JOURNAL OF AERONAUTICAL MATERIALS
ISSN: 1005-5053

Vol. 43, Issue-01, 2023
pp. 251-257

IMPROVING SOME MECHANICAL PROPERTIES (SHOCK, HARDNESS) OF UNSATURATED POLYESTER USING ENVIRONMENTAL RESIDUES.

Sohaib Nafaa Hameed[1]
College of Education for Pure Sciences, University of Anbar, Anbar, Iraq
E-mail : Soh20u3012@uoanbar.edu.iq

Dr. Waleed Bdaiwi[2]
Professor, College of Education for Pure Sciences,University of Anbar, Anbar, Iraq.
E-mail : esp.waleedb.salih@uoanbar.edu.iq

Abstract

This research includes an experimental study for the manufacture of a polymeric based composite material supported by Luffa fibers particles with different volumetric fractions (5%, 10%, 15%, 20%, 25%) where the composite material was prepared bymanual molding at room temperature. The results showed that increasing the reinforcement ratios on thebase material leads to the improvementof mechanical properties (shock, hardness).

Keywords: luffa fiber, unsaturated polyester, hardness, shock resistance

1-1. Introduction:

In light of the scientific and industrial development that has occurred in the world, composite materials have become a clear echo in this development, as they were able to reduce something of environmental pollution and added important properties to industry, as it helped it to advance the scientific and industrial reality Its distinctive properties because of: (light weight, durability, corrosion resistance and low cost), which can be used in multiple fields such as cars, ships, aircraft, etc., and for that the materials were produced Overlapping, which we can define as the union of two or more substances of a substance with different specifications that are related to each other in a certain way and have better properties than the properties of the materials involved in the composition if used individually. [1]

Natural fibers are environmentally friendly, low price, easy to separate, non-corrosive, abundant, lightweight and friction for processing equipment.

Environmental protection and fiber production and end-use have received great attention these days, so many scientists and researchers have recently tended to think about natural fibers as a supporting material for composite materials. [2]

The high prices of reinforcement and building materials such as nanoparticles and synthetic fibers are considered one of the difficulties facing researchers, and for this it was necessary for researchers to find alternative materials that are natural and inexpensive, such as luffa fibers, cannabis, bamboo, coconut, flax, corn plates and others, so the researchers devoted their efforts towards using the waste of this material and benefiting from its fibers or particles. Or its outer or inner shell or its use in the form of panels or sheets - which are among the environmental waste - in the reinforcement of polymeric materials, building materials, etc., and thus we have obtained two benefits, the first: ridding the environment of these wastes, and the second: the exploitation of these wastes to strengthen these materials, so the issue of recyclinghas become one of the priorities of the industrial world today[3].

The luffa fiber is a climbing plant genus, belonging to the family of cucurbitaceae and is called by several names such as: lofa, sponge luffa, vegetable sponge, cylindrical luffa, bath sponge, and kitchen sponge. It is abundant in China, Japan, India, Central and South America, as well as other countries in Asia [4].

In their general study of luffa fibers [5], **Mwaikambo** and his colleagues found that these fibers exhibit hardness and strength and have a high-water absorption capacity compared to other natural fibers. **Interestingly, most of these fibers contain a quantity of cellulose**, **55-90% hemicellulose, 8-22% lignin**, **10-23% ash, 0.4%** and **other extracts 3.2% and this makes them suitable reinforcing materials for polymeric based composites [6].**

Luffa fibers have many uses, including: strengthening polymers [7], wastewater treatment [8], used as an auxiliary material to absorb colors in solutions, used in cleaning utensils as they are characterized by gaps in their natural composition as they are woven, used in the **manufacture of some automotive parts as well as shoes** [9] and other uses. Our current research aims to study the effect of luffa fiber reinforcement of unsaturated polyester with volumetric fractions of (5% ,5% ,10%, 15% ,20% , 25%) On mechanical properties such asthe bloodand the plastic.

2-1. Objective of the research:

Disposal of luffa fiber residues (LF) that affect the environment and improvement of the mechanical properties of polyester (UPS) resin fortified with luffa fiber (LF).

2-1. used Materials:

First: The matrix material (unsaturated polyester):

The unsaturated polyester (UPS) is in the form of a transparent liquid color with moderate viscosity (Saudi origin) and density (1.2 g/cm^3), where we can treat it until it is solid by adding a transparent hardener (Hardener), a compound of methythyl ketone peroxide (MEKP) and a ratio of (2g) per (100g) of resin, and an accelerated material is added for solidification, which is cobalt (Co – Catalyst). Which is in the form of a dark liquid color in the form of drops and an addition ratio of (0.2g) per (100g) of resin for the purpose of increasing the speed of the hardening process of the resin and after half an hour it begins to turn into a gelatinous substance (Gel) at room temperature.

