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Effect of Chemical Solution on Creep and Impact Properties of The Polymer Composites Reinforced

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ABSTRACT

In this study, creep resistance and the impact property of the high-density polyethylene as a matrix reinforced glass fibers (glass fiber short , glass fiber woving roving, and glass fiber short + glass fiber woving roving) for constant volume fraction 30%. These tests are carried out on samples at room temperature (23+3ºC). A comparison was done between woven roven samples, random samples and sandwich composite samples which consist of (woven roven and random). Finally, the results show that the sandwich composite gives higher creep strength, while the composite reinforced with woven roven fiber has maximum impact values; before and after immersion of chemical solution (KOH – HCl - $NaCO_3$, normality 0.5). Tests showed that the results of the values of each of the creep resistance and impact increases after immersion in chemical solutions, and that the solution KOH is more influential on creep resistance, and that the solution $NaCO_3$ is more influential impact resistance.

Keywords: *Composite HDPE, creep, impact*

1-INTRODUCTION

Study of the mechanical properties of engineering materials of things are very important because it determines the behavior of these materials under the influence of stress.[1] Under the influence of various external conditions (pressure, temperature, time of stress, speed stress, chemical solvents) and other factors that affect the mechanical properties of materials composite with basis polymer. After knowing the mechanical properties can choose appropriate material for practical purposes, according to the nature of matter[2]. Classification of the mechanical properties of materials depending on the nature of the forces to the (Statically Mechanical Properties), (Dynamic Mechanical Properties) [3,4].

The composite materials is a building consisting of two materials Or more with different specifications associated with each .A certain way to give the desired compositions. And be the best properties of properties Materials used in the composition if used Individually[5,6]. Composite Material consists of two phases 1- Matrix,2- Reinforced Material. These through the surface of the link called interface . Composite material may consist of a basic process of one or more It is material to Reinforcement one or more to get . Many composites , called the Material resulting hybrid composite materials [7].

The Impact testing can be used to compare new materials with other which have proved satisfactory in service. The presence of a notch in the specimen will create stress intensity in this region. The notch effects can be created by poor – quality, machined – surface finishes [8]. The creep mechanism is very important and complex so that no direct correlations are established between the creep behavior of any given material and its other mechanical characteristics, such as creep and yield strengths, hardness, impact..etc. Reinforcement material makes the Material matrix strength be stronger and stiffer than the matrix and capable of changing failure mechanism to the advantage of composite. Fibers are the most important fiber class of reinforcements, as they satisfy the desired conditions and transfer force to the matrix constituent. Influencing and enhancing their properties as desired. Glass fibers are the earliest known fibers used to reinforce composite materials [9].

Impact test is an attempt for measuring opposition to growth of craze, any opposition to growth of craze from any solid material depend on the mechanism of energy absorption [10]. polymer materials, is an instantaneous elastic strain followed by a viscous time-dependent strain. After an interval of time, and when the stress is removed, the elastic strain recovers immediately but the viscous time-dependent strain remains until the reversal of stress. This mechanism is attributed to the relocation of molecular chains of a material under stress from the sites with higher strain energy to the sites with lower strain energy.

Creep is the gradual increase in strain that occurs in a material when it is subjected to a constant load over an extended period of time. Viscoelastic materials, such as polymers can undergo creep at relatively low stress levels and often at temperatures below room temperature. Dimensional stability under stress is essential in many applications so creep can be a significant problem. Creep will ultimately lead to rupture either by ductile or brittle failure. At load temperatures and high loads creep rupture will be brittle, at intermediate loads and temperatures failure will be ductile, and after long lifetimes slow low energy brittle failures will occur. It is these slow low energy brittle

failures that are more problematic in the prediction of life expectancy [11].

2-EXPERIMENTAL PART

Using a high-density polyethylene (density 0.950 g/cm^2) as materials matrix , fiber glass [short fiber(density of 0.277 Kg/m^2) , Woven roven with angle of [(0^0-90^0) density (0.5 Kg/m2)] as materials reinforcement, three samples,[HDPE+Random, HDPE+woven roven, HDPE+ sandwich(w-r+r)] were prepared from materials composite manner thermal compression and constant volume fraction,. These tests are carried out on samples under the influence of normal conditions room temperature (23o+3^{o}C) and after immersion of all samples in the chemical solutions (KOH-HCL- $NaCO_3$) . The normality for all these chemical solutions is 0.5, Then the results were compared before and after immersion.

The Instruments of measuring mechanical properties used in this work can be clarified as follows : impact test instrument then creep test instrument.

Impact tests depend on the sample geometry and the method of measurement. These include the widely used Izod and Charpy tests in which a hammer like weight strikes a specimen and the energy-to- fraction is determined from the loss in the kinetic energy of the hammer[12]. The type of scientific device, which has been used, is (TMI) . It is made in New York, USA, in The Charpy impact test is . Hammers with various fracture energies are used. Hammers of (2, 5 and 30 Joul).

Impact strength is calculated from the relation [13]

I.S =U/A (J/m^2) ……... (1)

Where

I.S. = impact strength.

U = Energy of fracture in (joule).

A = Cross section area in (m^2).

Creep test instrument: using the creep instrument. After fixing the sample in situ, the required stress was applied; ΔL was determined by the dial gauge against the recorded time. It is possible to find out the relation of strain - time (ε-t) by dividing ΔL by the original length of the sample. using the stress constant for all specimens, the following equation is used.

$$\sigma = \frac{P}{A} = \frac{(2.96 + 8_{rn} \cdot 9.81)}{A} \quad \text{…….(2)}$$

The amount (2.96) represents special constant for the instrument of creep.

