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ANALYSIS OF THE GRADIENT OF TEMPERATURE OF COMPOSITE MATERIAL IN HOT SYSTEMS

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Abstract. *Now the great majority of the applications of thermal isolation in the strip of drops and averages temperatures (up to 180ºC), it is made being used from aggressive materials to the nature such an as: glass wool, rock wool, polystyrene, EPS among others. Such materials, in spite of the effectiveness in the retention of the flow of heat, possess considerable cost and when discarded they are long years to be to decompose. In that context, trying to adapt the world politics the about of the preservation of the environment, a study began with intention of developing a material composite, with properties of thermal, originating from insulating industrial residues. For that, composite the base of it scrapes of tire and latex seeking to be applied for thermal isolation in "hot" systems (up to 180ºC). The results obtained experimentally they proved that the composite, it can be used for isolation ends in warm surfaces, in the strip of temperature of 180ºC as it can be observed analyzing the gradients of temperatures.*

Keywords*: Scrapes of tires, Composite material, Temperature gradient.*

1. INTRODUCTION

There is a world tendency in looking for alternatives for the traditional materials in all the sections of the economy. In this context, it has been increasing the studies addressed to the rational use of the natural resources and the use of residues spilled in the nature

Being like this, the recycle that it has been a lot stimulated. Now, in the market, several products that are produced with recycled materials already exist: paper, packing's of aluminum and other metals. Santos (2005), affirms that in spite of this progress, the accelerated development of the society takes everyday, to the environment, a great number of materials pollute the vital elements to the human being survival, such as: soil, air and water. Several residues have been studied for the application in mortars and isolation materials as you scrape them of tire eraser coming of the recycled tires.

They are many the materials that can be used as insulating; the choice of the appropriate material to a certain process of transfer of heat is made of mechanical property analyses, physics and thermal.

As a material insulating ideal, the comparison among the available options doesn't exist it makes possible the choice of that that best satisfies to the fundamental beginning of the engineering: relationship cost x benefit. Besides, should be considered environmental parameter and of safety.

Now the great majority of the applications of thermal isolation in systems domestic, commercial and you elaborate in the drop strip and average temperature (up to 180ºC), it is made being used aggressive materials to the nature such a mainly as: glass wool, rock wool, polystyrene, EPS among others. Such materials, in spite of the effectiveness in the retention of the flow of thermal energy, possess a considerable cost and when discarded they are long years for they be absorbed by the nature.

Trying to adapt to a world politics concerning the preservation of the environment, it was made a study with the intention of developing material composite reinforced with you scrape of tire, residue that is characterized for they have low cost, besides low density when compared to conventional materials.

In that way, to present research it was motivated by the promising economical advantages and you adapt offered by the use of tire residue, tends as objective the development of a composite to be used as insulating thermal to the base of scrapes of tire and latex for application it tames, commercial and industrial, for hot surfaces 180º.

For this, they were used them you scrape of tire as reinforcement of the composite. Abundant material in every country and with little use and that has as characteristic principal: lightness, flexibility and low cost. As head office the latex was used. Material originating from of the "Hevea brasiliensis" whose production in Brazil is of the order of 90.000 ton/year, and that has as characteristic principal the little humidity absorption, high elasticity and low cost.

2. THEORY

2.1. Residues of tires

With the development of the automobile industry in the century XX, there was also an increment in the generation of residues and by-products, turning important the regulation of the destination of those materials. The cost of garbage deposition has been increasing, so much for the generated volume, as for the new demands of environmental stamp (GRIPPI, 2001). The need of creation of techniques exists capable to reuse such materials.

In a general way, the transports are vital for the development and the economical and social well-being, however, your high noxious effect is recognized in environmental level. Among the several ones modal existent, it is the road that produces a larger impact in the several components of the atmosphere. The principal caused negative effects are the pollution of the air, for the emission of gases and resulting particles of the combustion and the pollution of the soils for residues of oils, tires and scraps.

