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Re-Use of Glass Wool Fiber as New Composite Polyester System

Abstract- *Four different ratios of composites were prepared by varying the wool glass, at different additive weight percentages (0, 0.2, 0.4, 0.6 wt. %) in order to study the effect of glass wool reinforcement on mechanical and chemical properties of GW-reinforced polyester composites. The vacuum bagging technique was adopted for the fabrication of hybrid composite materials. Afterword many mechanical properties as hardness, impact resistance, and compression resistance for these hybrid composites were evaluated according ASTM Standards. The mechanical properties were improved as the fibers reinforcement content increased in the matrix material. The chemical properties were improved as increased the weight of glass wool. The chemical and mechanical properties have been increased for maximum value when glass wool fiber has reached 0.6% wt.*

Keywords- Keywords: polyester hybrid, ASTM, hardness, impact resistance, chemical properties

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1. Introduction

Polyester systems represent active part of engineering applications as mechanical improvement components. Attributing to their excellent strength and stiffness ratios, in addition to poor erosion resistance compared with other types of , also they applied for a wide variety of applications as aerospace structural systems, automotive structures , industrial parts applied for handling fluids or chemicals, such as cams, gears, brushes and so [1-5].

Many investigators were applied the glass wool fibre in the composite system as filler in many membrane systems, where Punnet Sharma1 2013 was taken different volume fraction of glass wool waste with epoxy as composite system (i.e., 2, 4, 6 and 8%) [6]. Other fillers were modified the mould shrinkage, excellent abrasive nature and reduces the processing cost significantly, where more than 50% of all produced composites systems are in one way or another filled with glass wool fiber to achieve the desired properties [7]. In addition, the resistance heating, flame ignites utilize these systems an electrical conductor applications.

Microstructure and orientation of applied fiber/filler reinforcement with matrix would vary all characterize properties such as mechanical properties, anisotropic structural of a composite material, loading scenarios, suitability for final material to establish the service life. therefore many properties are used to study the variation of on the durability and service life are impact strength, compression strength, hardness, therefore many investigator in this field were [8] studied the failure mechanism and thermo-mechanical properties of fibre/filler reinforced polyester matrix composites and reported that filler-matrix de-bonding is the primary failure mechanism of composites above 360°C. Where Saha et al. [4] have been studied dynamic mechanical investigations on chemically treated jute fibre reinforced polyester composites before and after chemical treatment for this applied fiber it concluded that this type of fiber improves sever max modulus and Tg of the composites. Another investigation by Falak et al. [9] have been studied the effect of different ceramic fillers (glass, carbon, Kevlar) on the behaviour of thermo-mechanical properties of polyester composites, they proved that silicon carbide (SiC), have better filler characteristics compared to those of alumina (Al_2O_3) and then produced a cost effective systems for automotive applications. In addition to improvement of mechanical properties for polyester composite reinforced by bio- fillers as bean shells by Raghad et al. [10] with another research applied okra shell bio-filler in development of mechanical properties of polyester composites respectively in 2015 [11].

2. The Aim of this study: is to modify the mechanical behaviour of new composite such as (hardness load, impact resistance, compression resistance), in addition of chemical resistance behaviours of glass wool filled polyester composites and unfilled materials were examined. This study evaluates the influence of reinforced

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by glass wool on chemical- mechanical behaviour of polyester composites and the effect of this material on the final applications of these composites.

3. Materials and Methods

I. Polyester

Matrix material applied was unsaturated polyester resin (UP) that supplied by (SIR) Saudi company (Table 1). This resin characterize by high viscosity, transparency. In addition, it's one types of peroxide supplied by the company itself. The mixing weight ratio between hardener and resin is 2 g of hardener to 100 g of thermoset resin.

Table 1: General properties of polyester

Type of properties	Values and units
Mechanical properties	
Stress	63.2 Mpa
Modulus	1.04 Mpa
Strain	4.7 Mpa
Modulus of elasticity	3.3 Gpa
Flexural strength	45 Mpa
Maximum elongation	1%
Tensile strength	40 Mpa
Physical properties	
Viscosity	250-350 cp 1.09
Density	
Thermal properties	
Heat distortion temperature	85ºc

II. Experimental procedure

Waste glass wool was applied as reinforcement fiber in new composites, then this composite are prepared by blending unsaturated polyester resin, with waste glass wool in a different effective weight percentage as reinforcement factor.

1. Four different ratios of composites were prepared by varying the wool glass, at different additive weight percentages (0, 0.2, 0.4, 0.6 wt. %) in order to study the effect of glass wool reinforcement on mechanical and chemical properties of glass wool-reinforced polyester composites see Figure 1.

2. The proper proportions of the various ingredients were blended in a laboratory mixer. Initially the GW fibres were added with further mixing for about 10 min.