P: The amount of applied force to the sample (N).

m : The sum of the used masses (kg), which represents the masses of the beam + hanger + supporting pins that belong to the instrument in addition to the hanged mass.

A: The cross sectional area of the sample (m^2) [14].

The creep rate is found by determining the slope of the creep curve in the secondary creep stage[15].

Creep rate = Δε / Δ t……..…..(3)

3-RESULTS AND DISCUSSION

The chemical solutions, which have been used in this research ,results show in figs. (1,2,3,4,5,6,7,8,9,10,11and 12) for all samples one can notice that from curves an increase with strain rates takes place after immersion of samples in chemical solutions. The samples of blend reinforced with hybrid (f.g w-r+r) still possess a high creep resistance, followed by samples of reinforced with fiber glass(w-r), and samples of reinforced with fiber glass , finally a failure has been occurred in creep resistance for samples of reinforced with fiber glass (r). This situation can be explained as diffusion of corrosive liquids through the matrix materials lead to substantial reductions in mechanical properties.

From figs .(1,2,3,4,5,6,7,8,9,10,11and12) creep strength test show that samples of blend reinforced with hybrid (w-r+r) have highest values of creep strength. Samples of creep test which have been immerged in chemical solutions for months have been used in this test. NaCO3 is the most effective solution on samples due to values of creep strength, but there is no decisive explanation for it, there were only some ideas or expectations which relate this behavior to many factors such as composition, degree of homogeneity, crystallinity and interfacial adhesion [16].

Figs. (13, 14 ,15) shows the impact resistance of the samples reinforced fiber glass values (randum, woven roven, weaved woven roven + randum) due to increase energy fraction of the material composite prepared to carry reinforcement material part of the force of the impact so as to increase the interdependence of Material basis and materials reinforced as a result of the penetration of Material matrix between fiber which lead to increased energy needed to fraction the sample. In normal conditions , from figs .(13-14-15) results show that hybrid composite (HDPE) reinforced with glass fibers(woven roven+rondum)) has highest value of impact strength , While the lowest value for the impact resistance of composite material [HDPP+f.g(r)] . Figs.(13,14.15) shows an increasing of I.S due to the presence of those reinforcing materials. The reason behind this increase, is that the fibers tend to distribute the stresses on larger volume of the part instead of localizing them. The increase of I.S of hybrid-composites is more than that of E-glass-composites only [17].

impact test is an attempt for measuring opposition to growth of craze, any opposition to growth of craze from any solid material depend on the mechanism of energy absorption . This disability depends on the bonding strength of the interface between the surface of the reinforced materials and material matrix in order to fraction the transmission through the interface [18] .

The chemical solutions, which have been used in this research ,results show decrease of impact strength for all samples, While samples of blend reinforced fibers show an increase in

the values of impact strength especially after of immersion in the chemical solutions then values of impact strength are decreased. results show. highest values of impact strength after of immersion in Na CO_3 as compared with immersion samples in the other chemical solutions

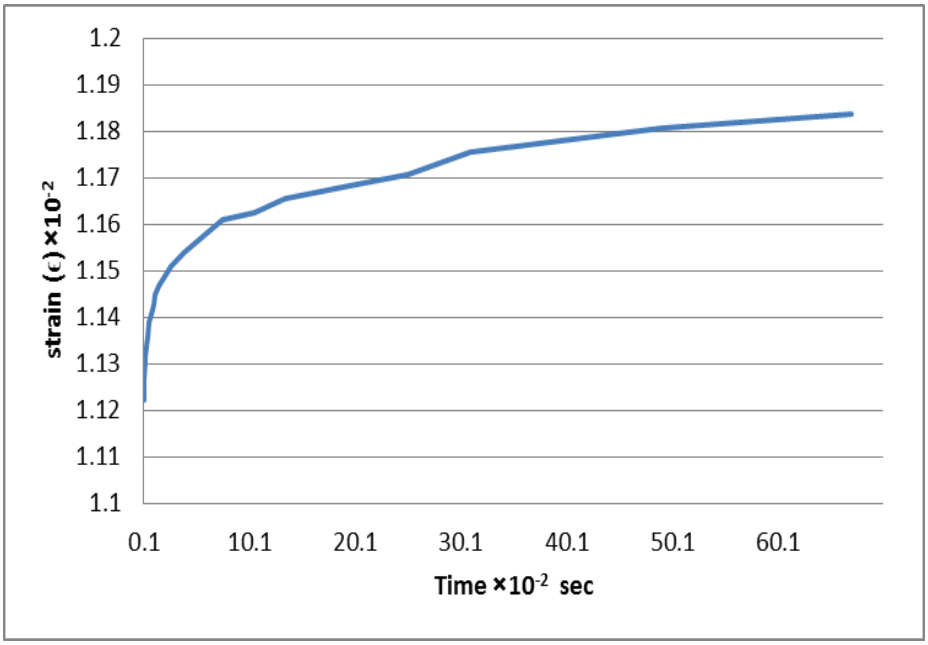

Fig .(1): Variation in the (creep_ strain) with the time to HDPE+f.g(r) before immersion in chemical solutions