Among the components of the section road the tire possesses fundamental and unquestionable paper in the people's daily life, so much in the passengers' transport as in the transport of loads. That paper becomes still more important in the countries in development, where the transport of goods is made in your great majority by trucks.

However, the consumption of tires reached expressive numbers. The amount of produced tires every year in the world surpasses 2 million tons in Europe and North America, in Japan that production passes of 1 million tons. The China presents a problem in wide scale, because 80 million scraps of tires were produced and studies show that in 2011 the country will have 200 million abandoned tires (CAO, 2007).

In the world the problem of the inadequate discard of tires in the environment is being a great concern of the society in what refers to the administration of solid residues (BOVEA and GALARDO, 2006). In Brazil, they discarded 900 million of tires approximately and disposed at inadequate places (LARSEN et al, 2006).

The tires when useless they cart a series of problems: they are of slow degradation, perceptible and voluminous, needing appropriate conditions of storage and deposition. According to the classification of residues effective in Brazil (ABNT/NBR 10004), the tire is considered residue class III (inert residue). The placement of tires without use in embankments sanitarium has not been showing if a good solution, once the material is practically incompressible and of slow degradation (approximately 500 years), when compared to the residues to which the embankments are destined.

In Brazil, there is not any verification on the part of the federal government, on the forms of final deposition of the used tires, as well as there is not rising of the deposits of abandoned tires in every country. Some estimates indicate that 35 million carcasses of tires are generated annually (FIORI, 2009).

Still in agreement with Fiori (2009), in the united states they are generated more than 1 tires/person/year; Bertollo (2008) it esteems that in the state of São Paulo 0,46 tires/person/year and in Brazil 0,26 tires/person/year.

It's also unacceptable, under the sanitary point of view, that carcasses of tires are discarded to open sky, once it is focus of proliferation of insects and rodents. That problem can still be accentuated at places where diseases exist transmitted by those you encourage, as: primness and fever yellows. According to data of ministry of health in 2008 (MS, 2008) more than 20% of the registered cases of primness in the country they are caused by insect that are born in accumulated waters in old tires.

2.2. The latex

Some vegetables produce latex, which flow of cuts as resin. Cells called special "latíciferes" produce latex. The alkaline latex was coagulated to form a head office starting from which the balls and other goods were made. During the first millennium, rubber balls were used by the Mayan. Those "toys" had been made starting from the latex originating from of one it hoists native of Central America's and South. The ashes of the bonfires, that they were used to heat up, might have been the black acquaintance's "black of smoke" first contribution, that from that time went the responsible to give larger resistance to the rubber goods (LEBER, 2001).

All the latex is emulsions, in other words, aqueous suspensions of insoluble materials among them can be included: resins, felonies, proteins, sugars and carbon hydro's. Nor all the latex is elastic; those with elasticity contain carbon hydros of long chains. Rubber is a coagulated of elastic latex. Vegetables that produce latex elastic band are thoroughly "new tropics". The commercial natural rubber is produced of the latex of the "Hevea brasiliensis", originally collected of wild trees in South America.

As the rubber was recognized as a material that presented interesting physical properties, the researchers of the beginning of 1700 began to study the behavior of natural rubber when mixed in solvents, with the objective of developing some material that goes water balloon that possessed elasticity for production of balloons to hot air.

The modernization of the industry of polymeric began with the development of the rubber in Europe. Your first appearance in the commercial scenery dates of the century XVI, when French began to discover the advantages and applications of that material. In 1820, Thomas Hancok began the obtaining of products of the rubber and in 1837 it patented equipment for mixture and rubber mastication (HANCOK, 2008).

M. Faraday in 1826 was the first to analyze the chemical structure of the material and it was the first to postulate that was treated of a material constituted exclusively of carbon and hydrogen. The heating took the one reside and one distilled of carbon hydro's with one formulates empiric equal C_5H_8.

