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The studying of Wear property for Hybrid Polyester Composites of Glass Fibber and Continuous Carbon Fibber

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Abstract

The aim of this research is to prepare composites material in a simple way (Manual Moulding Method) of which is reinforced by polyester resin glass fiber and continuous carbon fiber in fraction volumetric (20%, 30%, 40%) and the wear was measured, and the result declared that wear was decreased by increasing the fraction volumetric and curing time.

Key words: Unsaturated Polyester resin, glass fiber, carbon fiber, wear

دراسة خاصية التآكل لمركبات البوليستر الهجينة المصنوعة من ألياف الزجاج وألياف الكربون المستمرة

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الخلاصة

هدف هذا البحث هو تحضير مواد متراكبة وهي عبارة عن بناء مكون من مادتين او اكثر تمتلك مواصفات مختلفة ترتبط مع بعضها بطريقة معينة لتعطي التركيب المرغوب به ، وتكون ذات خصائص افضل من خصائص المواد الداخلة في تكوينها فيما لو استخدمت بشكل منفرد ، واستخدمت اسهل طريقة وهي طريقه (القولبة اليدوية) من تدعيم راتنج البولي استر مع الالياف الزجاجية والياف الكاربون المستمر وبكسور حجمية مختلفة (20%،30%،40%) وتم قياس البلى ، وأوضحت النتائج العملية ان البلى يقل بزيادة الكسر الحجمي وبزيادة زمن التقسية (curing time).

1. Introduction:

The composite materials are used to produce mixture of properties which can't obtain them from the matrix materials. These materials are used in different fields and different shapes either continuous and intermittent fibers, fillings, particles, or peels.

Advanced Composites term has appeared in design of new materials which have distinguished properties employed in advanced technological applications.

Hybrid composites are defined as the materials that are produced either by mixing more than of reinforced materials with matrix material or mixing two or more of matrix materials of reinforced materials. [4]

Working on the development of composite materials by reinforced them, by unpolluted fiber instead of industrial materials, became more important thing early because of increasing of environment awareness. [11]

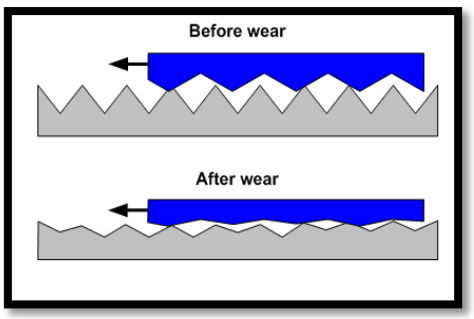
Composite polymer materials have been used in engineering, constructional industries fields, sectors of bridges design and its rehabilitate, laying of cables and also in military and space applications.

The cause of using the fibers in reinforcement of polymer materials instead of particles, is homogeneity of properties, low coast, easy to produce and using in thermal and electrical insulations and other industrial applications. [9]

1-1 Wear

Sliding Wear tester has been used which consists of flat metal arm including holder to fix the sample and roller iron disk contacted with an electric motor. When the sample is put over the solid surface, it would not only suffer of friction but wear too. The particles will be lost of both surfaces even one of the surfaces is more solid than other. And wear is caused by the same process which causes the friction like moving sharp ridges between the two surfaces. And what we should keep our attention, is polymers mostly have wear rate ((2-10)X10^{-8} N/mm^2) [6], so, wear occurs naturally between any two surfaces have movement rate.

Wear has species which are: chemical, physical and electro-static wear [15]. The figure (1) shows the sharp ridge movement between two contacting surfaces and shows what is happened before and after the wear process.



The shapes of movement which produce wear process, are consisted of four major types of wear. [14]

Figure1 shows the sharp ridge between two contacting surfaces before and after the wear

1. Sliding motion
2. Impact motion
3. Rolling motion
4. Flow motion

There are many types of wear, according to the test which are measured:

1. Erosive Wear
2. Abrasive Wear
3. Corrosive Wear
4. Surface Fatigue Wear
5. Fretting Wear
6. Adhesive Wear

Methods of Wear Measurements

Weigh Method

One of the simple methods to calculate wear rate, is weigh method, which involves the sample weight before and after the test, then the difference in weigh should be calculated. And wear rate can be calculated by the following aquation.[13]

$$\text{Wear Rate } (W_R) = \frac{\Delta m}{s_D}\left(\frac{gm}{Cm}\right) \dots\dots\dots\dots (1-1)$$

Δm the difference in the simple weight before and after the test (gm)

And s_D presents the sliding distance given in aquation:

$$S_D = 2\Pi rnt \dots\dots\dots\dots (1-2)$$

Then

r: a radius from the centre of sample to the centre of disk (cm)

n: round number of the disk (m/r)

t: test time (m)

2. Experimental work

2-1 Matrix Material

One of the properties matrix materials has, should be a medium that connects the reinforced materials to each other. And that material could transport and contribute the forces and exertions on the reinforced material. Also, protects the reinforced materials from the damage of surfaces that produced of chemical reactions or of mechanical effects with the outer.