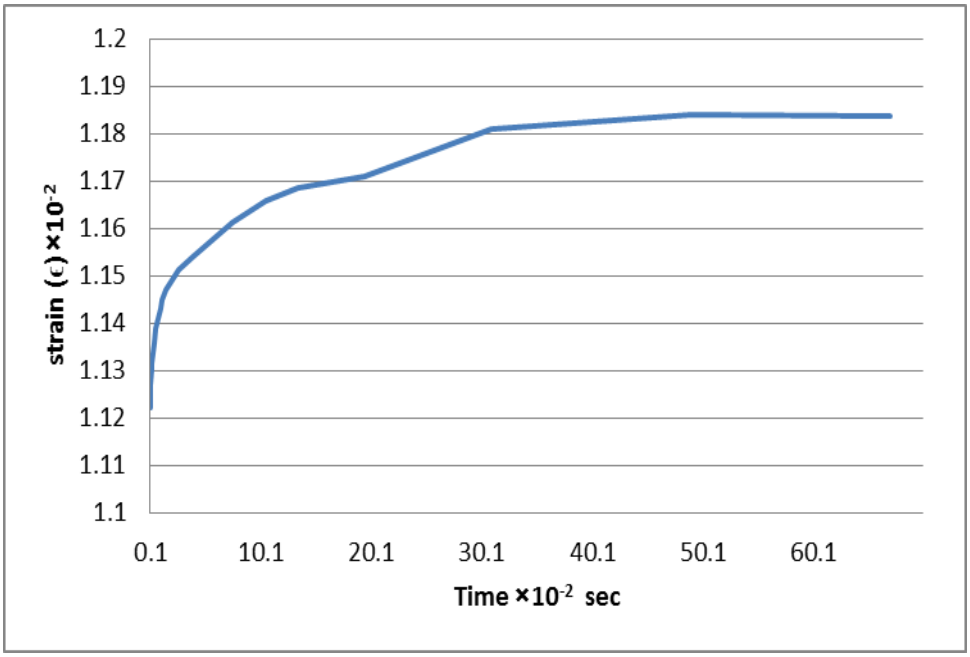

Fig .(2): Variation in the (creep_ strain) with the time to HDPE+f.g(r) after immersion KOH

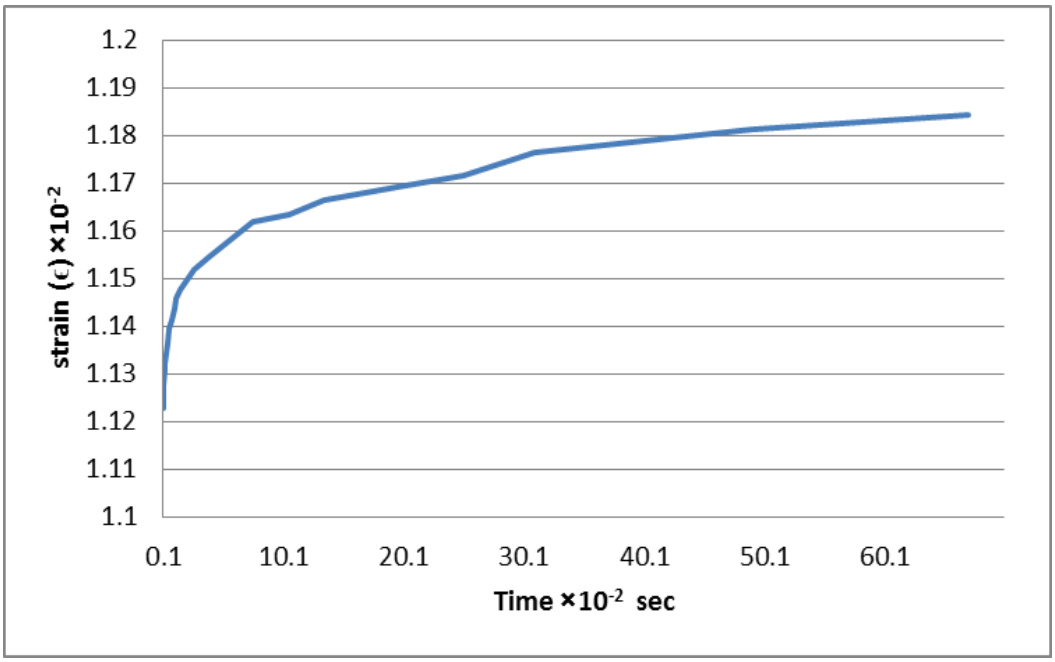

Fig .(3): Variation in the (creep_ strain) with the time to HDPE+f.g(r) after immersion HCl

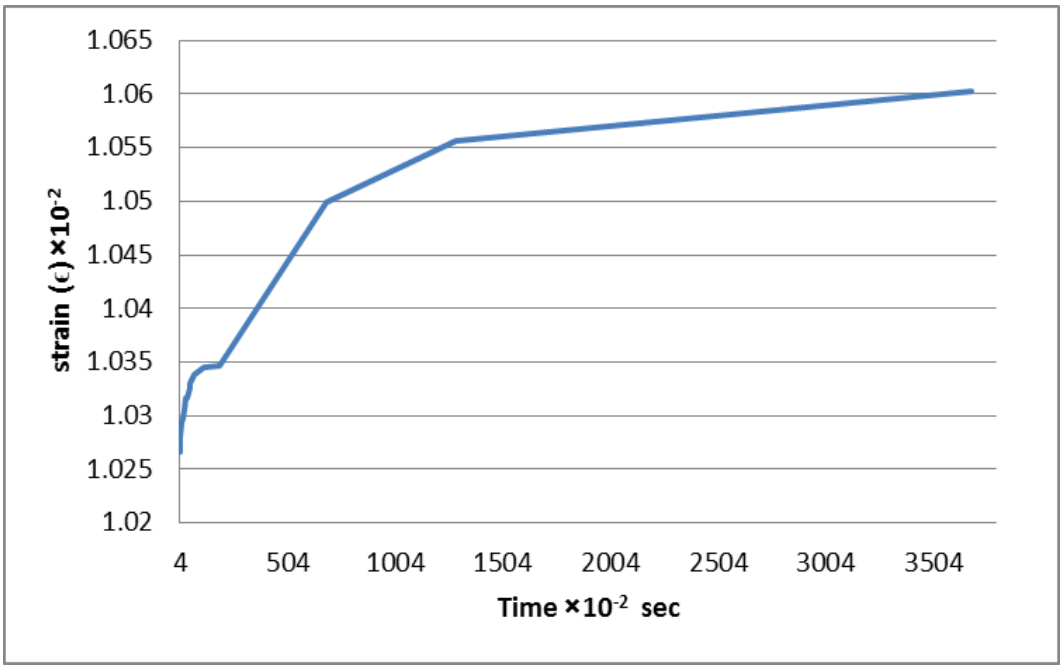

Fig .(4): Variation in the (creep_ strain) with the time to HDPE+f.g(r) after immersion NaCO3