Second: Supported Material:

We were able to obtain luffa fiber (LF) from the luffa plant found in Iraq, especially Anbar province, and it was extracted by special mechanical methods. Where the fibers were cleaned and washed with distilled water and then dried by an oven by a hot air oven at a temperature of (100 °C) for 15 minutes and then grinded in minutes at a volumetric fraction (0.3 mm) as shown in Figure (1).

Figure (1) Luffa fibers before and after grinding

2-2. Preparation of samples:

The manual molding method (Hand lay – up molding) was used to prepare the samples. A mold of manufactured aluminum with the required sample dimensions was used. The samples were prepared according to the volumetric fractions prepared for this research (5%, 10%, 15%, 20%, 25%), where unsaturated polyester (UPE) was mixed with its hardener in a ratio of 2:100 g) using a glass rod and gradually to get rid of bubble formation and to reach a homogeneous state.

Luffa fibers were added to the unsaturated polyester continuously to obtain a volumetric fraction of the fibers of (5 %) and this process is repeated for other volumetric fractions

The volumetric fraction of Leaf (V_f) associated with the gravimetric fraction of Leaf (Ψ) can be calculated using the following mathematical relationship [10]

$$Vf = \frac{1}{1+\frac{1-\Psi}{\Psi} x \frac{\rho_f}{\rho_m}} \quad \text{..... (1)}$$

$$\Psi = \left(\frac{W_f}{W_c}\right) x100\% \text{ ..... (2)}$$

$$W_c = W_f + W_m \quad \text{..... (3)}$$

W_f , W_m , W_C: Weight of composite material, base material and reinforcement material respectively measured in units (g).

: The density of the ρ_f , ρ_m *base material and the density of the reinforcement material measured in (*g/cm)^3.

When the molding process is completed, the heat treatment of the sample is done by placing it inside a hot air oven at a temperature of (50 °C) for a period of (60 min) in order to complete the solidification process and *obtain the best entanglement of polymeric chains and get rid of the stresses generated on the sample during the casting process.*

4-2. Mechanical Tests:

Impact Test

I use the Charpy Impact Test device manufactured by the American company Testing Machine INC., AMITYVILLE, New York to calculate the energy required for breakage, through which it is possible to calculate the impact resistance of the material. This device consists mainly of a pendulum and an energy meter where the hammer of the device, which carries an energy of (7.5) joules is raised to the maximum height and fixed well and the sample is placed in the place designated for it horizontally between the supports of the device and the energy meter is zeroed first and then The pendulum is released using the lever installed on the scale and with an oscillating motion the potential energy is converted into kinetic energy, part of which is lost in the sample fraction, so the meter indicator reads the breaking energy of the sample ((U_C, and Figure (4) shows the shock resistance samples before and after the test. The dimensions of the sample according to the harsh ISO 179) specification are as follows: the length of the sample is (55)mm , its width is (10)mm, and its thickness is (5)mm, and the shock resistance has been calculated. I.S (Impact Strength) from the following mathematical relationship [12]:

$I.S = U_C / A$ ..... (4)

Whereas: U_C: Breaking energy measured in KJ.

A : cross-sectional area of the sample measured in m^2.

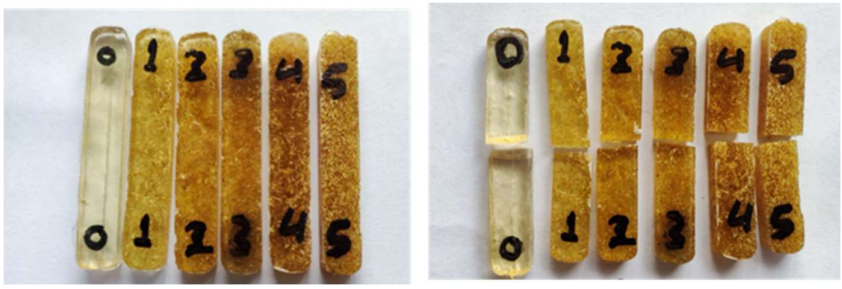


Figure 4 Shock samples before and after

Hardness test:

The hardness of the samples was measured using the method of Shore (D), which is of the type (HUATEC GROUP Hardness Tester HT-6600C Shore D) and manufactured by the Chinese company (HUATEC) and the device consists of a needle-shaped stitching tool that penetrates the surface of the sample to record the amount of hardness of the sample surface and all hardness tests were conducted at laboratory temperature (27 ˚C), where the samples were prepared according to the American international specifications [ASTM-D 2240][13], as shown in Figure (5), and Figure (6) shows the hardness test samples that have been prepared. The hardness test for polymeric samples enables us to know the cohesion of the mass of the material and its durability, so this test was conducted in order to measure the surface hardness of the samples prepared from polymeric materials and their fibrous compounds and for the various reinforcement ratios, as (10) readings were taken for each sample, then the rate of these readings was extracted to find out the hardness value, and the test was conducted at laboratory temperature. 27˚C) .

