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Study some Mechanical Properties for Unsaturated Polyester resin reinforced with Powder and Nano Magnesium Oxide

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Abstract

This work included preparation two groups polymeric composites, from unsaturated polyester resin reinforced with Magnesium Oxide with weight fraction{ 3%,6%,9%,12%,15% }gm by employing hand lay-up method. First group (G1: powder MgO) : consists of five samples prepared from reinforcing unsaturated polyester with (MgO powder) in the same above weight fraction .Second group { G2 : Nano . MgO) : consists of five samples prepared from reinforcing unsaturated polyester with (Nano MgO) in the same above weight fraction. Bending results showed that the deflection is directly proportional with the applied load for all samples, and Young Modulus decreases with increasing the weight fraction of MgO – for all samples this value of (Ea) be ($28.97x10^2$ MPa) for sample No.(1P.) and this value decreases to ($25.36x10^2$MPa) for the sample (5P) . The same result for samples reinforced with Nano MgO , the value of (Ea) for sample No.(1N) is ($26.14x10^2$MPa) and this value decreases with increasing concentration to value ($24.56x10^2$MPa) for sample No.(5N).Wear rate increases with increasing the weight fraction of MgO in the samples , the wear rate is ($2.335x10^{-8}$ g/cm) for sample No.(1P) , increases to ($3.927x10^{-8}$gm/cm) for sample No.(5P) , and the same case for samples of (G2) . The value of wear rate for samples of (G1) is more than the value of wear rate for the samples of (G2).

Keywords: unsaturated polyester resin, Magnesium Oxide Powder, Nano Magnesium Oxide, Bending test, Wear rate test.

Introduction:

Composite materials Know as solid systems those resulting from the mixing of two or more different forms or structures, on condition that they do not chemically interact but they have a physical bondbetween them in order tocreate a new different material that differ in its properties from the individual properties of the initial materials[1,2]. composite material mainly consist from Matrix Material and Reinforcement. It is possible that they be in form of polymeric materials or metal or ceramic.

Polymers are inert and lightweight materials, generally they have a high degree of ductility, characterized by low electrical conductivity and thermal so they use as electrical and thermal insulators. They show a low intensity and large elongation when compared with the minerals with changing of temperature. Furthermore, they have stiffness, low-lying, high corrosion resistance. Thus, they do not consider from the hardened materials [2].

Unsaturated Polyester resin

Unsaturated Polyester resin recently consider from a common used polymeric materials in all applications because of its low costing and its fast performance and operating. polyester interaction is one of heat emitting interactions, thus we must overcome and control this heat during the forming process. The high temperature leads to occur cracks and fissures caused by generating heat stress in the final product. Therefore,this will affect on the mechanical, physical, and electrical properties of these materials.Polyester prepares from Raw materials which can be obtained from petroleum. It is the result of Dicarboxyliereaction

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with Dihydric Alcohol. Terephthalicacid is one of the most acid used in the preparation of polyester.A changing in this reaction produces many kinds of materials with different propertiesof resins.

Where these physical and electrical properties look at the most important features of the polyester as well as its easy handling and stiffness without escalating gas or any other results. Polyester characterize as highresistanceof corrosion and temperatures when adding small amounts of chemical certain, as well as its resistance to weather conditions like ultraviolet radiations. The modern evolutionwhich took place on this material made it is possible to form a various forms of affordable with appropriate prices better than it in last times. It is not preferable to usethese resins on their own because they are not strong enough, but when they combine with tonic materials within certain combinations will gain good properties make it suitable for use in different areas such as the ability to withstand inflicted weightlifting [3.4].

Experimental Part

We have prepared a composed material consists a polyester resin sustained by MgO powder andMgO nano particles by using Hand lay-up molding because it is an easy and common use method. Unsaturated Polyester resin has been used as a basis in the preparation of polymeric materials which manufact ured by SIR Company(Saudi Arabia). This resin can be found in form of liquid, viscous, transparent pink color at room temperature with a density of (1.1-1.4gm / cm^3). It turns from a liquid to a solid state by adding a hardener manufactured by the (SIR) company (Saudi Arabia) as well. The type of resin is Methyl ethyl Keton peroxide and it is symbolized by the (MEKP). It shows as a transparent liquid form. It adds to the polyester resin with mixing rate 2 gm per 100 gm.