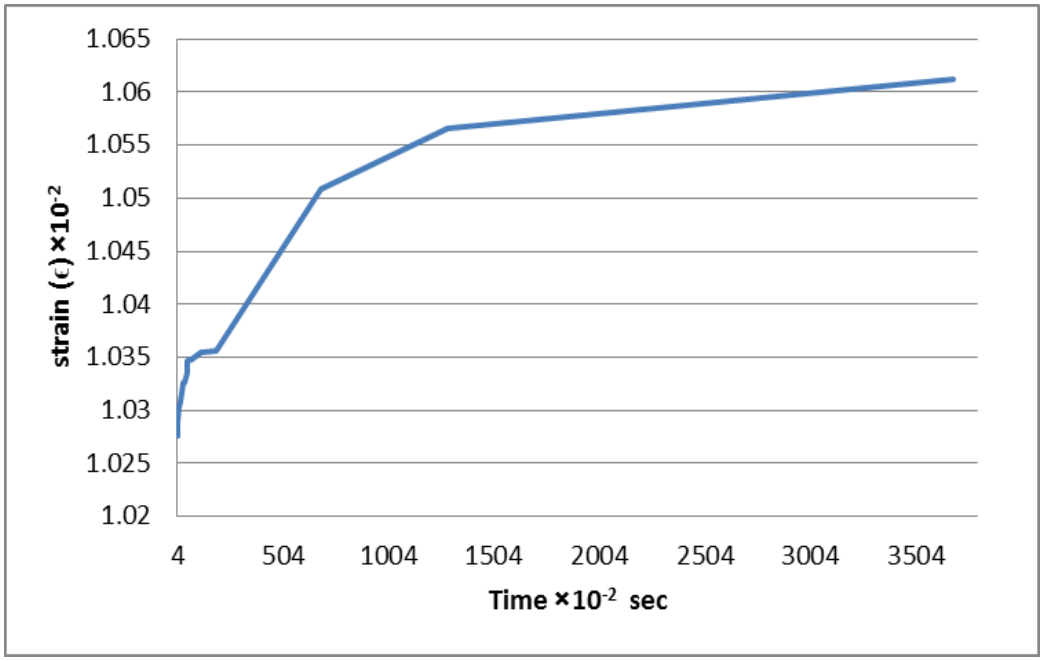

Fig .(5): Variation in the (creep_ strain) with the time to HDPE+f.g(w.r) before immersion in chemical solutions

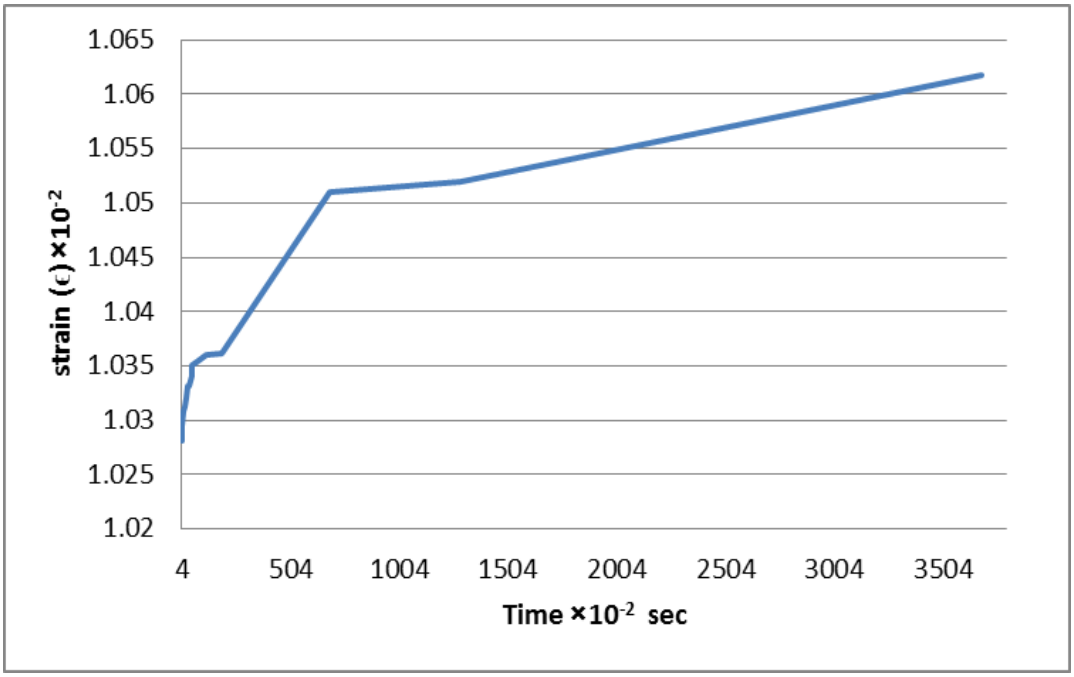

Fig .(6): Variation in the (creep_ strain) with the time to HDPE+f.g(w.r) after immersion in KOH

