Mechanical Properties for Polyester resin Reinforce with Fe Weave Wire

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ABSTRACT

In the present work we prepared and study a polymer composite using from and polyester polymer with iron weave wire ratios (5,10,15,20%) .At first was studied and examined with chemical composition analyzing, then some of physical and mechanical properties of the composite were studied stress –strain , impact strength, fracture toughness , hardness and thermal conductivity. Results show an improvement in these mechanical properties after reinforcement by metals the value of mechanical properties will increase with increasing percentage of reinforcement.

Keywords: polymer composite, polyester , Fe weave wire , impact strength, fracture toughness, hardness & thermal conductivity**.**

1. INTRODUCTION

Composite materials were created as a result of an intensive search for materials which offer high reinforcement levels, with good mechanical properties and light weight.[1] Polymer composites can be classified as :Macro-composites ,Micro-composites and Nanocomposites according to fillers size[2,3]. Unsaturated polymers (UPE) resin is used for a wide variety of industrial and consumer applications. This consumption can be split into two major categories of applications: reinforced and nonreinforced. In reinforced applications, resin and reinforcement, such as fiberglass, are used together to produce a composite with improved physical properties. Typical reinforced applications are boats, cars, shower stalls, building panels, and corrosion- resistant tanks and pipes[4]. Non fiber reinforced applications generally have a mineral “filler” incorporated into the composite for property modification. Some typical nonfiber reinforced applications are sinks, bowling balls, and coatings. Polyester resin composites are cost effective because they require minimal setup costs and the physical properties can be tailored to specific applications. Another advantage of polyester resin composites is that they can be cured in a variety of ways without altering the physical properties of the finished part. Consequently, polyester resin composites compete favorably in custom markets [5]. Functional elements of iron and steel and their origin: bar, wire, cable and Weave[6]. The main purpose of a resin system is to transfer load from fibre to fibre, alongside this, the resin will also; Protects sensitive fibres from abrasion Forms a protective barrier between fibres and the environment Can provide shear, tensile and compression properties to the composite[7]. Strengthening fiber iron and steel are important in applications other than polymers overlapped, but in the applications against Concrete earthquakes, where he researcher W. G. Lim et.al.[8] studied seismic performance of four concrete infill wall elements with test variables of vertical slits and hooked end steel fiber reinforcing, experimental results exhibited more stable from that without Reinforcing.The aim is to produce composite materials from polyester and reinforced with weave iron wire to study the mechanical properties for composites.

2. EXPERIMENTAL WORK

The material used in this work was polyester resin as a matrix and woven steel as reinforcement. The matrix material used for fabrication of composites consist of polyester resin polymer manufactured by "Saudi Industrial Resins Company Limited" with hardener were mixed in ratio 1:11. A hand-up method used to perform the samples,table (1) shows some properties of unsaturated polyester resin [9].

Table (1):- Some of unsaturated polyester resin properties[9].

Property	Unit
Density	1200(kg/m^3)
Thermal conductivity	0.17(W/m. ^{o}C)
Tensile strength	70.3 -103(MPa.)
Modula's of elasticity	2.06 – 4.41(GPa.)
Fracture tautness	0.6(MPa.m$^{0.5}$)

Table (2) shows the analysis of metal wire that used .

Table (2):- Chemical analyzing of pure metal**.**

Compound	%
Fe	89.6355
Ti	5.8634
Cr	3.2515
Mn	0.7497
W	0.3184
Cu	0.1018
Mn	0.0797

Four samples , sample A (pure polyester resin), and samples B,C and D (polyester with metal fiber) as shown in table (3).

Table (3):- The weight of polyester and Iron in the samples

Sample	Polyester wt%	Iron Wire wt %
A	100	0
B	95	5
C	90	10
D	85	15

For testing the tensile specimens prepared has used the machine (Instron 1195 Tensile Test) is manufactured by a company (Instron) English brought tensile strength at a rate of pregnancy (5000 N) and an average of emotion (2 mm / min) and through the Tracer chart your results were obtained directly Authority graphic form (stress - strain) according to ASTM (D – 638)[10]. In flexural strength Samples were tested according to the test method-I procedure A in the standard ASTM D790M-92 (Standard Test Method for Flexural Properties of un reinforced and Reinforced Plastics and Electrical Insulating Materials) .It is the ability of the material to applied bending forces perpendicular to the longitudinal axis of the specimen ,a three-point loading system utilizing center loading on a sample supported beam .The modulus of elasticity is the ratio, with in the elastic limit of stress to corresponding strain, calculating as follows [11]:

$$E_{Bend} = \frac{f\ell^3}{48\, I\delta} \qquad ....(1)$$

E_{Bend} modulus:modulus of elasticity in bending (MPa),f: applied force, L: is the support span, I: moment of inertia and δ: is deflection in beam. The sample dimension was (4.8 × 13 × 191) mm and Span to Depth Ratio was 1:32. Moment of inertia I can be calculated from:

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

Where b and d are the width and the depth of beam tested, respectively.