The reinforcement material that used in this research are magnesium oxide MgO in both Magnesium Oxide Pure Powder and Magnesium Oxide Nano Powder by weight percentages (3% ,6%, 9% , 12% ,15% each). The magnesium oxide powder has a 150 µm grain size and the purity of 99.9% which imported from the British company (AnalaR - Dehaen AG).

The Nano powder magnesium oxide is a granular size (30-40 nm) and purity of 99.9% which has produced by the Chinese company (Nanjing Nano technology).

Mechanical tests

1- Bending Test

Bending resistance can be define as the sample's ability to bend under the influence of hanging pregnancy without breaking it [5], where this test isone of the most important tests of composited materials which uses to determine the properties of flexibility and plasticity.The bending resistance of the material is defined as the affordability of materialto the forces of bending inflicted more perpendicular to the longitudinal axis.As well as, it consider as one of the complicated tests being contains more than one type of stress, such as compression stress in the upper section of the layers and the tensile stress in the lower section of the layers, but sometimes overcomes one over the other and cause material failure. There are some of the factors influencing this test which are type and the rate of loading, the distance between the cushion, and the dimensions of the cross-section of the model [6].

There are two ways of calculating :

1. triple points bending test (Three- point Test)

2. quadruple points bending test (Four - point test)

The triple bending points is one of the most common and easy test in bending calculation. Bending flexibility coefficient is measured by the unit (MPa) by using the following equation:

$$E_b = \frac{FL^3}{48I\delta}$$

whereas:
F: The force hanging over the sample (N)

L: The distance between cushion (mm)

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δ : The deviation in the sample as a result of load shedding (mm)

I: moment of inertia of the cross section of the sample (mm^4), that has width (b mm) and thickness mm (d). It has been calculated by applying the following formula[7.8].

$$I = \frac{bd^3}{12} \quad \text{.....(2)}$$

2-wear test

It is the corrosion that occurs for solid surfaces resulting from friction or trauma. When a hard surface is placed on another hard surface, the atoms will lose on both surfaces even if it was more solid than the other. The wear is a direct result of the operations themselves that cause friction, such as moving the acute outcrops between the two surfaces [9]. In general, the wear normally occurs between any two touched surfaces have a relative movement between them and can be classified to: physical-chemical wear and electrostatic wear [10]. The factors affecting the wear are: sliding speed, temperature, load, type of material, the hardness of the surface, the outer perimeter, and oiling [11]. There are many types of wear : storytelling wear , wear of erosion, Erosive wear, surface wear ability , andsoreness wear ability. We can calculate the rate of wear W_r by using the following equation [12]:

$$\boldsymbol{WearRate(W_r)} = \frac{\Delta w}{S_D}\left(\frac{gm}{cm}\right) \text{ ... ... (3)}$$

Whereas:

Δw: weight different (before and after measurement)

S_D:sliding speed

We used the weight Method because it is a simple way to measure the wear rate and includes measuring a sample weight before and after testing, then calculating the difference in weight. The wear rate calculates from the equation (3).The sliding distance S_D is given by the following relationship [16]:

$$S_D = 2\,\pi\, r\, n\, t \quad \text{.....(4)}$$

Whereas:

r:Radius from the center of the sample to the center of the disc.

n: number of disk cycles (cycles / min).

t: test time (minutes).

Results and Discussion

The Result Of Bending Test

This is a basic test of the fragile materials in order to determine the properties of flexibility and plasticity. There are some important factors affecting the result: the type and rate of loading, the dimensions of the cross-section of the model, and the distance between the cushion [14].

As well as, it is a complicated test being contains more than one type of stress such as tensile stress in the lower section of the layers, and compression straining in the upper layers, and sometimes overcome, one on the other and cause the failure of the whole material [15,16].

We have used three-bending test way to calculate the flexibility of the samples and practical results values of the relationship of the block with a deviation of all samples. The results shown in figures (1) and(2) which illustrate that the deviation is directly proportional to load hanging and when the demise of the impact of pregnancy hanging material relive its original state. This shows that the material is subject to Hooks law. Also, the ratio of mass to deviation (mass / Deflection) a fixed amount and this represents the slope which can calculate the modulus of elasticity (E). It is clear from the shapes that the deviation increases with the concentration of magnesium oxide in compound for all samples. The reason is that the bonding strength between the polyester molecules and particles magnesium oxide for all groups decreases with increasing concentration of magnesium oxide, and this means increasing the deviation due to the

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accumulation of particles magnesium oxide and increase ductility material.