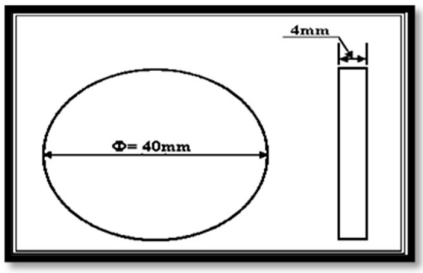


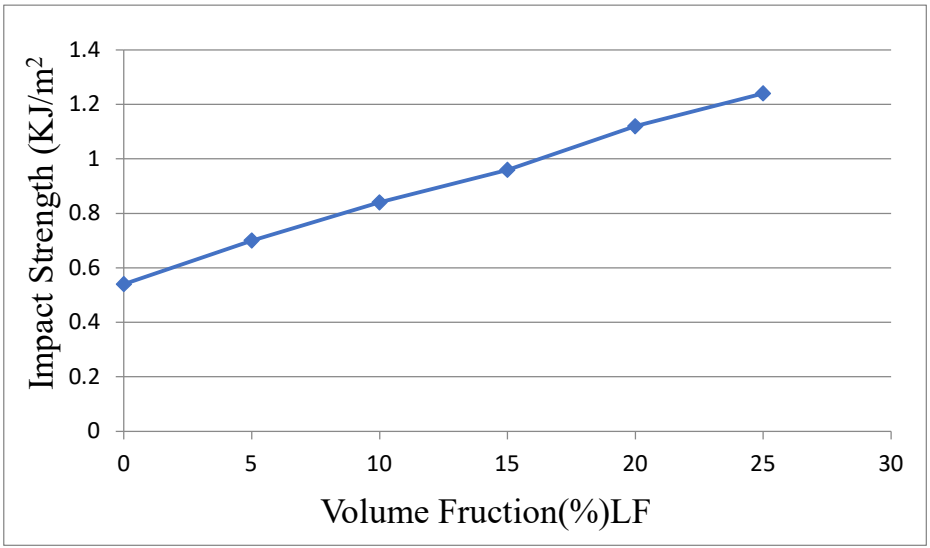
Figure (5) Standard dimensions of hardness samples according to American specifications (ASTM)

Figure (6) Hardness Test Samples

3- Results and discussion:

1-3. Impact Test

The results of the shock resistance test that was reached shown in Figure (7) for the prepared samples showed that there is a noticeable and significant improvement in the shock resistance of all samples when reinforced with luffa fibers, and the reason for this improvement is due to the presence of those reinforced fibers that bear the bulk of the shock stress on the material and transferred from the base material to those fibers through the interface, as these fibers distribute the external kinetic stress applied to the size of Larger than the sample and reduce the possibility of concentration of stress at its central region, the fibers will thus inhibit the growth of the fracture; this agrees with the researcher [15].



Relationship between impact resistance values and volumetric fraction of fibers

2-3. Hardness Test:

The hardness test for polymeric samples enables us to know the cohesion of the mass of the material and its durability, so this test was conducted in order to measure the surface hardness of the samples prepared from polymeric materials and fibrous compounds and for the various reinforcement ratios, as the readings were taken for each sample, then the rate of these readings was extracted to find out the hardness value, and the test was conducted at laboratory temperature (27°C). The results shown in Figure (8) for the hardness values of the prepared samples that there is a significant improvement in the hardness property of all samples when reinforced with luffa fibers. The reason for this is due to the presence of those reinforced fibers that are characterized by their high hardness; this agrees with the researcher [3], as the external stresses applied from the base material to the reinforced fibers are transmitted through the interface, so these fibers hinder the movement of polymeric chains, which leads to an improvement in mechanical properties, including the hardness property, and therefore the This leads to an increase in the resistance of the materials supported by these fibers to scratching and penetration, as well as the reinforcement fibers make the polymeric material more rigid and thus raise the hardness values of the prepared composite material, as well as these fibers will create a large adhesion force between them and the resin through a narrow and strong area

called the interface that increases the durability of the prepared samples, as well as these fibers will distribute the load applied to them, which reduces the penetration rate of the surface of the composite material Another reason for increasing the hardness values of the prepared material with an increase in the proportion of fibers added to the polymeric base material is that the fibers occupy the largest possible space within the resin, allowing for better distribution of the load applied to them; this is consistent with the researcher [16].