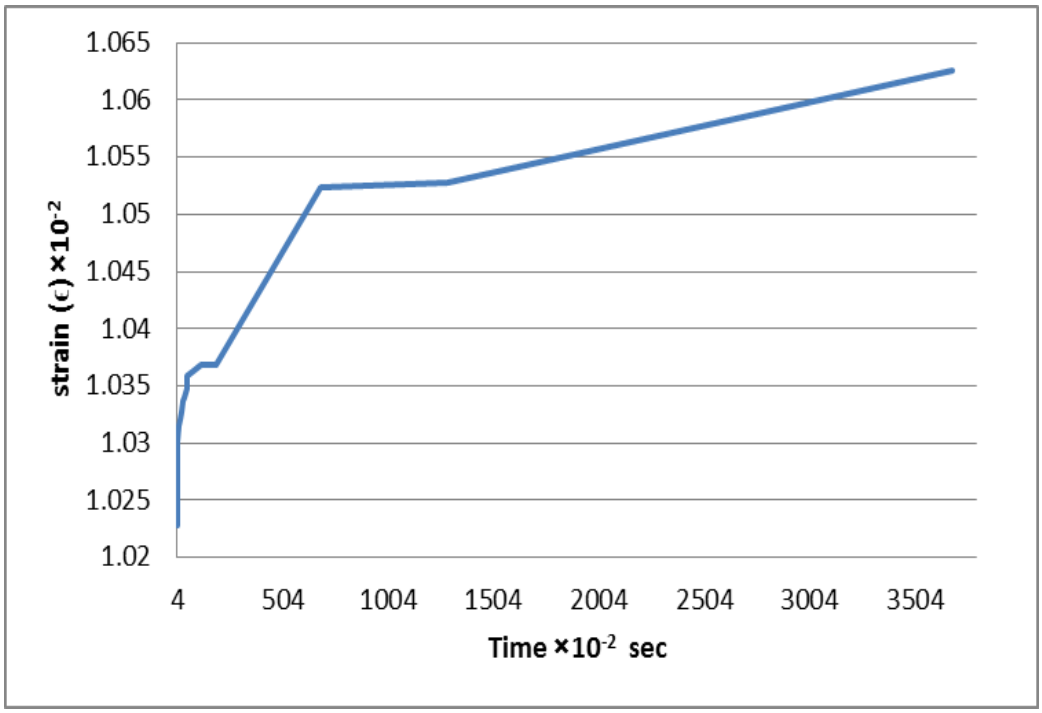

Fig .(7): Variation in the (creep_ strain) with the time to HDPE+f.g(w.r) after immersion in HCl

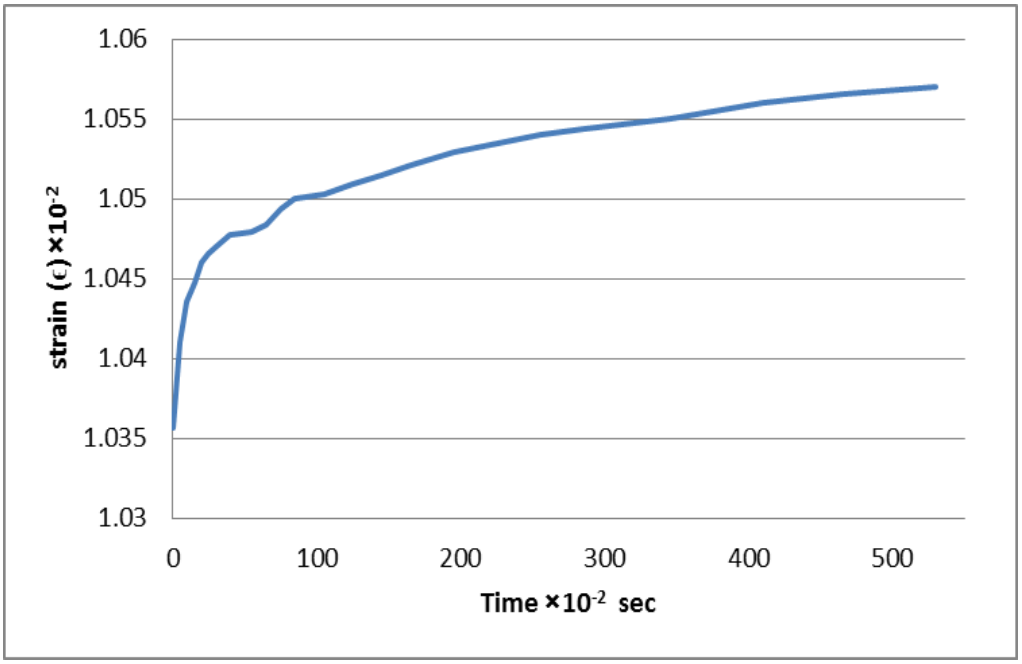

Fig .(8): Variation in the (creep_ strain) with the time to HDPE+f.g(w.r) after immersion in NaCO3