The volatile fraction was characterized in England in 1860 as tends an ebullition point among 37-38ºC, and it was called isoprene. Your structure was determined by W. Tilden, when studied the volatile fraction separately. And it concluded that that fraction was the responsible for your elasticity.

The fundamental discovery for the development of the rubber happened in 1839 for Nathaniel Hayward and Charles Goodyear, in the United States and Thomas Hancok in England, in independent works. Although the merit has been granted to Goodyear, both obtained similar plenty results. They heated up the natural rubber with sulfur and white lead obtaining this way a material with superior properties to the one of the natural rubber. The properties of the rubber vulcanized, name of the cure process then developed, it constituted, and it still constitutes, a model so that one can have idea of your properties elastic including among other, the possibility of great prolongations, high hardness, resistance to the stretching and fast retraction.

Brazil was already the largest producer and exporter of the natural rubber of latex of the world, same because the "seringueira" is original of the Amazonian. Time that the North area of Brazil tried a moment of great prosperity, becoming the economical area of the country in the beginning of the century XX. That position was occupied until the decade of 50. Economical problems and curses in the area impeded the maintainable development of the activity.

Today, most of the world production of 6.850.000 ton/year of natural rubber comes from the Asian Southeast, with a total of 5.126.700 ton/year. Brazil answers for a production of 90.000 ton/year of a total of 134.000 ton/year of Latin America. The cost in the exterior of the natural rubber is of us$ 740.00/ton. In Brazil the cost is of US$ 0.44/kg (www.borrachanatural.agr.br, 2010). Nowadays, the natural rubber is produced at the country through cultivation of plants of high productivity, selected and also adapted the areas Southeast and Center-west of the country.

2.3. Composite

A composite consists of the combination of two or more materials with different individual characteristics. One is the phase continuous or main and the other is the phase it disperses, being obtained, starting from that combination, a new material with properties different from the individual phases (COSTA, 1997).

The composites represent a case of matter importance inside of the group of the mixtures polymeric, where, in a general way, it can be said that constitute a class of heterogeneous materials. Given your vast application, special attention has been given all over the world by researchers, in the sense of to get better and to create new way materials the one that a range every time larger of that important material is had and with this, to increase the consumption perspectives (MANO, 2000).

The principal elements that are part of the structure of the composites: reinforcement - gives larger responsibility in the load support. Matrix - responsible for the form of the piece and some properties physical-chemistry polymeric. The reinforcement can be of nature organic or inorganic (metallic or ceramic), in way regular or irregular. In general the same is available in the form of fibers (fabric or no-fabric) or particles (spherical, plane, etc.). The matrix is almost always a polymeric one organic soft or hard, thermoplastic or thermo fix, could also be metallic or ceramic. The paper of the matrix in the transfer of the applied load to the reinforcement is of highest importance, since the same feels through the interface reinforcement /matrix.

3. METHODOLOGY

The production of the composite for development of the research in subject, it was used you scrape of tire originating from of recycled residue to serve as reinforcement and the natural rubber (latex) to serve as matrix polymeric.

3.1. Reinforcement

As reinforcement was used it scrapes of tire with characteristics fiber obtained through the residue of the process of tire recycled. As can be observed in the figure 1.

Figure 1. Scrapes of tires.

3.2. Matrix

It was used as matrix natural rubber (latex) in the liquid form, originating from of the state of Pará in Brazil. Where was extracted of "seringueira" (Hevea Brasiliensis). As can observed in the figure 2. The latex is characterized as a polymeric one lineal with molecular weight varying from 30 thousand to 4 million and it consists of at least 97% of molecules of cis-1.4 isoprene.

Figure 2. Extraction of the latex.

