Manufacture of Thermal Building Insulators from Waste Cigarette Butts

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Abstract

Waste cigarette butts fiber (CBS) was used and recycled by reinforcing it with unsaturated polyester resin (UPE). It was used to obtain structural sections at a low cost and eliminate the environmental pollution risks resulting from these wastes (CBS). Samples were prepared by manual casting according to the mass fractions (0%, 2%, 4%, 6%, 8%, 10%) of cigarette butt fibers (CBS). The prepared samples carried out mechanical tests (hardness, bending, and tensile elastic modulus). The results showed that the modulus of elasticity and bending resistance increased with the increase of the weight ratio and that these values were directly proportional to the increase in the amount of reinforcement from the CBS fibers.

Key Words: Mechanical Properties, Polyester Resin, Cigarette Butts, Environmental Pollution.

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Introduction

Many researchers pay a great attention to the environmental waste in order to preserve the environment and reduce reliance on raw sources and their exhaustion. Consequently, the role of compound materials became very wide and attracted the attention of engineers and manufacturers. Due to the high strength and rigidity of these materials in addition to their low cost and light weight, their use occupied a large scope in many engineering, technological and other industries fields. [1] In general, the entry of polymers is to meet the needs of the modern era, which witnessed a clear development and a great demand for such materials. As a result of this great development and the increasing demand for polymeric composite materials, the world cannot be imagined without polymers. Whereas, these materials were distinguished (metallic, ceramic) by simplicity of manufacturing, resistance against oxidation and non-corrosion when exposed to alkaline and acidic solutions, as well as being easy to color [2]. The rise in the prices of raw materials has increased the demand for biodegradable materials which depend on renewable natural resources [3].

Many studies have been conducted on natural fibers for several years, as for edible nuts shells, such as hazelnut shells, walnut shells, pistachio shells, and ground pistachio shells in the form of particles or powder which had received a remarkable attention in the past few years. In particular, the shells of pistachio (PS) are among these nuts which can be utilized as a preservative for some polymeric resins. It was found that the shells (PS) were less used in the reinforcement of polymeric materials; the shell of pistachio is an agricultural waste that is abundant in countries according to its consumption.

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It can be collected, cleaned and grinded to strength the resins to obtain polymeric materials which can be utilized in different applications as these (PS) shells have high solidity and hardness in addition of being cheap and biodegradable [4].

The materials that are strengthened by particles are one of the most important materials used in engineering purposes because of their large molecular structures due to the process of binding and building the small molecules. One of the factors that affect the composite materials supported by the particles is the shape and size of these particles in addition to the mechanism of their distribution in a regular and random manner within the base material. Furthermore, the strength of the bonding among the base material, the supporting materials and the area of the interface which formed amidst the two phases has an efficient role in effecting the composite materials. [5]

The aim of the research:

1. Design structural sections using cigarette butts fiber waste with unsaturated polyester (UPE) resin.
2. Elimination of environmental pollution resulting from throwing cigarette butts (CBS) waste.

Materials and Experimental Work

Recycled Material

The reinforced materials are waste fibers (CBS) after the process of arranging and cutting them into the required sizes.

Adhesive

Unsaturated polyester resin (UPE) was used, and this is the base material; it is a thermoset resin in the form of a transparent viscous liquid with an estimated density of (1.2 gm /cm3) at room temperature.

Preparation of Samples

All samples were prepared using the manual casting method according to the required samples and according to the mass fractions (0%, 2%, 4%, 6%, 8%, 10%) of (CBS). The (CBS) fibers were mixed with (UBE) slowly. Gradually until we get a homogeneous and acceptable mixture with both (CBS) and the base material (UBE) to get rid of the resulting bubbles through the process of rapid mixing and affect the two materials, it is worth noting that the process of mixing the two materials took place in all directions and for a period of time ranging from (2-3 min.) a minute, due to the absence of lumps within the base material, which greatly affect the prepared mixture. The mixture is poured regularly and evenly into the mold, and when the samples inside the mold harden, they are placed in an electric oven (Oven) for a period of (1 h) and at a temperature of (50 ºC). Then the samples remain in the oven for a period (4 h) until The samples are gradually cooled and reach the temperature of the laboratory room to ensure an excellent homogeneity and crosslinking of these polymeric chains and to obtain the best hardening and eliminate the stresses formed through the process of casting and solidifying samples. All the mentioned steps were repeated with all samples prepared according to the weight fractions of the CBS fibers.

Mechanical Tests

Tensile Test: Tensile samples were prepared as in Figure (1), which shows an accurate description of these standard dimensions according to the approved American measurements (ASTM-D-638 [7]. This tensile device is of the type (LAREE Yaur tasting Solution, by the effect of load force (strain) on these samples and using the curves (Stress-Strain), the properties of the tensile elastic modulus of the samples were obtained. Figure (2) shows the device used in the testing process. The two figures show (4, 3) tensile inspection samples before and after the test.

