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A STUDY ON THE EFFECT OF TEMPERATURE ON THE MECHANICAL PROPERTIES OF THE FIBER- EPOXY COMPOSITE

This study used an composite which consist of epoxy resin and basalt, jute fibers .this study highlight on the effect of temperature on the fiber epoxy composite .The results of experiments show, the tensile and flexural strength decreased by increasing temperatures but by adding 10% flame retardants, the heat resistance of epoxy will improve and therefore the epoxy resin will save it mechanical properties.
Key words: *epoxy, flame retardants, jute fibers, basalt fibers, flexural strength, tensile strength.*

Introduction. A composite is a structural material that consists of two or more constituents that are combined at a macroscopic level and are not soluble in each other [1]. One constituent is called the reinforcing phase and the one in which it is embedded is called the matrix [2]. The composite material however, generally possesses characteristic properties, such as stiffness, strength, weight, high-temperature performance, corrosion resistance, hardness, and conductivity that are not possible with the individual components by themselves [3]. The mechanical properties of composite materials have a great important in the field of using these materials, where the values of these properties should be high and acceptable so it can do its duty successfully [4]. The particular combination of fibers is usually selected to balance strength and stiffness, provide dimensional stability, reduce cost, reduce weight, or improve fatigue and fracture resistance [5]. These materials can be used sufficiently in thermal systems to resist high temperatures comes from hot liquids and gases [6]. The developments in composite material after meeting the challenges of aerospace sector have cascaded down for catering to domestic and industrial applications. Composites, the wonder material with light-weight, high strength-to-weight ratio and stiffness properties have come a long way in replacing the conventional materials like metals, woods etc. Although the tensile strength and Young's modulus of jute are lower than those of glass fibers, the specific modulus of jute fiber is superior to that of glass and on a modulus per cost basis, jute is far superior. The specific strength per unit cost of jute, too, approaches that of glass. Therefore, where high strength is not a priority, jute may be used to fully or partially replace glass fiber without entailing the introduction of new techniques of composite fabrication. The need for using jute fibers in place of the traditional glass fiber partly or fully as reinforcing agents in composites stems from its lower specific gravity (1.29) and higher specific modulus (40 Gpa) of jute compared with those of glass (2.5 & 30 Gpa respectively). The jute composites may be used in everyday applications such as lampshades, suitcases, paperweights, helmets, shower and bath units. The growing industrial activities create continuous demand for improved materials which satisfy the increasing stringent requirements, such as higher strength, modulus, thermal and electrical conductivity and fire resistance [7, 8]. Many studies were performed to reduce flammability of polymeric materials by using flame retardants.

Flame retardants are defined as a chemical compounds that modify pyrolysis reaction of polymer or oxidation reactions implied the combustion by slowing them down or by inhibiting them , flame retardants are divided into additive , reactive flame retardants [10] .Known flame retardants can be classified into organic and inorganic compounds [9,11]

A- Organic compounds include: Compounds of phosphorus, generally solid-phase retardants, Compounds of halogens which have effectiveness in the order F> CL > Br > I, Compounds containing both phosphorus and halogen. B- Inorganic compounds include: Antimony compounds which are used synergistically with halogens containing flame retardant, Hydrates which decompose endothermic ally releasing water vapor into gas-phase (e.g. Al_2O_3. $3H_2O$, Mg $(OH)_2$), Acid and forming salt such as: ammonium salts, sulfur acid, phosphoric acid, and boric acid which act as a solid first –phase retardant Many studies showed that a large variety of organic and inorganic phosphorus compounds has been as being useful in reducing the flammability of different polymeric materials, from these studies: [12,13].

Materials.

The materials one used in this study include: Epoxy resin, jute and basalt fiber (in length 10 mm), fig. 1, and triammonium orthophosphate.

Specimen preparation:

Hand lay-up technique was used to prepare the sheets by using the cast mould. Cast mould include: A glass plates of dimensions (300 x 300 x 6) mm used as a mould stage, glass strips of dimensions (250 x 25 x 3) mm, used as boundaries for cast mould. The specimens of Epoxy resin containing additive with weight percentages of 10 and reinforced with 30% basalt fiber and jut fiber.

Practical part

- used one material used this research epoxy resin has high adhesion properties, the reinforcement materials used in this study two types of fiber, basalt fiber (2600 kg / m^3), and jute fibers, (1040 kg / m^3) – addition ratios – 30% .

Basalt fibers Jute fiber

Fig. 1. basalt and jute fiber

Table 1.