The impact properties of the polymeric materials depend mainly on the toughness of the material. Impact energy is a measure of toughness, and the impact resistance is the ability of a material to resist breaking (fracture) under a shock-loading.[12] Izod impact test was done on specimen with dimention (4 × 10 × 80) mm according to (ASTM D 256) .The impact strength(G_c)(J/m^2) is calculated from fracture energy (U_c) and cross section area (A) by the relation:

$$G_c = \frac{U_c}{A} \qquad ……………………..(3)$$

Fracture Toughness K_c can be calculated from:

$$Kc = \sqrt{G_c E} \qquad ………………………..(4)$$

Where E :young modules(MPa) ,

Where P: is the maximum load (force at fracture). Thermal conductivity was done by using (Lee's Disc), with sample diameter (40 mm) and thickness (5 mm).and using equation[13]:

$$\lambda.\left(\frac{T_2 - T_1}{d}\right) = e.\left[T_1 + \frac{2}{r}\left(d_1 + \frac{1}{2}d\right)T_1 + \frac{1}{r}d.T_2\right] \qquad ………… …………(5)$$

$$i*v = \pi.r^2 e.(T_1 + T_3) + 2\pi.r.e.\left[d_1 T_1 + d.\frac{T_1 + T_2}{2} + d_2 T_2 + d_3 T_3\right] \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots(6)$$

Where λ: thermal conductivity(W/m. C^o),e heat loss in (sec) in unit area (m^2) and different in the temperature between discs and environment, d_1, d_2, d_3: discs thickness (m), d :sample thickness(m) , r: disc radius (m),T_1,T_2,T_3:temperature at disc1,2,3 respectively in (K^o)and i: current throw the heater coil in (Ampere) and v: is the voltage on the heater(Volt). The morphology of nanocomposite sample was test with optical reflected-microscope type BEL,MTM 1A(200x).

3. RESULTS AND DISCUSSIONS

The properties of the composites depend upon the reinforced materials . tensile properties of the composites are mostly affected by the materials , method , specimen condition and preparation and also by percentage of the reinforced.

The results of the mechanical properties at different weight percentages are illustrated in these figures. In fig. (1) shows the relationship between the stress and strain with different weight percentage , we shows the stress and train decrease with increasing weight percentage. We shows after reinforcing by metals this property will be improved greatly ,where the fibers will withstand the maximum part of loads and by consequence will raise the strength of composite material .The tensile strength will be increased as the fibers percentage addition increased , where these metals will be distributed on large area in the resin [14].

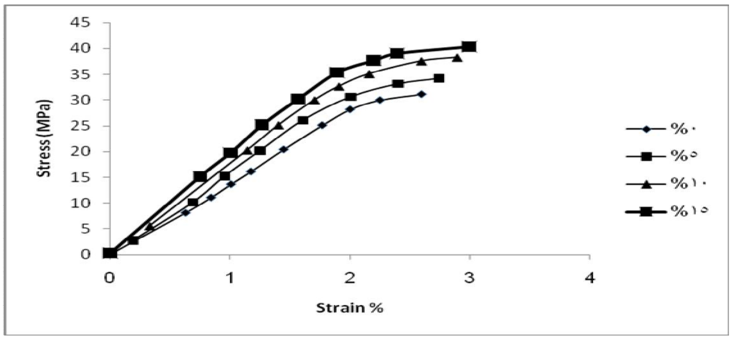

Fig. (1) : The variation between the stress and strain at different concentration **.**

The hardness plotted with weight fraction in fig.(2) , we notices that hardness increase with increasing hardness, Polymers have low hardness, the lowest value for araldite resin before reinforcement .But this hardness value will greatly increased when the resin reinforced by hybrid fibers, due to distribution the test load on metals which decrease the penetration of test ball to the surface of composite material and by consequence raise the hardness of this material [15].