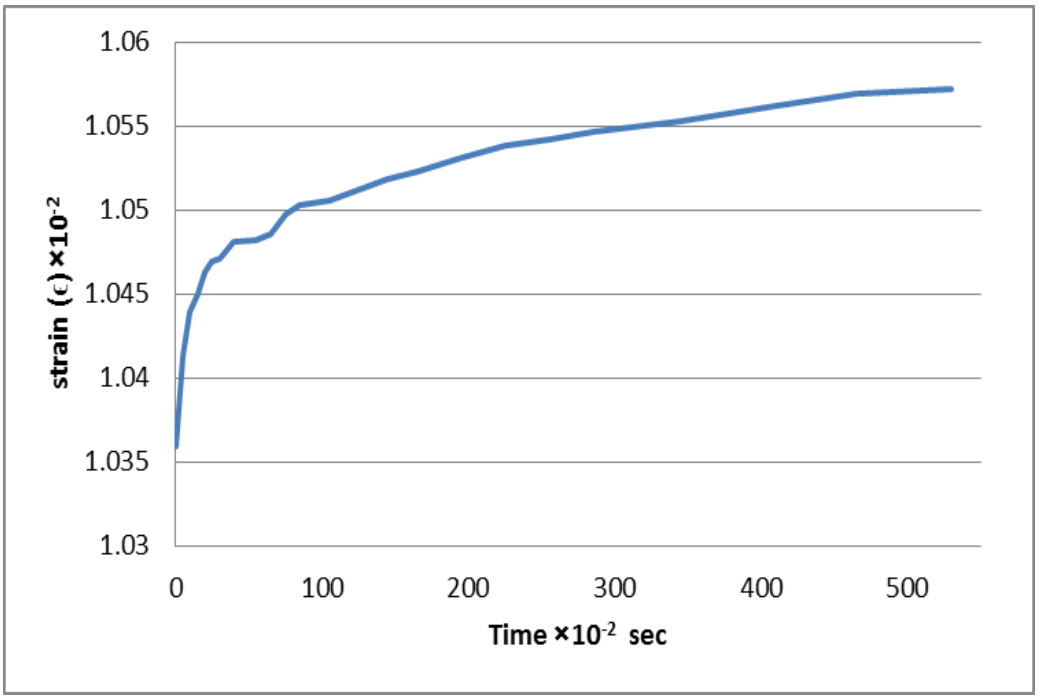

Fig .(9): Variation in the (creep_ strain) with the time to HDPE +f.g(w.r+r) before immersion in chemical solutions

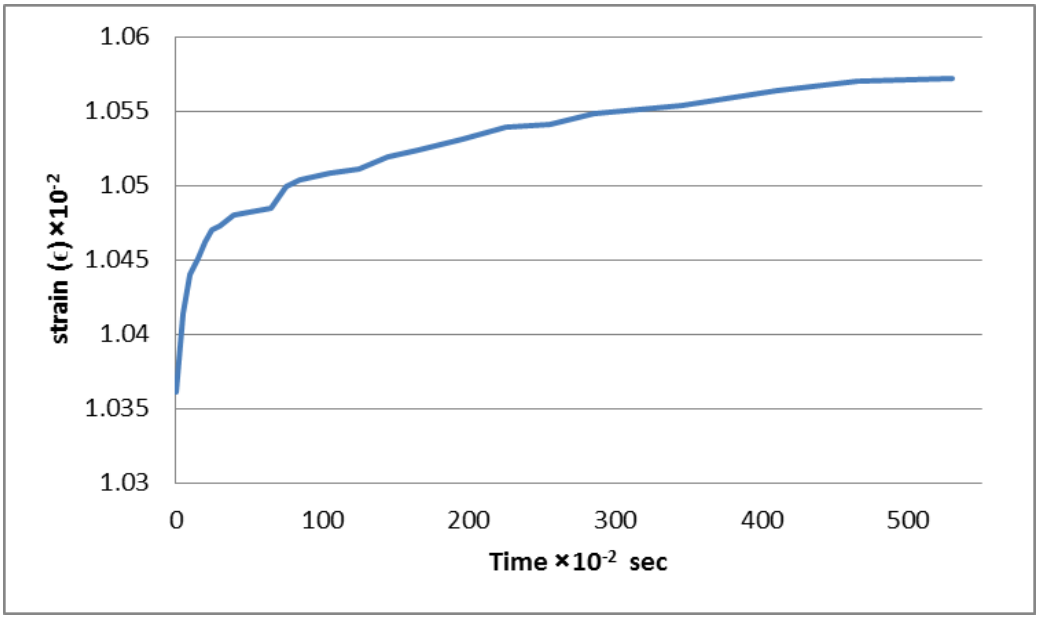

Fig .(10): Variation in the (creep_ strain) with the time to HDPP+f.g(w.r+r) after immersion in KOH