Physical properties of basalt fibers

Fiber type	Specific gravity	Tensile strength MPa	Elastic modulus GPa	Strain at break in/in
Baslat	2,7	2800-4800	86-90	0,0315

Table 2.

Physical properties of jute fiber

Physical property	Jute fiber
Density g/cm^3	1,4
Elongation at break %	1,8
Cellulose content %	50-57
Lignin content %	8-10
Tensile strength Mpa	700-800
Youngs modulus GPa	30

- Preparation technology is prepared first samples of material epoxy calculated without adding any materials for consolidation, and the second of overlapping material containing epoxy and fiber, basalt fiber and jute fiber with (30%), put a jute fibers between layers of resin and 10% flame retardants ., and left this compound 48 overlapped hour for the completing hardness process, and then separating overlapped on the board (100°C) mineral and left another three-hour period at a temperature and for completing the chemical reactions.

Mechanical properties

Tensile strength

The tensile test was carried out according to ASTM D 3039-76. The specimen dimensions was 250 mm x 25 mm x 3 mm and load was applied on both the ends. The test was performed in the universal testing machine. The flexural strength of the composite specimen was determined using the following «equation 1».

$$\sigma = \frac{P}{A}$$

Where: σ = tensile strength in MPa, P = test load in N., A = cross section area of sample in m^2.

The resin considered as brittle materials where its tensile strength is very low as shown in this Fig3. The tensile strength will be decreased as the temperature increased, but by adding for epoxy resin 10% flame retardants ,the heat resistance of epoxy will improve and therefore the epoxy resin will be saved it mechanical properties.

Specimens made from epoxy and basalt fibers Specimens made from epoxy and jute fibers

Fig.2. Specimens for the tensile test

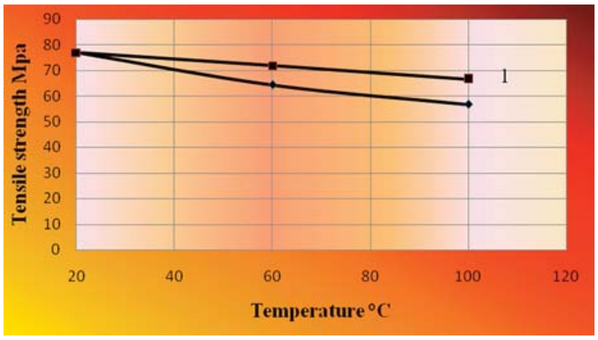

Fig. 3. Represents tensile strength of epoxy vs. temperature,
1 – with flame retardants,
2 – without flame retardants

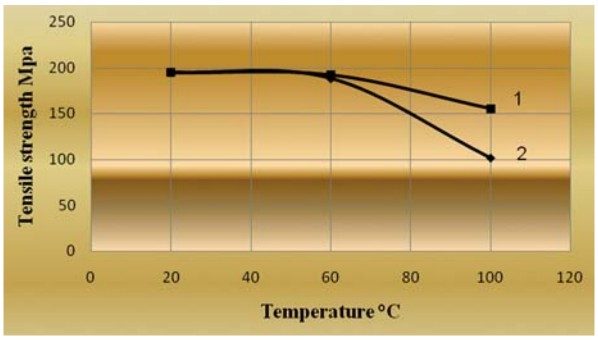

Fig. 4. Represents tensile strength of composite material made from jute fibers and epoxy vs. temperature,
1 – with flame retardants,
2 – without flame retardants

The resin considered as brittle materials where its tensile strength is very low as shown in this Figure, but when reinforcing by fibers this property will be improved greatly, where the fibers will withstand the maximum part of loads and by consequence will raise the strength of composite material [14] . The tensile strength will be decreased as the temperature increased, but by adding for this composite 10% flame retardants ,the composite will improve it heat resistance and therefore the composite will be saved it mechanical properties.

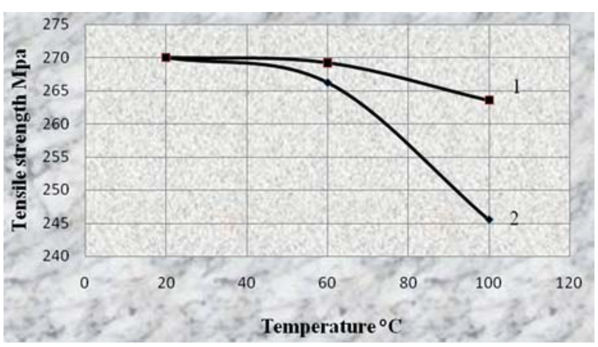

Fig. 5. Rrepresents tensile strength of composite material made from basalt fibers and epoxy vs. temperature,
1 – with flame retardants,
2 – without flame retardants

