Reaction to the Fire of a Composite Material the Base of Scrapes of Tires End Latex for Thermal Isolation

E. T. L. Cöuras Ford, V. A. C. Vale, J. U. L. Mendes, R. M. Nascimento

***Abstract*—**The great majority of the applications of thermal isolation in the strip of drops and averages temperatures (up to 200ºC), it is made of materials aggressive 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. In this research, the behavior of the composite was analyzed, as submitted the fire. For this, the reaction rehearsals were accomplished to the fire for the composites 2:1; 1:1; 1:2 and for the Latex, based in the "con" experiment in agreement with the norm ASTM - E 1334 - 90. As consequence, in function of the answers of the system was possible to be observed to the acting of each mixture proportion.

***Keywords*—**Composite, Latex, Reaction to the fire.

I. 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 is of aluminum and other metals. Reference [1] affirms that in spite of this progress, the accelerated development of the society takes every day, to the environment, a great number of materials pollute the vital elements to the human being survival, such as, oil, 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.

Many materials may be used as an insulator; the choice of the appropriate material to a certain process of transfer of heat is made of mechanical property analyses, physics, and thermal.

Since there is no ideal thermal insulation, it is necessary to select the one 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 industrial in the drop strip and average temperature (up to 200ºC), 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 in the preservation of the environment, it was made a study with the intention of developing material composite reinforced with residue of tire, that is characterized for have low cost, besides low density when compared to conventional materials. Therefore, to present research it was motivated by the promising economic advantages and you adapt offered by the use of tire residue, tends as objective is analyzing the reaction to the fire of a material composite the base of it scrapes of tire and Latex for application it tames, commercial and industrial, for hot surfaces 200ºC.

Was used tire scrapes 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 of the "*Hevea brasilliensis*" 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.

II. Theory

A. 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 [2]. 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 economic and social well-being; however, the high noxious effect recognized in environmental level. The principal caused negative effects are the pollution

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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 [3].

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 [4], [5].

The tires when discarded, cause a number of problems: It has slow degradation, perceptible and voluminous, needing appropriate conditions of storage and deposition. According to the classification of residues effective in Brazil [6], 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 no verification by 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 [7].

Still in agreement with [7], in the United States are generated more than 1 tires/person/year; [1] in the state of São Paulo 0.46 tires/person/year and in Brazil 0.26 tires/person/ year. It is also unacceptable that the tire carcasses are disposed of in the open, as is the focus of proliferation of insects and rodents. This problem accentuated at places where diseases exist transmitted by those you encourage: primness and fever yellows. According to [8], in 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.

B. The Latex

Some types of trees produce a fluid called Latex. During the first millennium, the Mayan used eraser balls. Those "toys" had 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 [9].

The Latex is emulsions, i.e., in other words, aqueous suspensions of insoluble materials among them can be included: resins, felonies, proteins, sugars and hydrocarbons. No all the Latex is elastic; those with elasticity contain hydrocarbon of long chains. Rubber is a coagulated of elastic Latex. Vegetables that produce Latex elastic band are thoroughly "new tropics". The commercial natural rubber Latex from the "*Hevea brasiliensis*" originally collected from wild trees of 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 [10].

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, Hancok began the obtaining of products of the rubber and in 1837; it patented an equipment for mixture and rubber mastication [10].

M. Faraday in 1826 [8]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 Hydrocarbons with one formulates empiric equal C5H8.

The volatile fraction was characterized in England in 1860 as tends an ebullition point among 37-38ºC, and it was called isoprene. W. Tilden [10], when studied the volatile fraction separately determined your structure. In addition, 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 Hancok in England, in independent works. Although the merit has been granted to Goodyear, both obtained similar plenty results [8]. 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 " *Hevea brasiliensis*" is original of the Amazonian. That position occupied until the decade of 50. Economic problems and curses in the area impeded the maintainable development of the activity [10].

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, 2014). Nowadays, the natural rubber is produced at the country through cultivation of plants of high productivity, selected and adapted the areas Southeast and Center-west of the country [8].

C. 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, and a new material with properties different from the individual phases [11].

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 [12].

The principal elements that are part of the structure of the composites: reinforcement - gives larger responsibility in the load support. 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 usually 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.

III. Materials and Methods

Aiming at 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.

A. Reinforcement

As reinforcement was used, it scrapes of tire with characteristics fiber obtained through the residue of the process of tire recycled (Fig. 1).

