International Journal of PharmTech Research
CODEN (USA): IJPRIF, ISSN: 0974-4304, ISSN(Online): 2455-9563
Vol.9, No.11, pp 210-215, 2016

Study The Properties For Unsaturated Polyester (UP) With Addition Glass Fiber (GF) And Polyvinylchloride (PVC) Powder By Ultrasonic Technique

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Abstract : The mechanical properties of unsaturated polyester (UP)composite have been studied, by ultrasonic technique at 26 KHz. UP composite resin was used for binding glass fibers (GF) and polyvinylchloride (PVC) powder as the reinforcement materials. These properties are density, ultrasonic velocity, passion's ratio, shear and elasticity modulus. With the increasing of the concentration GF% in the composite the results shown that these properties increment expect elasticity modulus and passion ratio decreasing, passion's ratio is decrease even reach the percentage of 15%GF where no further decrease occurs with gaining GF ratio.
Key Word : CEFCC,TCID,CCL,CXCL.

Introduction

This research was done to gain more information about the effects of the mechanical properties for polymer composite when adding glass fiber to UP resin. There are many advantages of polymer composite reinforced by fiber when utilized as components in the fields of (navel, aerospace and automotive or construction industries) because of their stiffness to weight ratios, high strength to weight and corrosion strength. Due to these properties components that exhibit significant weight savings and enhanced performance of service time can be produced which are better than the traditional materials such as steel and aluminum alloys[1]. The fiber content differences affect on the mechanical properties for composites reinforced via fiber[2-5]. The transmission of the ultrasonic wave throughout the entire tested specimen relies on the density of the medium and elastic properties which are predisposed to alteration due to change in the fiber content of the specimen[6,7].Based upon the specific value of elastic modules, an easy estimation of ultrasonic velocity could be made particularly for isotropic solids[8,9].

The speed of ultrasound was calculated by relating the specimen thickness and time into the sample [10].

$$V = \frac{x}{t} \dots\dots\dots\dots\dots (1)$$

x : the specimen thickness calculated by digital vernier and t: the time of the waves through the specimens[11].

The relationship between transverse constriction strain to longitudinal extension strain in the same direction for tension force is called the passion's ratio (σ) as shown in equation below. Compressive deformation is considered negative and tensile deformation is considered positive[12-14].

$$\sigma = \frac{1 - 2(V_T/V_L)^2}{2 - 2(V_T/V_L)^2} \dots\dots\dots\dots\dots (2)$$

where (V_L) is the ultrasonic longitudinal velocity; (V_T) is the ultrasonic transverse velocity.

The shear modulus (G) for isotropic materials, is the relationship between shear stress and shear strain. This modulus was determined by the following equation[15,16].

$G = \rho * v_T^2$ ……..(3)
ρ: the density of composite materials and measured from equation.
$\rho_c = \rho_f * V_f + \rho_m * V_m$ ……..(4)
ρ_f: fiber density, ρ_m: matrix density
V_f: volume fraction for fiber, V_m: volume fraction for matrix.

The ability of the material to exhibit elastic deformation (non-permanently) when force is applied on this material is called the elastic modulus(E)[17,18] and is measured by the following equation.

$$E = \frac{V_L^2 \rho(1+\sigma)(1-2\sigma)}{(1-\sigma)} \dots\dots\dots\dots\dots\dots (5)$$

Methods Utilized for the Ultrasonic calculating Technique

There are three methods for ultrasonic testing the echo method, pulse velocity method and the resonance method. It has been shown that the second method (pulse velocity method or transmission method) is the easiest and most known method for materials testing. This method calculates the longitudinal ultrasonic wave's path length through transmission medium (specimen) (as Fig: 1). Another transducer configurations were utilized in concrete testing (Fig:1 b and c). The positioning of the receiving transducer and the emitting transducer might be on inverse side either on similar sides (Fig:1c) or on perpendicular surfaces (Fig:2 b).

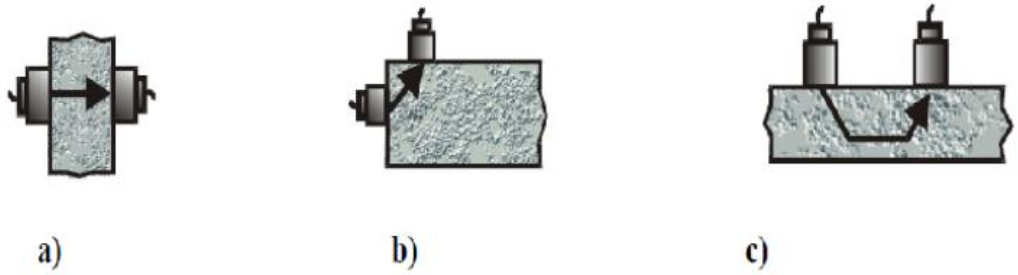

Figure 1:The Ultrasonic transmission method a- direct method, b- semi-direct method, c- indirect method

The first method (ultrasonic echo method) composed of a short impulse ultrasonic wave produced by the emitting transducer and used to find defect in metal members. (Fig:2).