Second Filho and Bó (1985), in your composition it happens, on average, 35% of carbon hydro's, standing out the 2-methyl-1,3-butadieno 1,3 (C_5H_8) commercially known as isoprene, the monomer rubber. The latex is a stable colloidal dispersion of a substance polymeric in an aqueous way. The latex is practically neutral, with pH 7,0 to 7,2, but when exposed to the air for a period from 12 at 24 hours, the ph falls for 5,0 and it suffers spontaneous coagulation, forming o the polymer that is the rubber.

In agreement with the cure process, the same is framed in the rubber "type it not leafs smoked" in other words, it doesn't go by a smoking process to be reached the cure and, in agreement with the tenor of residues expressed for the specification SMR (Standard Malaysian Rubber), that consists of verifying the percentile of residues retained in mesh sieve 40μm. Para the case in subject the tenor of residues found it was of 6,5%, being able to the same to be framed as of the type SMR 10 (FILHO and BÓ, 1985).

3.3. Composite

A composite is a conjunction of two or more materials with united specific characteristics to form another material. For this, the a tire residue was used with aleatory distribution of the fibers, interfering in this residue, the latex as matrix polymeric. Composites were manufactured in the proportions 1:2 (33:67%); 1:1 (50:50%) and 2:1 (67:33%) (scrapes of tire - latex), As can observed in the figure 3. Through the method of manual lamination. Then these composites were characterized in function of the analysis of your properties gone back to ends of thermal isolation.

Figure 3. Composites 1:2; 1:1 and 2:1.

3.4. Resistance to the flow of heat in hot systems

The variation of greatness temperature along the mass of a material die characterizes the gradient of temperature of that material, which is associated to the resistance of that material to the flow of heat.

For analyses of this property a source of heat was used in a circular pin of steel carbon 1020 with 20 mm diameter, 120 mm length and a source of potency of 1100 watts. Involving the warm circular pin the composite was placed of you scrape of tire and latex in the proportions 1:2 (33:67%); 1:1 (50:50%) and 2:1 (67:33%) in form of blanket of 10 mm of thickness, as can be observed in the figure 4, 5 and 6.

Three thermo-pars were used of cobre-constantan (type T) in the composite being a located one in the interface composite circular pin, other to 5 mm of distance of the surface of the pin and other in the surface it expresses of the composite. The experiment was accomplished in Lab. of Mechanics of the Fluids and Transmission of Heat / UFRN-Natal, and it was accomplished in agreement with the norm ASTM C-518-76.

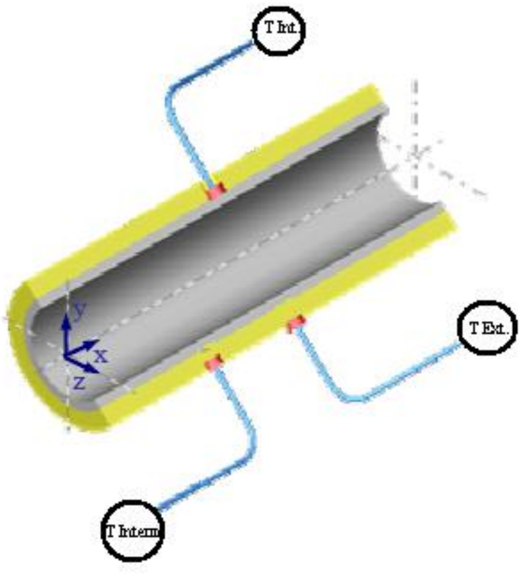

Figure 4. Outline of distribution of the thermo-pars.

Figure 5. Accompaniment of the experiment.

Figure 6. Details of the experiment.

4. RESULTS AND DISCUSSION

The low diffusion of the heat on the part of the composite was proven when in the analysis of the temperature gradient in the composite. It was verified in the experiment that, for the composite 2:1 (scrapes of tire - latex) a temperature of 172ºC in the interface warm pin - composite, followed by values of 110ºC and 99ºC for distances of the interface of 5 mm and 10 mm respectively. In that way, it was obtained a difference of temperature of 73ºC as it can be observed in the Figure 7.