Fig. 1 Scrapes of tire

B. Matrix

Natural rubber was used as matrix (Latex) in the liquid form, originating from of the state of Pará in Brazil. Where was extracted from *Hevea Brasiliensis*. As can observed in Fig. 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.

Fig. 2 Extraction of the Latex

According to [13], the composition: 35% of hydrocarbons, standing out the 2-methyl-1.3-butadieno 1.3 ($C5H8$) 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.

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

C. Composite

A composite is a conjunction of two or more materials with united specific characteristics to form another material. For this, the tire residue used with random 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 Figs. 5 and 6. 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.

Fig. 4 Model of the composite sample used in the experiment

Fig. 5 Model Latex sample used in the experiment

Fig. 6 Details the equipment

Fig. 7 Detail the behavior of the composites flame 2: 1 and 1:1

D.Analysis of Reaction to Fire

Resistance to combustion by a material reflects an important property in item security, especially for those who work near or in direct contact with sources of heat and / or flame, which justifies the need to make up the test reaction to fire.

The reaction to fire tests for composites experiment were based on the "cone" in accordance with [14], which is set horizontally on a specimen with dimensions of 10 mm X 10 mm (see Figs. 4 and 5).

A sample holder and insert it into the test chamber, as shown in Fig. 6 the test chamber is heated to 800°C, at this temperature the sample starts to release volatile gases that time an electrode emits a spark and starts the ignition. From this moment, the sample is in flames, and starts collecting data relating to the behavior of burning, gas emissions and time of self-extinction. The test is terminated at the time the self-extinction of the flame occurs and with it and made the analysis of the residuals. 1 (67: 33%) 2 composite for testing were performed; 1: 1 (50: 50%) 1: 2 (33: 67%) tire scrapings - Latex respectively; as well as Latex.

The experiment was conducted in a chapel with hood and enclosure with a temperature of 23 ± 2°C and relative humidity of 50 ± 5% and were performed at Lab Testing Reaction INEGI Fire / Faculty of Engineering, University of Porto -. FEUP - Portugal.

Fig. 8 Detail of the flame extinction process for composites 2: 1 and 1:1

Fig. 9 Detail of the residue of composite 2:1

Fig. 10 Detail of the residue of the composite 1:1

IV. Results and Discussion

The reaction to fire tests proved the composite 2: 1. More of them with combustible ignition to 7 seconds, followed by composite 1: 1. 8 sec with the ignition, the composite 1: 2 with the plugs 15 sec. and Latex with ignition at 21 sec.

For composite 2: 1 and 1: 1, for both the burning, had similar behavior with not too high and burning with burning smooth and uniform, without flashing abundant release of fire smoke. As extinction occurred very slowly for 2 composites around 2500 seconds. At the end of the trial waste with traces of sulfur (yellow color) were obtained. Details may be seen in Figs. 7-10.

Fig. 11 Detail of the composite flame to 1:2

Fig. 12 Detail of composite residue to 1:2

Fig. 13 Burning Latex with detail running and drops through the sample holder

Fig. 14 Detail of the residue to Latex

The composite 1:2, was developed for combustion with very high flame during burning was sputter-releasing particles also occurred a few drops on the bottom of the sample holder and abundant smoke emission. At the end of the assay residues with little trace of sulfur was obtained. Details can be seen in Figs. 11 and 12.

For Latex, combustion developed with very high flames during firing the material went into the casting process, bubbled and made crackling fell by drops of sample holder and abundant smoke emission. At the end of the assay obtained residues were completely melted. Details can be seen in Figs. 13 and 14.

As for the quantitative analysis for the reaction to fire test for composites 2: 1; 1: 1 and 1: 2, as well as Latex, can observed through Figs. 15-20.

For the sample of pure Latex, such as would be expected, some of the curves have a sudden variations therefore important mass losses occurred out of the sample holder due to the casting process of the material during the experiment.