3. Finally, 2 % methyl-ethyl-ketone-peroxide (MEKP) as hardener is mixed in the resin prior to reinforcement unsaturated polyester resin based binder was added and final mixing was carried out for another 5 min.

4. After mixing operation, the polyester composites were fabricated by conventional hand lay-up technique to prepare polyester composites of different percentage of glass wool fibre (0, 0.2, 0.4, 0.6 wt. %).

5. The mould was initially preheating up to 80°C, then oiled with a thin layer of oil Vaseline (which acts as a barrier between the composite and the mould cavity). After preheating, the mould cavity was filled with composite mixture and then placed on the mould under load in order to maintain a secure bonding between friction composite and moulds.

6. The assembly was subjected to drying under ambient atmospheric pressure at 37°C and 24 hrs. For proper curing the curing cycle completion refers to the toughening of a composite. After curing, the composite moulds were removed from the mould. See Figure 1.

7. Then specimens were arrangement as American Society for Testing Materials to suitable dimensions by cutting them with a diamond cutter for different applied properties, as impact strength, hardness tests compression strength and chemical properties. These applied tests were investigated effectiveness of different loading conditions such as wt. of applied fiber, time, temperature on the mechanical behaviour of the final composite material as deformation or breaking (failure).

III. Mechanical properties

1. Hardness test

The resistance of new material to sever abrasion or indentation was measured by use of Rockwell hardness tester, where a spherical ball of dimensions 1.5875 mm dia. was applied on surface of material under sever conditions of loading, until failure afterword the amount of hardness was recorder according to ASTM E-18 [12].

2. Impact test

The resistance to Impact test is measured by use Charpy tester to notice the consummation energy for specimen before fracture. V-notch samples were prepared at specified dimensions (60 × 12 × 3) mm according to D -256 ASTM. Then specimen was fixed on the tester, where the notch regions at the opposite face to the striking hammer. Afterword's shattering a pendulum hammer at 45º to V-notched specimen and afterward measured the spent energy to the cross section of the specimen [12].

1. Compression resistance

This type of test has been measured the failure crack propagation caused by sever compression load at the center of the core.

Figure 1: Shows a: the base polyester, b: polyester reinforced waste glass wool specimen.

IV. Chemical properties

The resistance to different chemical solutions were applied to new prepared specimens under normal moisture, alkali solution (NaOH 10%), and acidic solution (10% H_2SO_4), where a soaking to all prepared samples then check their change in weight period 24 hrs. for 7 days under 25ºc.

V. Results and Discussion

1. Mechanical properties

Mechanical properties for final composite systems are measured to appear the effect of loading weight fiber compositions with another variables time and temperature on the overall performance then discussed [13,14].

a. Hardness Test (Shore D)

Figure 2 showed the hardness values at increase loading weight from waste glass wool fiber. The addition of glass wool fiber content increases the hardness of composite material and resists deformation. Therefore, the thermoset resin part and solid fiber pattern would be pressed to each other more tightly [13,14].

b. Impact Resistance

From Figure 3 it is observed that composite exhibited maximum ultimate strength (8.7MPa) at high optimum (0.6% wt.) GW when compared with other filled composites and un-filled composite due to good arrangement and orientation of fiber that give strong polymer/fiber interface adhesion [15,14].

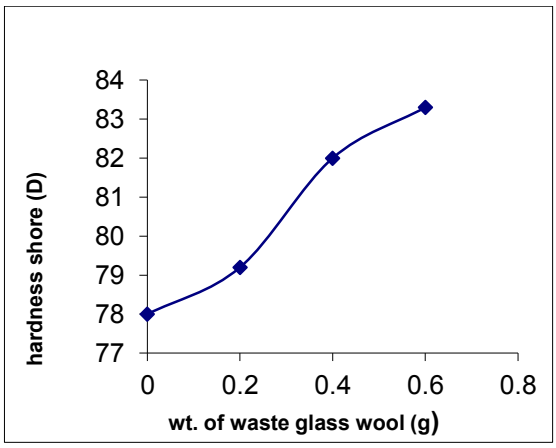

Figure 2: Hardness Shore (D) as a function of wt. of waste wool glass (g).

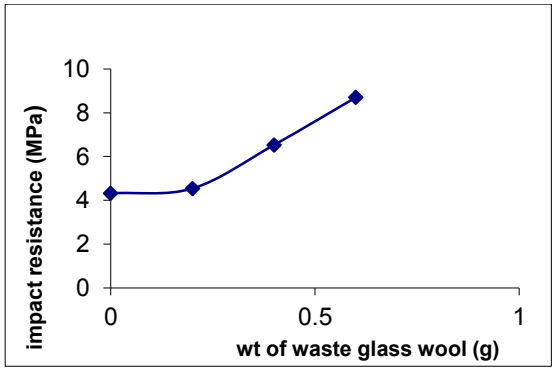

Figure 3: Impact Resistance as a function of wt. of waste wool glass (g)

VI. Compression resistance

Figure 4 Estimate that the composite system have high optimum values 27.J at (0.6% wt.) mixing ratio when compared with other filled composites and un-filled composite because of good fiber arrangement to give strong polymer/fiber interface adhesion and effective stress resistance [13,14].