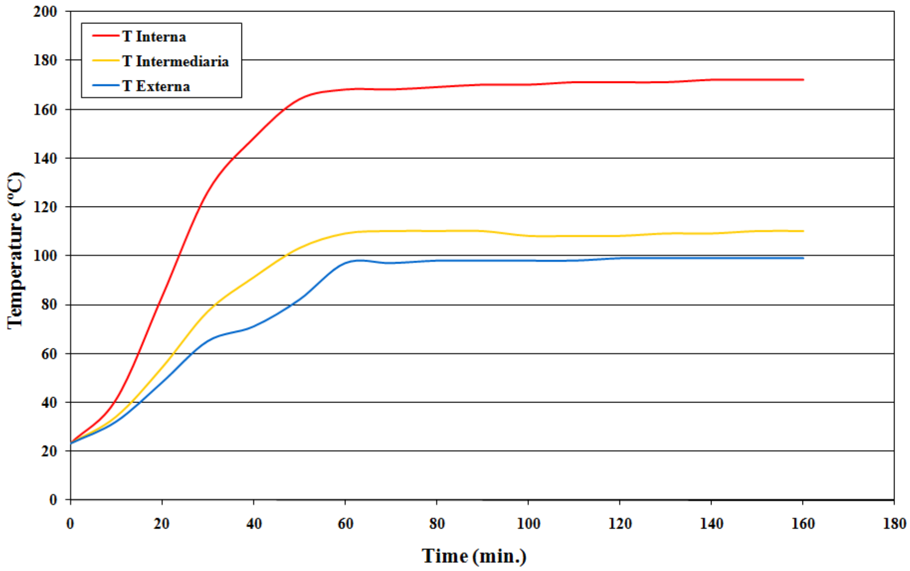

Figure 7. Gradient of temperature of the composite 2:1.

For the composite 1:1 (scrapes of tire - latex) a temperature of 172ºC in the interface warm pin - composite, proceeding respectively of the values 89ºC and 59ºC for distances of the interface of 5 mm and 10 mm. In that way, it was obtained a difference of temperature of 113ºC as it can be observed in the Figure 8.

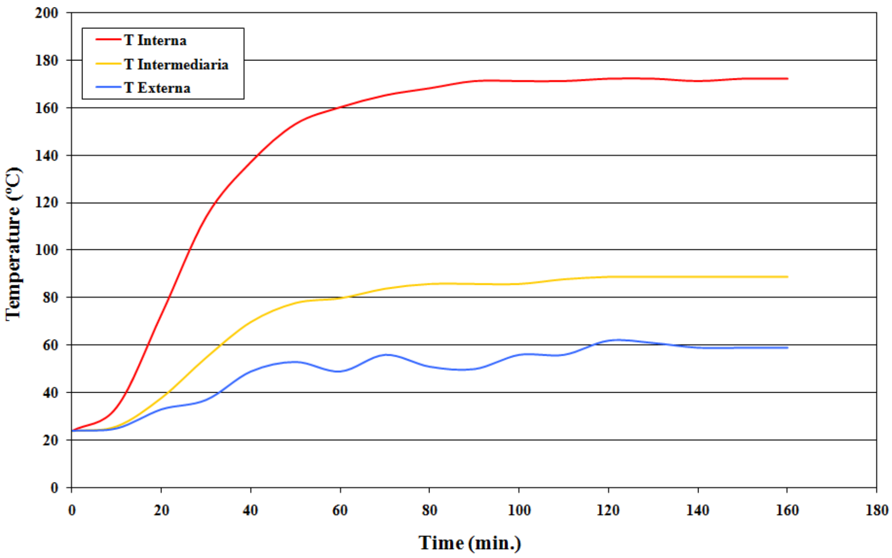

Figure 8. Gradient of temperature of the composite 1:1.