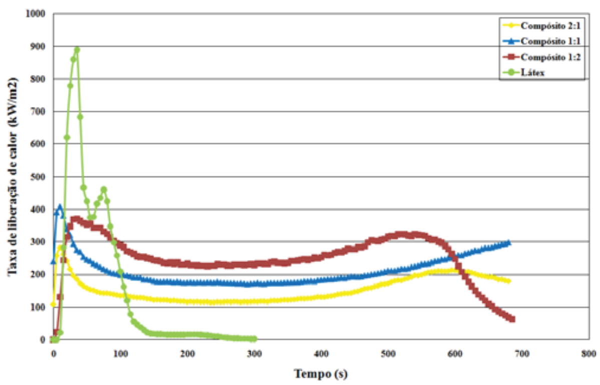

Fig. 15 Comparison of heat release rate as a function of time

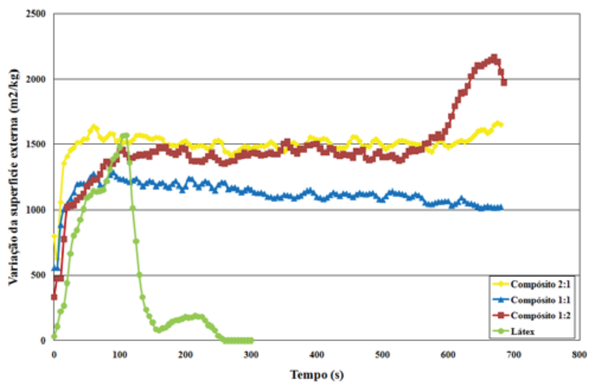

Fig. 16 Comparison of the external surface variation in function of time

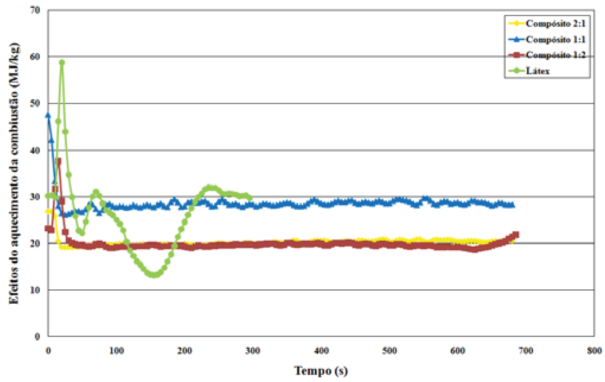

Fig. 17 Comparison of the effect of the heat of combustion as a function of time

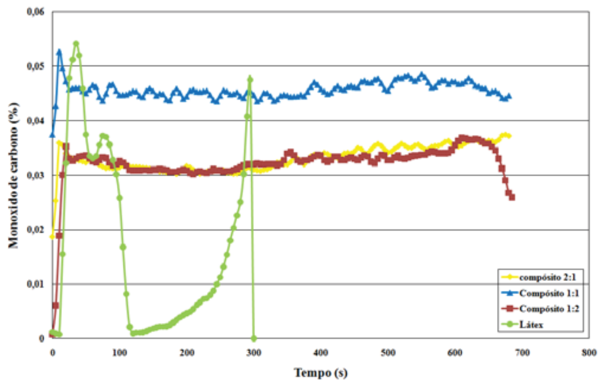

Fig. 18 Comparison of CO as a function of time

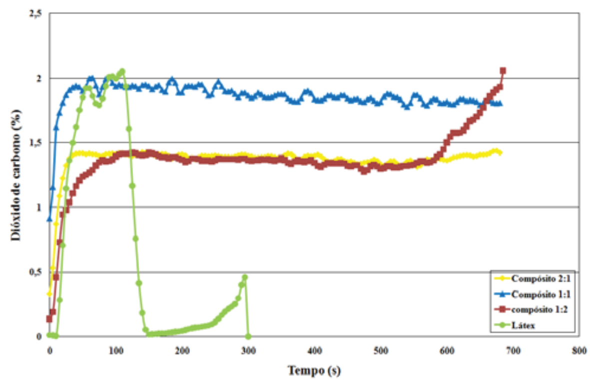

Fig. 19 Comparison of CO2 emission as a function of time

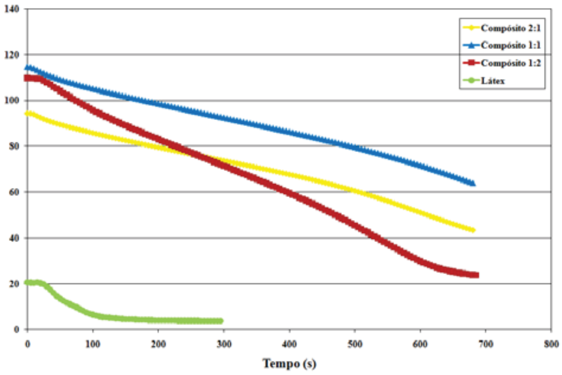

Fig. 20 Comparison of weight loss versus time

V. Conclusion

Accordingly, given the results, observed that the composites 2: 1; 1: 1 and 1: 2 can be used in direct or near sources of heat contact according to the results observed in tests of reaction to fire.

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