So, in this research, unsaturated Polyester is used, which is Thermosetting Resin type (Siropol-8341), that made by (SIR) Saudi Company. Thus, it is adhesive pink liquid at the room temperature with density between (1-2 gm/cm^3) and this be set when adding solid liquid type (Peroxide Methyl Ethyl Ketone) (PMEK). It is soft liquid and mix with 2mg rate for (100gm). [2]

Figure2 Polyester Unsaturated

2-2 Reinforcement Materials

These materials are added to matrix materials in composite materials that have high resistance and strength to increase its force and solidity and changing the thermal and electrical conduct and this represents the solid part of composite material. Reinforcement material might be ceramic, metal or polymer.

Reinforcement materials are classified into different shapes and types according to the using like, Fibers, Particles and Flakes. [12]

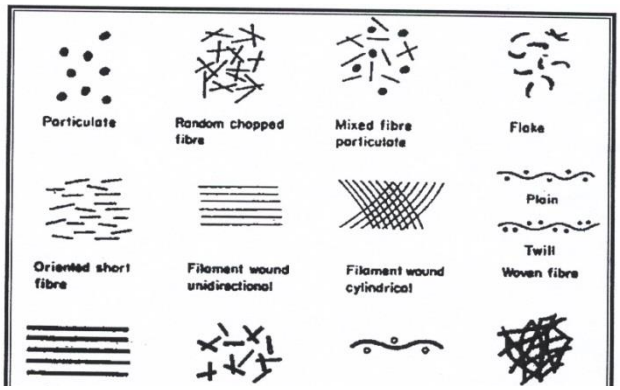


Figure3 Different types of single and homogenous reinforced materials

In this research, we use two types of reinforcement material are:

2-2-1 Glass Fiber

Glass Fiber has the unique properties of ordinary glass in terms of hardness, transparency, wear resistance, light wight, flexibility and processability. [5]

Glass Fiber is made by mixing matrix material of glass in needed rate and melts in melting furnace up to (1350-1400C^0) then are passed through bushings and pulled from another end in fiber shape. And lessening the fibers' fraction by matrix polymer materials in case of using them as reinforced materials because the connected material works as complex molecules, and that work in one hand with glass fiber surface and in another hand work with matrix polymer material at the setting. The density of glass fiber is about (2.54g/cm^3) and it has different types like rough (E-glass) used in this research as shown figure (4) that has high electrical insulator and high thermo-resistance. [8].

Figure4 Rough Glass Fiber

2.2-2 Continuous Carbon Fiber

It is fiber with density (1.8gm/cm^3) and micro fiber about (0.001-0.002mm) radius. Using this material briefly are:

- Different lengths are available and easy to transport as roller according to the production way as shown in figure (5).
- Sustainability in reinforcing systems through its wear resistance and the basic effects.
- High resistance of overload tension reaches more than (2400MPa).
- It has a high flexibility factor reaches more than (165000 MPa).
- It is considered light weight material that complex installing will not be needed. [7]

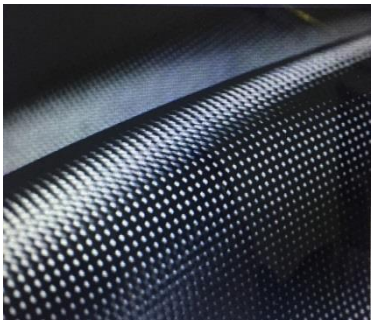


Figure5 Continuous Carbon Fiber

2-3 Preparation of Composite Samples

The simplest way preparation, that is manual moulding method, is used to prepare polymer composites because it is a successful way and easy to use. Two types of composites according to the hypered composites are prepared as shown in figure (6).

1. Composites samples are formed from reinforcing polyester (Glass Fiber layer + two layers of Continuous Carbon Fiber + Glass Fiber layer).
2. Composites samples are fromed reinforcing polyester (Continuous Carbon Fiber layer + two layers of Glass Fiber + Continuous Carbon Fiber layer).