VI. Chemical properties

Figure 5 represent the relation between the change in weight of samples and the time of immersion. High chemical stability and less change in weight appeared for all samples reinforced by waste glass wool rather than unfilled pure sample because of high chemical resistance of waste glass to moisture medium [15,23].

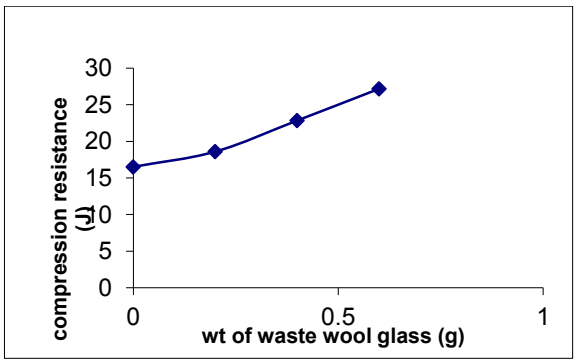

Figure 4: Compression resistance as a function of wt. of waste wool glass(g)

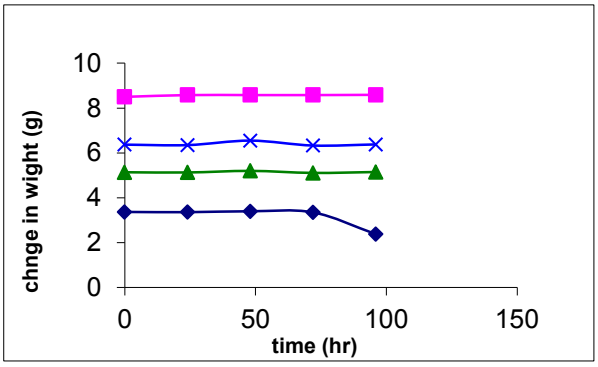

Figure 5: Change in weight as function of time (hr.) for samples immersed in distilled water

Figure 6 represent the relation between the change in weight of samples and the time of immersion in 10 % NaOH solution. High chemical stability and less change in weight appeared for samples reinforced by waste glass wool (0.4 and 0.6% wt. WG) rather than other filled unfilled pure sample because of high chemical resistance of waste glass to alkali medium at high percentage waste glass wool [15,23].

Figure 7 represent the relation between the change in weight of samples and the time of immersion in 10 % H_2SO_4 solution. High chemical stability and less change in weight appeared for all samples reinforced by waste glass wool with preference of (0.4 and 0.6% wt. WG) rather than other filled unfilled pure sample because of high chemical resistance of waste glass to acidic medium at high percentage of waste glass wool [15,23].

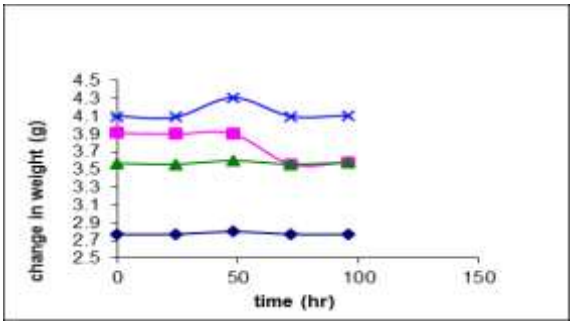

Figure 6: Change in weight as function of time (hr.) for samples immersed in(10)% NaOH solution

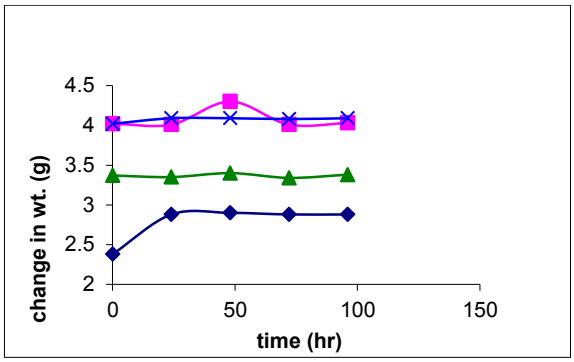

Figure 7: Change in weight as function of time (hr.) for samples immersed in 10% H_2SO_4 solution

4. Conclusions

From the results obtained in the tests, it was established that:

1. Optimum additive ratio (0.6% wt. from waste glass wool) exhibited maximum hardness number, compression resistance and impact test due to uniform dispersion between particles then increases their indentation resistance.
2. Optimum additive ratio 0.6% wt. from waste wool glass was increased the utilization properties compared with the neat resin and other application ratios.
3. The chemical property improvement with addition of fiber (0.6 and 0.4 wt. % from WG) compared with the neat resin and other mixing ratios.

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