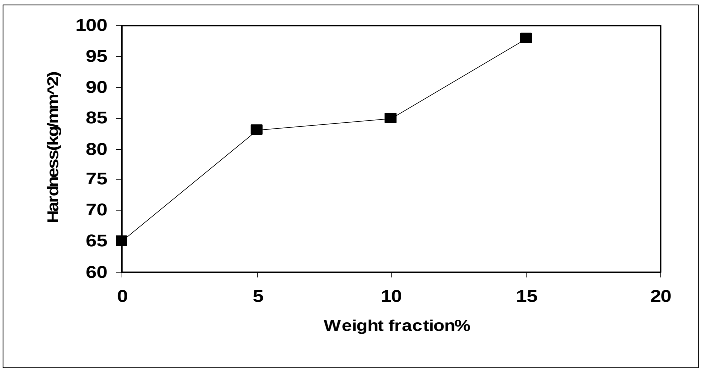

Fig.(2):- Hardness with weight fraction

Also the impact and fracture toughness take the same relationship, these appear in figures (3,4)respectively . Fig.(3) shows The impact resistance will continue to increase with increased of the fibers reinforcing percentage the impact resistance considered low to the resins due to brittleness of these materials ,but after reinforcing it by fibers the impact resistance will be increased because the metals will carry the maximum part of the impact energy which exposition on the composite material . The impact resistance will continue to increase with increased of the metals reinforcing percentage [16]. As mentioned above ,the resin is brittle ,therefore its flexural strength will be low before reinforcement as shown in (Fig.4) .But after added the metals to this resin the flexural strength will be raised to the producing material because the high modulus of elasticity of these fibers will helps to carry a large amount of loads and raise this strength [17]. As a result the thermal conductivity also increases with increasing reinforced with metals as shown in fig.(5).

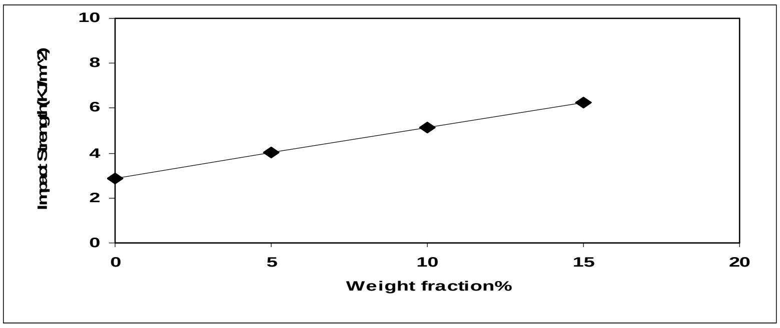

Fig.(3):- Impact strength and weight fraction.

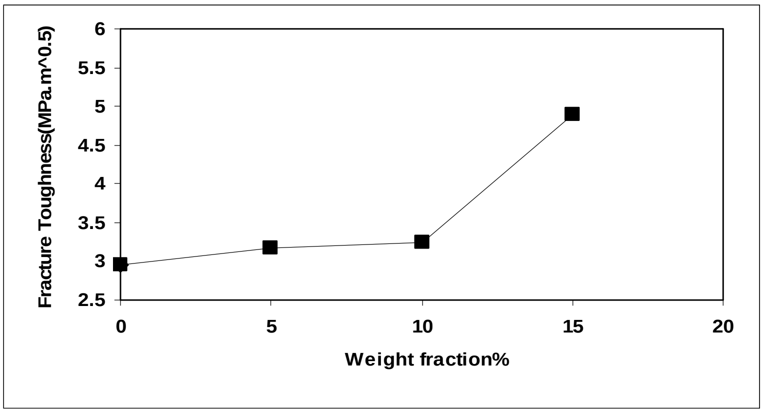

Fig.(4):- Fracture toughness with weight fraction

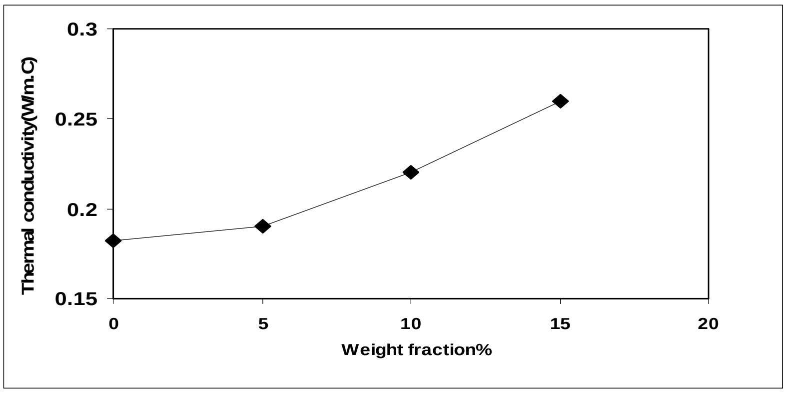

Fig.(5):- Thermal conductivity with weight fraction

4. Conclusions

In this paper, mechanical properties of polyester reinforced with different weight percent of metal were investigated. The experimental results indicate that the mechanical properties after reinforcement by metals the value of mechanical properties will increase with increasing percentage of reinforcement.

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