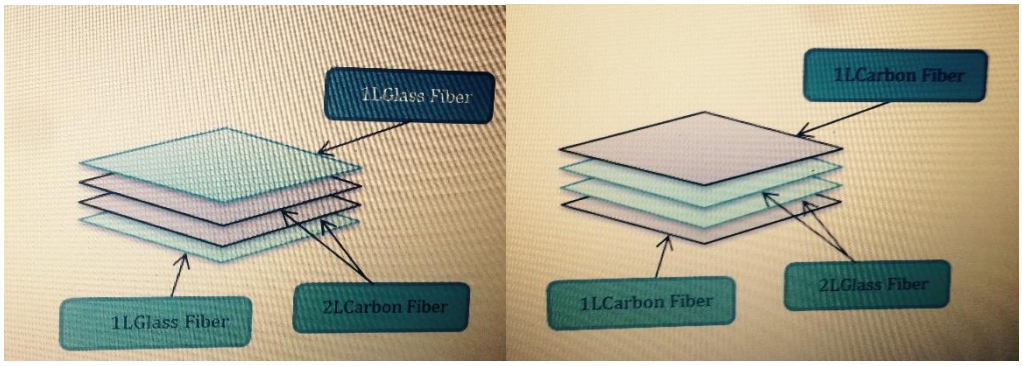
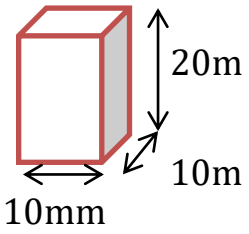


Figure6 Interference and switching Glass Fiber layers with Continuous Carbon Fiber

2-4 Cutting and Softening The Test Samples

For inspect the wear test, the test samples are cut and softened according to its own international dimensions as shown in figure (1).

Table1 standard Dimensions for samples that prepared

Standard System	Standard Dimensions of Samples	Types of Tests
ASTM		Wear test

3- The Used Devices

3-1 Wear Device

It is consisted of rotating iron disk connected with electrical motor as shown in figure (7)., metal flat arm contains holder to fix the sample, and the rotary disk speed is about (500 r/m). In this test, the sample surface is softened before the test by using softening paper of silicon carbide [1].

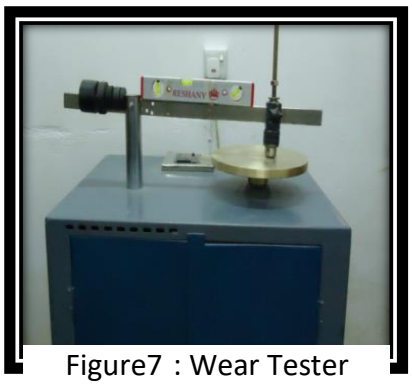


Figure7 : Wear Tester

Wear rate measurement

Wear rate is calculated by the following steps, that shows the loosing of sample mass, are:

1. Sample mass before the test W_1.
2. Install the sample by device holder and make the sample identical to the disk.

3. The arm should be put horizontally by level scale before putting the load on it.
4. For each test, the required load should be put.
5. Turn the device on for 10 minutes.
6. The sample mass is calculated after W_2 test to determine the mass loosing.

4- Results and Discussion

Weigh method was used to calculate the wear rate so, the sample was weighed before and after the test and the experimental results are shown in figures (8), (9), (10), that declare the relationship between fraction volumetric and the wear rate at the curing time (2 hours) and (4 hours). Those results showed that wear rate decreased with fraction volumetric. And, also decreased with curing time for all (G.+ ch.+ G.) and (Ch. + G. Ch.) samples because decreasing the sample at the friction that leads to decreasing the wear rate because of increasing of friction force for (F) friction force correlated with (N) press force

$$F \alpha N$$

$$F = \mu N \dots\dots\dots\dots . (4-1)$$

Then: μ is friction factor

The contacted surfaces consist of edges and asperities and at the beginning of contacting between the two surfaces, occurs at the sharp edges when the load applied. In addition to that, the temperature has affection on the wear rate, so the increasing of temperature will increase of the material plasticity leading to increasing of adhesion between the surface asperities, so the wear rate decreases according to [10].

The figure (10) shows the comparison of all samples at the curing time (2h) , (4h). and the highest value was (0.084) to the first set (Glass Fiber layer + two layers of Continuous Carbon Fiber + Glass Fiber layer) at curing time (2h). because the effect of the reinforced saturated polyester fiber made the sample stronger and less friction between the conducted surfaces.

While the lowest value was (0.001) at the second set (Continuous Carbon Fiber layer + two layers of Glass Fiber + Continuous Carbon Fiber layer) at the curing time (4h) because the Carbon fiber rate will be greater, in addition to the air holes into the Carbon fiber, which lessens the perfect adhesion among fibers,

and don't permit of the reaching the certain surface and the matrix material, but changing of the curing time from (2h) to (4h) led to decrease the wear rate because of effects of friction loads between the conducted surfaces according to [3].

