin and 30% carnaúba.

Proportion 2	Temperature º Celsius	Thermal conductivity $W/_{m.K}$	Thermal resistance $K.cm/_{W}$	Error
Face 1	26,62	0,166	601,6	0,0019
Face 2	26,82	0,201	496,4	0,0065
Face 3	26,78	0,234	428,1	0,0042
Face 4	26,90	0,176	569,7	0,0022
Face 5	27,53	0,217	461,9	0,0016
Average	**26,93**	**0,198**	**511,5**	

Tab. 3 – Proportion3, made of 50% kaolin and 50% carnauba

Proportion 3	Temperature º Celsius	Thermal conductivity $W/_{m.K}$	Thermal resistance $K.cm/_{W}$	Error
Face 1	23,45	0,128	778,7	0,0020
Face 2	23,60	0,132	754,8	0,0024
Face 3	23,62	0,210	476,0	0,0015
Face 4	23,89	0,132	760,2	0,0018
Face 5	23,83	0,244	410,1	0,0077
Average	**23,67**	**0,169**	**635,9**	

The thermal conductivity of the composite has undergone a considerable decrease when the increased amount of carnauba fiber such reinforces the literature the thermal conductivity of the straw is less than kaolin. After further increase up straw the proportion of 30% to 50%, the thermal conductivity of the composite does not undergo such a sharp decrease only one third of the preceding value.

Establish the relationship kaolin / carnauba was very important to know the influences in their thermal properties, thus enabling to establish the best interval proportions you want to use, for each raw material, to define the best applicability of the composite.

4. CONCLUSIONS

- The composite formed has a good thermal conductivity interval, 0.159 to 0.240 (W/ (mK)), characterizing it as a promising material for thermal insulation applications.
- The composite can be used in thermal applications to a temperature of 150 ° C without damage to its structure.
- The formed composite has a cost-effective, ensuring quality and low initial cost, and promote the local economy, by using abundant materials in the region.

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