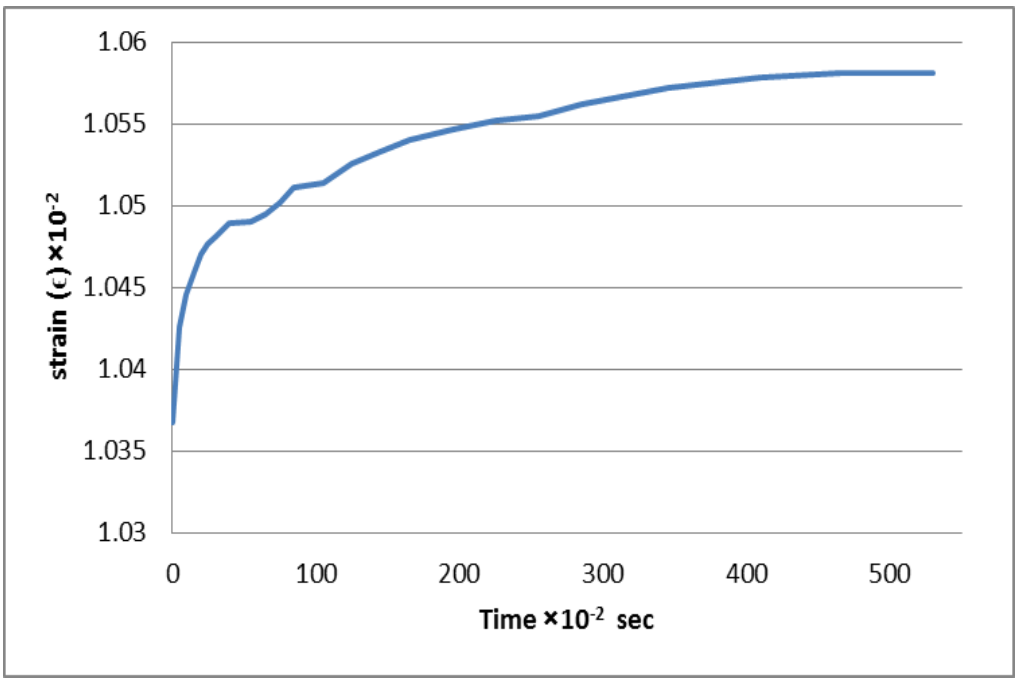

Fig .(11): Variation in the (creep_ strain) with the time to HDPE+f.g(w.r+r) after immersion in HCl

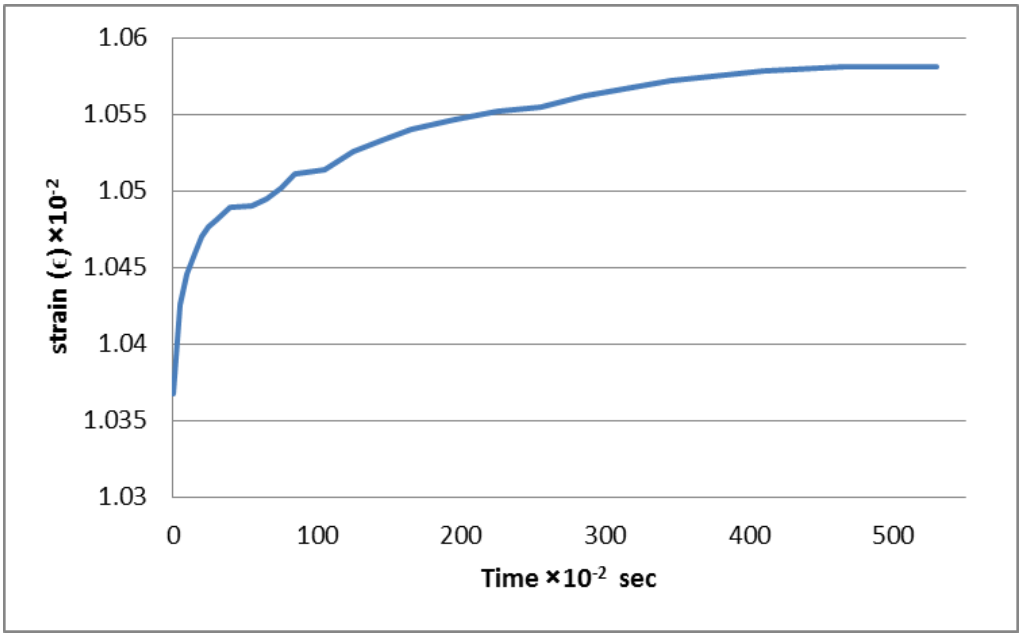

Fig .(12): Variation in the (creep_ strain) with the time to HDPE+f.g(w.r+r) after immersion in NaCO3

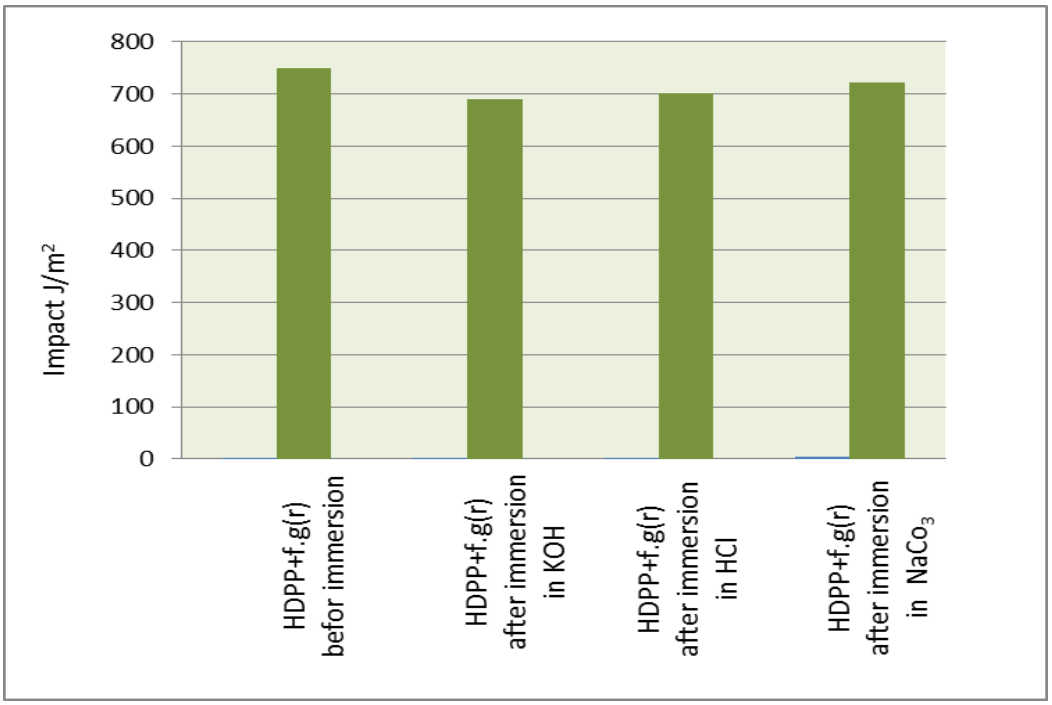

Fig .(13): Variation in the impact values to HDPE+f.g(r) before and after immersion