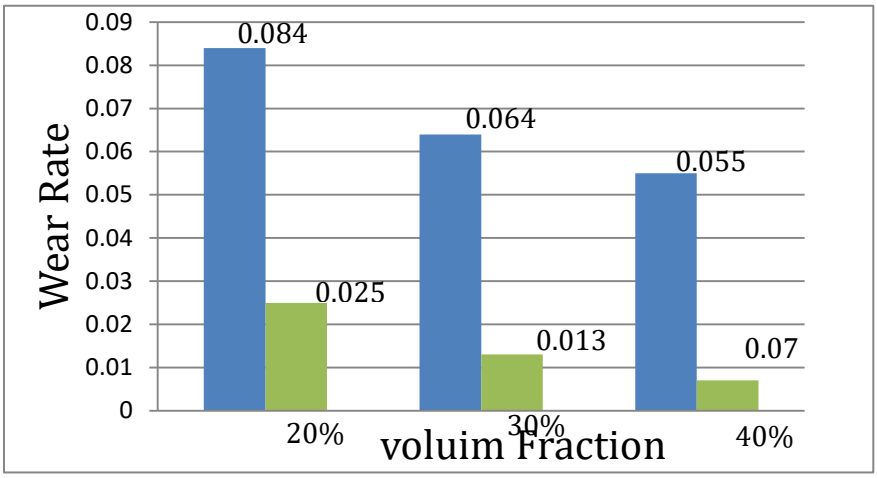
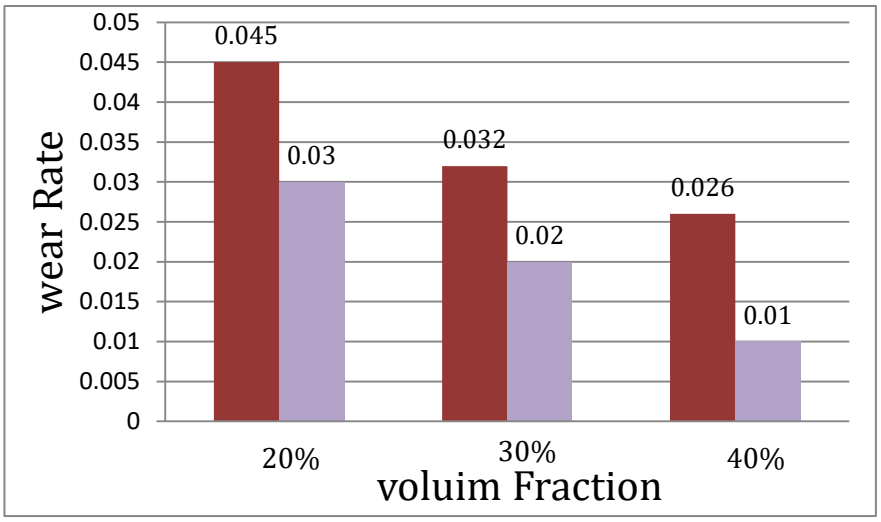


Figure8 Comparison between Wear Rate and Volumetric for (G.+ch+G.) and (Ch.+G.+Ch.) samples at the Current time (2h)



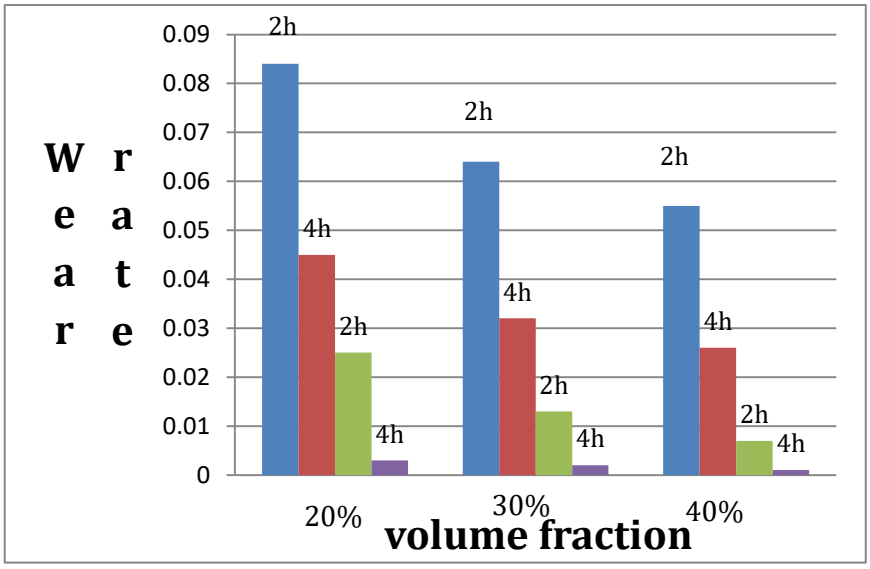


Figure9 Comparison between Wear Rate and Volumetric for (G.+ch+G.) and (Ch.+G.+Ch.) samples at the Current time (4h)

5- Conclusions

The experimental results that were obtained are:

1. The study showed that the wear rate decreased with volumetric increasing for all samples.
2. The results showed that the wear rate also decreased with curing time increasing for all samples

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Figure10 Comparison between Wear Rate and Volumetric for samples at the Current time

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