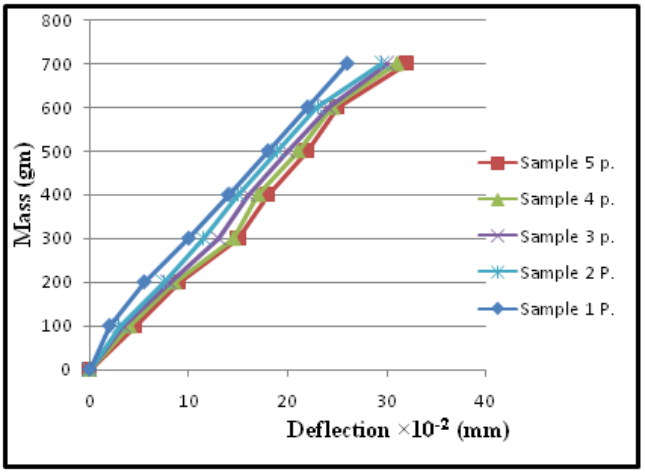

Figure 1: illustrates the relationship of mass with deflection of composite (P.MgO).

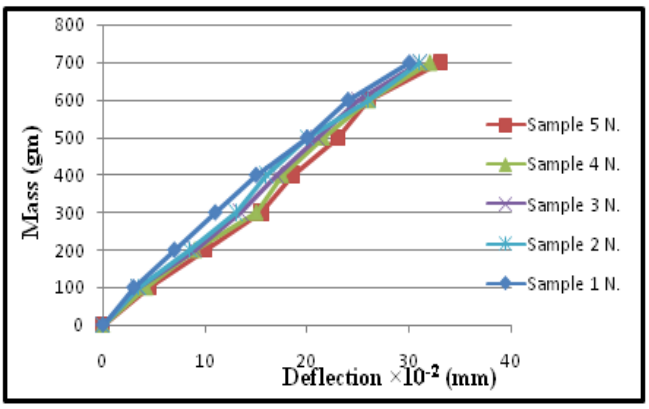

Figure 2: illustrates relationship of mass with deviation of composite (N. MgO)

It is clear from the figures (3) and (4) that the modulus of elasticity decreases with increasing concentration of magnesium oxide particles. The samples subsidized by powder MgO has a elasticity modulus larger than the samples that subsidized by nano particles MgO. The reason for this is due to poor bonding strength between the magnesium oxide particles and the polymeric series of basis material .In addition, the samples that subsidized by Nano particle magnesium oxide is more prevalent in the same proportional weight for the rest of the samples. This leads to reduce the spacing , increase stacking and bonding ,and reduce the slippage of polymer of the basis material that can cause to reduce the modulus of elasticity.

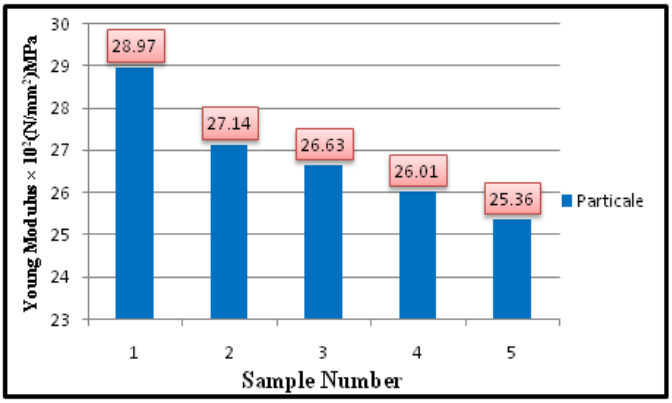

Figure 3 :illustrates the relationship of Young's modulus with the sample number (weightedfraction) of the composite (P. MgO)