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Flexural strength

The flexural strength was carried out according to ASTM D790. The three point bend test was conducted on all the composite samples in the universal testing machine. The dimension of each specimen was 130 mm x 25 mm x 3mm and Span length 100 mm. Three identical test specimens were tested for calculating the flexural strength. The flexural strength of the composite specimen was determined using the following «equation 2».

$$\sigma = \frac{3 \cdot P \cdot S}{2b \cdot t^2}$$

Where: P = maximum load in N, S = dimension between loaded points in mm, b = sample width in mm, t = sample thickness in mm.

Specimens made from epoxy and basalt fibers

Specimens made from epoxy and basalt fibers

Fig. 6. Flexural strength tested specimens

As we seen from this figure the flexural strength of resin will be low with increasing of temperature decreased, but by adding 10% flame retardants ,the heat resistance of specimens which made from epoxy will be improved and therefore the will be saved it mechanical properties.

For this composite before reinforcement because the brittleness of resin. But after added the fibers to this resin the flexural strength will be raised to the producing material because the high modulus of elasticity of these fibers will helps to carry a large amount of loads and raise this strength [14] but with increasing of temperature the flexural strength will decreased, but by adding for this composite 10% flame retardant, the composite will improve it heat resistance and therefore the composite will be saved it mechanical properties.

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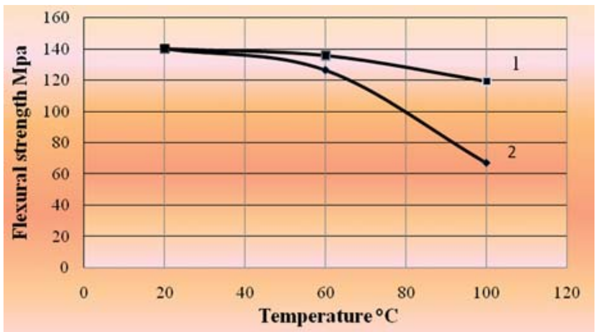

Fig. 7. Shows the flexural strength results of epoxy and temperature,
1 – with flame retardants,
2 – without flame retardants

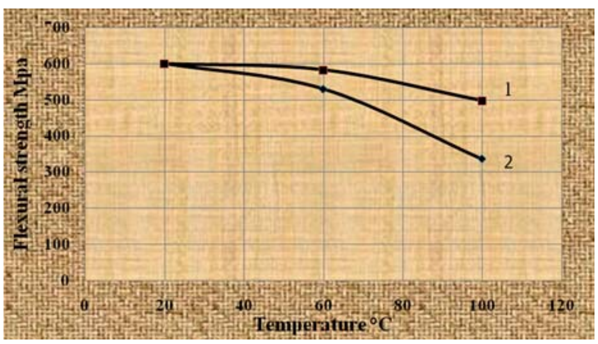

Fig. 8. Shows the flexural strength results for composite material from jute fiber and epoxy and temperature,
1 – with flame retardants,
2 – without flame retardants

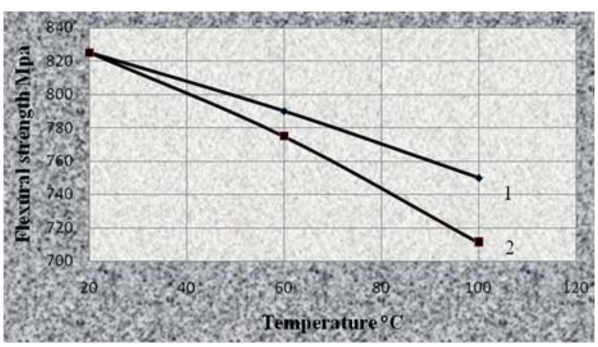

Fig. 9. Shows the flexural strength results for composite material from basalt fiber and epoxy and temperature.
1 – with flame retardants,
2 – without flame retardants.

Conclusions

The investigation of mechanical behavior of composite lead to the following conclusions:

1. The mechanical properties of the composites were greatly influenced by the filler content;
2. The test result shows that composites filled by 30% volume basalt fiber and 10% flame retardants exhibited maximum ultimate tensile strength. maximum flexural strength;
3. Composites filled with 10% flame retardants will be saved mechanical properties of composite.
4. The addition 30% basalt fibers and 30% jute fibers improves the tensile strength, flexural strength, of epoxy resin , but when increase temperature , tensile strength, flexural strength, will decreased.

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