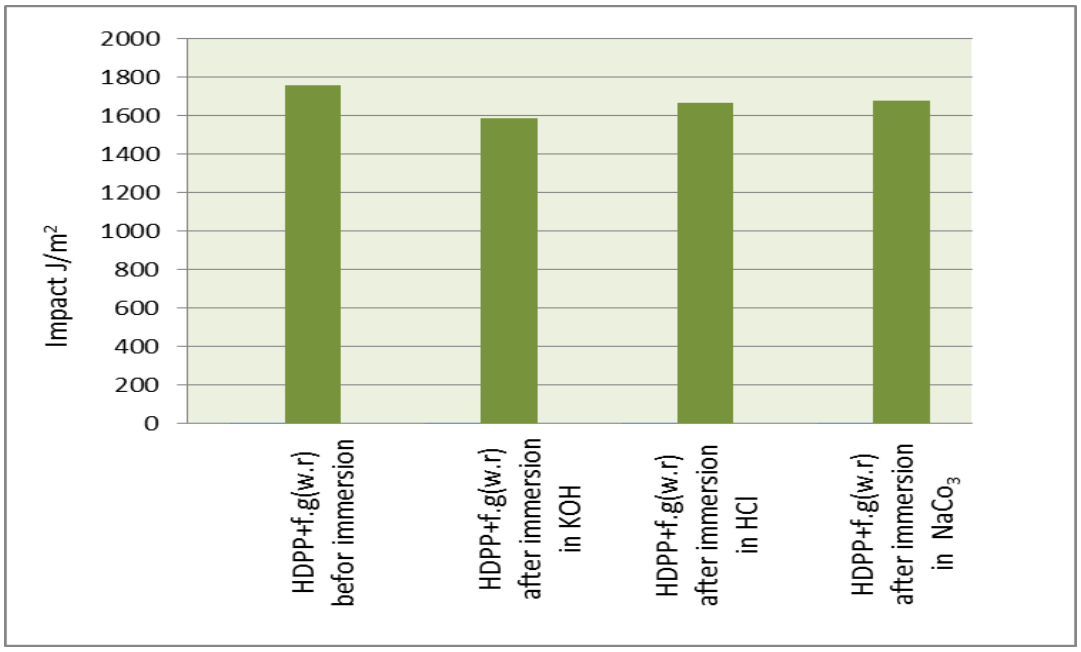

Fig .(14): Variation in the impact values to HDPE+f.g(w.r) before and after immersion

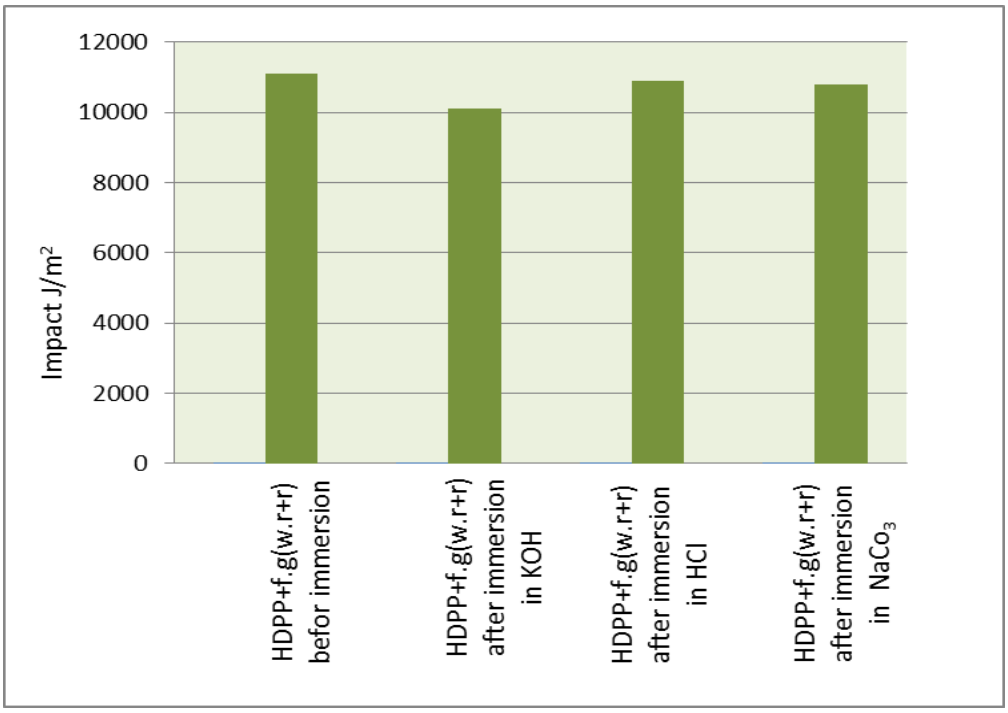

Fig .(15): Variation in the impact values to HDPE+f.g(w.r+r) before and after immersion

4-CONCLUSIONS

The results showed that, the mechanical tests values increased when materials reinforced by glass fiber. Composite materials of reinforced with hybrid (w-r+r) succeed to prove better mechanical properties in most of the mechanical tests that have been done in this research. While samples of blend reinforced with fiber glass (r) failed in most of the mechanical tests; they have weak mechanical properties, which means that they have limited applications.

Values of parameters related to the mechanical tests are reduced when samples are immerged in chemical solutions. All the chemical solutions have a great effect on samples due to the obtained results, but KOH is the most effective solution, followed by NaCO3, and finally HCl.

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