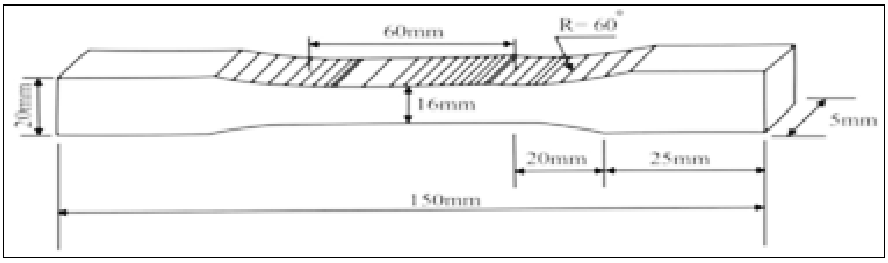

Figure 1. Shows the dimensions of the sample used for tensile testing under the current study [7]

Figure 2. Shows the device used in the tensile testing process

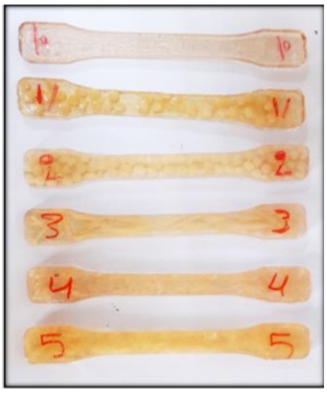

Figure 3. Tensile testing samples before carrying out mechanical tests

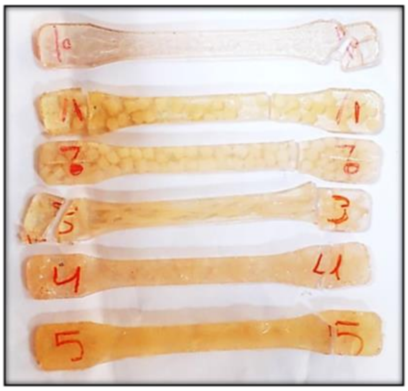

Figure 4. Tensile test samples after performing mechanical tests

Bending Test: The samples were prepared for testing according to the American Standards (ASTM D-790) prepared for testing [8]. As shown in Figure (5), which shows the standard dimensions of the samples, Bending Examination. The tests were carried out using the three-point test device (Three Pending test), and the LAREE device was used in conducting the bending tests shown in Figure (6), using the graph of the bending samples, where the (Stress-Strain) curves were obtained. Calculation of the bending resistance of these samples Figures (8 and 7) shows the bending test samples before and after performing the mechanical tests.

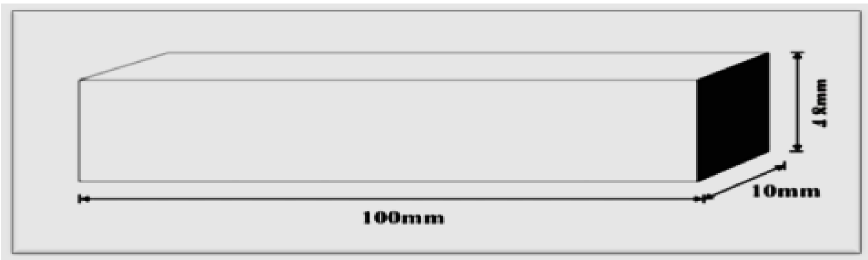

Figure 5. Shows the dimensions of the sample used for the bending test under the current study [8]

Figure 6. LAREE device used in conducting bending tests

Figure 7. Bending test samples before carrying out mechanical tests.