For the composite 1:2 (scrapes of tire - latex) a temperature of 171ºC in the interface warm pin - composite, proceeding respectively of the values 99ºC and 81ºC for distances of the interface of 5 mm and 10 mm. In that way it was obtained a difference of temperature of 90ºC as it can be observed in the Figure 9.

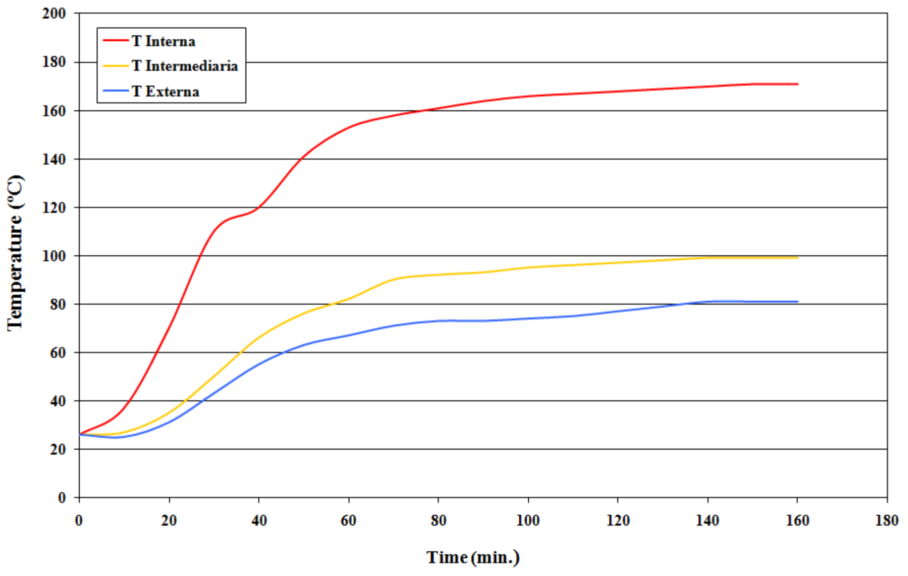

Figure 9. Gradient of temperature of the composite 1:2.

Therefore, it was verified that the composite 1:1 obtained the best acting among the analyzed proportions, with a difference of temperature of 113ºC in only 10 mm of thickness of the analyzed material, in other words, of the insulating thermal, denoting the characteristic of retention of heat of the same clearly.

5. CONCLUSIONS

- The geometric characteristics and you structure they allow that scrapes of tire it is used for production of blankets, given your flexibility, lightness and resistance to temperatures of up to 180ºC.
- Among the analyzed residues, it's suggested the use of the scrapes of tire as one of the most appropriate for production of the composite, because your properties revealed that the same satisfies to the minimum requirements for such an objective, as resistance to the temperature, lightness, flexibility besides having smaller improvement cost.
- The natural rubber (latex) can also be used together with you scrape them of tire in thermal applications to the limit of temperature of 180ºc, without damages to your structure.
- The flexibilities of the composites make possible to the same they cover surfaces of several geometries with found them in the automobiles.
- The volumetric densities and percentages of absorption of humidity of the composite characterize the same as light material and of little absorption.
- The composite can be used as insulating thermal until the limIt of temperature of 180ºC without risk of damages to your structures.
- The composite 1:1 is commercially competitive because, for a blanket of 1m2 for 5cm of thickness, your cost is approximately 31% smaller than the one of the glass wool, one of the insulating ones thermal commercially spread and sold. That is valid, because these materials have similar efficiency in what tells respect the isolation.
- Among the analyzed composites, the 1:1 came as the most appropriate for end of insulating thermal, in hot systems (up to 180ºC), due to the smallest thermal conductivity and cost of competitive.

6. ACKNOWLEDGEMENTS

PPGEM/UFRN – Universidade Federal do Rio Grande do Norte; UP/FEUP - Universidade do Porto; INEGI/UP; CAPES; CNPQ.

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