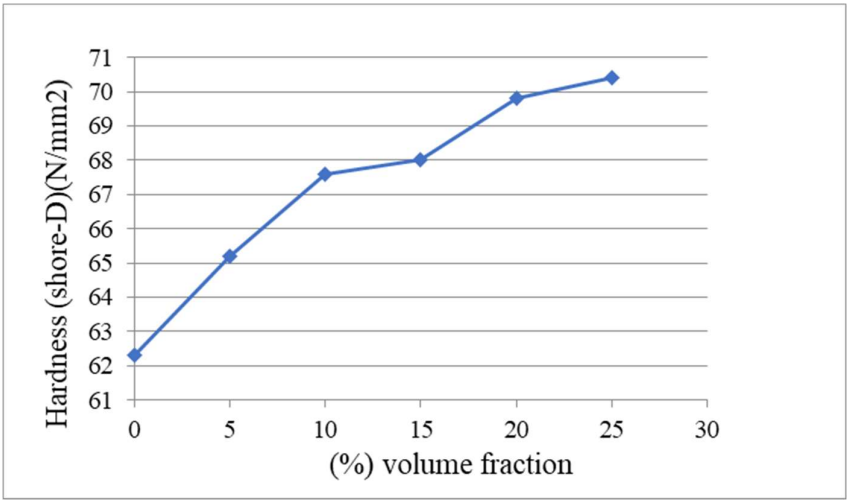


Figure (8) The relationship between hardness values and volumetric fraction of fibers

References

[1] K. R. Al-Rawi and R. A. Salman ,“ Study of Some Mechanical Properties For The Composite Material MgO - Epoxy ”, Al-Nahrain Journal of Science , Vol.(17) , No.(1) , PP.(10-14) , (2014).

[2] Singha, A.S and Vijay Kumar Thakur ,“ Mechanical properties of natural fiber reinforced polymer composites”, Bull. Mater. Sci., Vol. 31, No. 5, PP.(791–799), (2008).

[3] H. B. Al-Atraqchi ,“ Effect of Reinforced by Coconut Fiber Core on The Mechanical Properties for Un-Saturated Polyester Matrix Composite Material ”, Engineering and Technology Journal , Vol.(31) , No.(17) , PP.(296-308), (2013).

[4] Oboh IO, Aluyor EO. Luffa cylindrica—an emerging cash crop. African J Agric Res 2006; 4:684-8.

[5] Mwaikambo LY and Ansell MP. Chemical modification of hemp, sisal, and kapok fibers byalkalization.J Appl PolySci2002; 84: 2222–2234.

[6] Ouajai S and Shanks RA. Composition, structure and thermal degradation of hemp cellulose after chemical treatments. Polym Degrad Stab2005;89327–335.

[7] Tserki V, Matzinos P, Kokkou S, et al. Novel biodegrad-able composites based on treated lignocellulosic waste flour as filler. Part I. Surface chemical modification and characterization of waste flour.Compos Part A: Appl Sci Manuf 2005; 36: 965–974.

[8] Ray D, Sarkar BK, Rana AK, et al. Effect of alkali trea-ted jute fibers on composite properties. Bull Mater Sci.135–129 :24 ;2001.

[9] Nair KC, Diwan SM and Thomas S. Tensile properties of short sisal fiber reinforced polystyrene composites.J Appl Poly Sci1996; 60: 1483–1497.
[10] R. H. Mohamed , "A study of the effect of weathering conditions, radiation and chemical solutions on the properties of epoxy composites, " Master's thesis, Department of Applied Sciences, University of Technology, (2004).
[11] Astm, D.(2003).638 Standard Test Method for Tensile Properties of Plastics. ASTM, West Conshohocken, PA.
[12] Crawford R.J., (1987)," Plastics Engineering", 2nd edition, Pergamon Press, New York.
[13] Annual Book of ASTM Standard ," Standard Test Method For Plastics Properties *Durometer Hardness ", D(2240-03) , PP: (1-12),
[14] S. T. Sai, A. Bhaumik, B. Danappanavar, U. Joseph, and A. George , "Mechanical Characterization of Corn FiberPolypropylene Reinforced Composites at Different Fiber Weight FractionsEnriched UsingMaleic Anhydride Grafted Polypropylene , "Journal of Solid State Technology , Vol.(63), No.(5), PP.(2521-2527), (2020).
[15] R. A. Abbas ," Study What Can be Achieved by the Lack of Flexural Strain Energy of Change for The Efficient Recovery of Novolak of The Elasticity As a Result of Fiber-Reinforcement ", Engineering and Technology Journal, Vol.(30), No.(12), PP.(284-301), (2012).
[16] S. S. Al-Zubaidi ," Effect Of Solutions Absorption On Some Mechaical properties Of Polymeric Composite Blendens ", Master Thesis, College of Science , University of Anbar, (2015).