Figure 8. Bending test samples after conducting mechanical tests

Results and Discussion

Tensile Test: Special tests were carried out to check the tensile results (Tensile) for all samples processed from cigarette butts fibers (CBs) with the polymeric bond of the unsaturated polyester type (UPS). The purpose of tensile testing of samples is to know the strength of the material. This can be done by looking at the results that have been reached and through the nature of the (Stress-strain) curve until reaching the maximum durability and failure in the samples (reaching the fracture state of the sample). Figure (9) shows us the special relationship between the tensile strength and the weight fracture of cigarette butts residues (CBs). We note that the greater the weight fractions (CBs) values, the greater the tensile comparison values for the samples. These results recorded that the highest value obtained is at the weight fraction (6%). This increase is due to the porosity of the cigarette butt fibers bearing the largest portion applied to them. This stress is transmitted from the base material to the reinforcing material through the interface as these fibers divide the externally applied stress over the largest possible area of the sample and thus work to reduce the stress concentration on a specific point in the sample [9]. This increase is also attributed to the nature and extent of the bonding between cigarette butts residues (CBs) and unsaturated polyester. In addition, the distribution of cigarette butts fibers is homogeneous within the polymeric bond, which worked on comparing the movement of its polymeric chains [10]. Then after the weight fraction (6%), the samples began to gradually decrease until they reached their lowest value at the good weight fraction (10%), where the tensile value at this fraction was recorded as (Mpa23). The reason for this decrease is due to the viscosity of the polymeric fluid, which works as an obstacle that prevents the rate of the wetting ability of the cigarette butts fibers (CBs) and thus leads to the lack of suitable interfaces between the adhesives and residues (CBs), and this, in turn, reduces the tensile strength value of the samples under test [11]. In addition, the weak bonding strength is due to the presence of agglomerates of fibers (CBs) inside the polymeric bond, which caused a weakening of the bonding strength of the polymer composite material. Also, these agglomerations helped focus the stress to be in a specific area of the sample, and therefore the amount of stress is based on this area and is not completely distributed over all parts of the sample, which leads to failure (fracture) in the places where these lumps are [12].

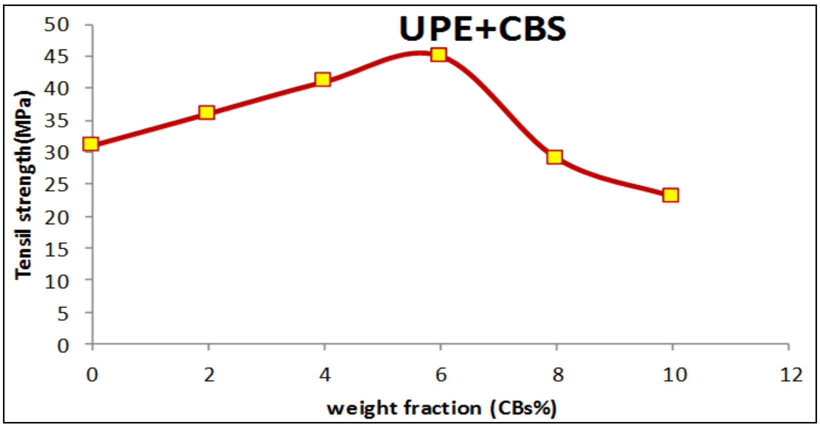

Figure 9. Shows the relationship between the tensile strength and the weight fracture of the composite (UPE + CBs)

Bending Resistance

By looking at Figure (10), we notice that the bending elasticity coefficients of the samples started to gradually increase compared to the values of pure unsaturated polyester (UPE). It reached its highest value at the weight fraction

(6%). This increase is due to the nature of the fibers used in strengthening the polymeric material and the high flexibility of these fibers. In addition, the bondability between each of the base materials (PEU) and the reinforced material (CBs) is symmetrically cohesive, which increases the crosslinking and durability of the polymeric material [13]. After that, the values begin to decrease as the weight fraction of cigarette butts fibers (CBs) increases. The decrease in curvature values is due to the weak bonding between the composite material components (weak bonding between UPE and CBs) with the increase in the amount of cigarette fibers. They fuse when stress is applied to the sample, forming a large slit, and this slit causes the sample to fail. Also, the presence of cracks and indentations on the outer surface of the sample plays a role in the failure of the sample and the low modulus of elasticity [14].

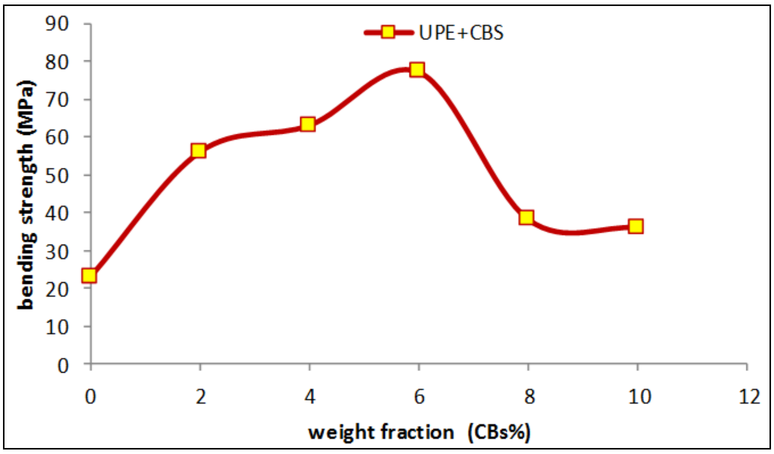

Figure 10. Shows the bending strength of the composite (UPE+CBs)

Conclusions

It was shown by the results when using quantities of fibers (CBs) with the polymeric adhesive (UPS) leads to an improvement in the mechanical properties (the modulus of tensile elasticity, bending strength) with an increase in the weight ratios of the fibers (CBs).

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