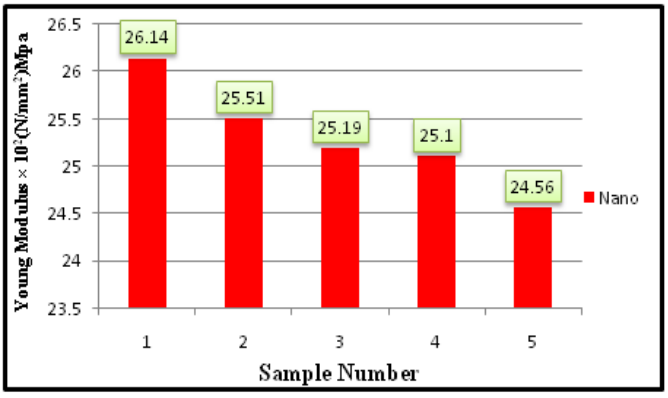

Figure 4: illustrates the relationship of Young's modulus with sample number (weighted fraction) of the composite (N. MgO)

Wear Test Results:

We used a weight of (10) Newton, and fixed amount of recycling duration ((10 minutes, and the speed of sliding fixed amount (3.14 m / sec)in order to calculate the wear rate. The used disc is Iron disc with a hardness of(269 HB). Figures (5) and (6) show that the wear rate increases with the concentration of magnesium oxide in composited material for all samples , because the increasing of magnesium oxide powder in the compound means increasing grained ceramic and thus increase the bumps and grooves that can be removed from the sample surface during the

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friction between the superficial sample turntable disc. Add to this that the friction resulting from the impact of compression and rotational force leads to high temperature samples' components which helps to easily extract magnesium oxide grains, which increases the wear rate as in Figure 5.

Wear rate of the samples subsidized bynano magnes ium oxide is lower than the samples subsidi zed by powdered magnesium oxide, the reason for that is the nano-scale of magnesium oxide led to dispersal it among the basis material and this has led to increased stacking and reduce the spacing between the polymeric series of unsaturated polyester resin andthe grained of nano particles magnesium oxide. This has led to increased hardness and durability in addition to the nano-scale size of magnesium oxide led to a few bumps and ruts and cracks in the sample which causing toreduce the breaking of these outcrops and wrested from the surface of the material. All these led to the lack of wear rate.

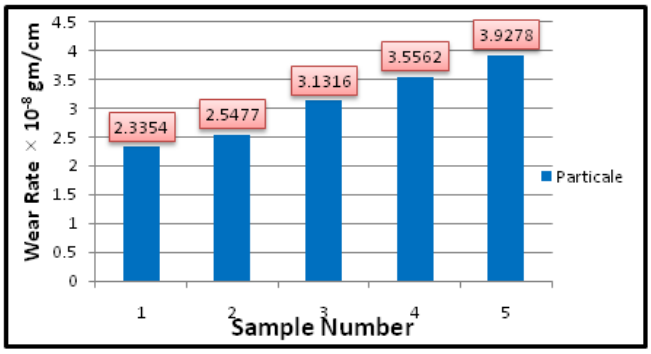

Figure 5: shows the wear rate relationship with the sample number of the composite (P.Mgo)

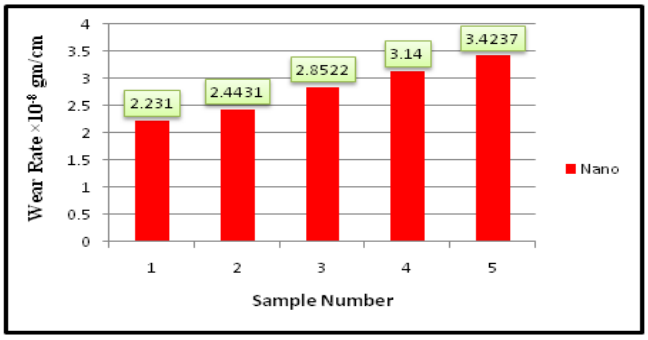

Figure 6: shows the wear rate relationship with the sample number of the composite (N.Mgo)

Conclusions

In this research, we have gotten thatdeviation increases with increasing force meted and the increase in the concentration of MgO in all the samples. Young Modulus decreases with the increasing of MgO concentration in all samples, and its value in the samples of (MgO Powder) is larger than it in the samples of (Nano MgO). Wear Increases with the increasing in the concentration of MgO in all samples, this value is less in the case of Nano MgO, than it in the case of theMgO powder.

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