Figure 2:The ultrasonic echo method of concrete: a- receiving and transmitting transducer, b- double transducer

The third method (resonance method) involved emitting an ultrasonic wave into the specimen so that a resonant standing wave that has a wavelength of λ is going to be produced.

$g = n (\lambda/2)$……(6)
g = the thickness of specimen (constant).
n = constant number.

Experiment

This part of the research involves the specimens consisted of the materials that used in its preparation, weight percentages of mixing and methodology of testing. These specimens were casted and cured in one hour at 100 °C.

Matrix Material:

The matrix of polymeric composite material in this work composed of UP (a product of Industrial Chemical of resins Co. LTD in Saudi Arabia). The hardener (transparent liquid (Methyl ethyl peroxide coded MEKP) product of the same company) was utilized to solidify the matrix. 1% mixture of the hardener was added to the UP resin at room temperature. The hardening process was quickened by addition of a catalyst (Cobalt naphthenate, a product of the same company) to the mixture of polymeric composite material.

Reinforced materials:

In this research glass fibers (type E-Glass and produced by Mowding LTD**.** UK) were utilized as strengthening phase in the form of chopped glass fibers with different percent (5%, 10%, 15%, 20% and 25%), The average diameter of the filament for these chopped glass fibers was (8–16 μm) with a length range of (0.02-0.08 mm).

Table (1-1):demonstrate the mechanical and physical properties of glass fiber according to the produced company (SIR Saudi):-

Tensile strength MPa	Density g/cm^3	Modulus of elasticity GPa	Diameter μm	Specific Heat J/kg. K	Coefficient of thermal expansion 10^{-6} (˚C)$^{-1}$	Percent Elongation (EL%)	Thermal conductivity W/m.K
3450	2.58	72.5	8-14	810	5.0	4.3	1.3

Whilst PVC (thermoplasticpolymer) composed of repeating vinyl groups (ethenyls) in which a chloride group is attached instead of a hydrogen atom. In this work PVC was used in constant ratio (10%) with size particulate (300,154 and125 μm) and density 1.39 g/cm^3. PVC distinguishes by easily collected, inexpensive and durable, so is vastly utilized in construction. This blend converts to solid state for one hour and the blend was used as fixed length 165 mm. Ultrasonic wave determination were produced by pulse technique of ultrasonic concrete tester (CSI)type (cc – 4 as shown in Figure: 2) .

Results:

Fig (3) shows that density of composite is increased with increasing GF ratio because GF density approximately twice the density of UP therefore such density increase is reasonable.

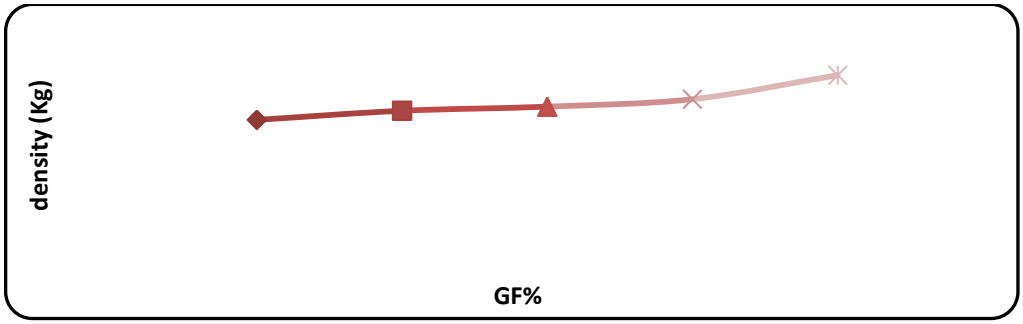

Fig (3): illustrate density with GF percentage.

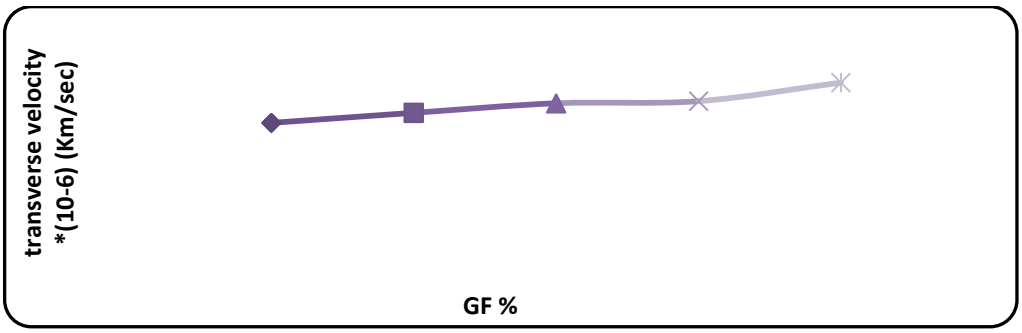

Fig (4): show transverse velocity increase with increasing GF percentage.

The transverse velocity is increased by increasing GF ratio as shown in fig (4). This is due to increase in composite density.

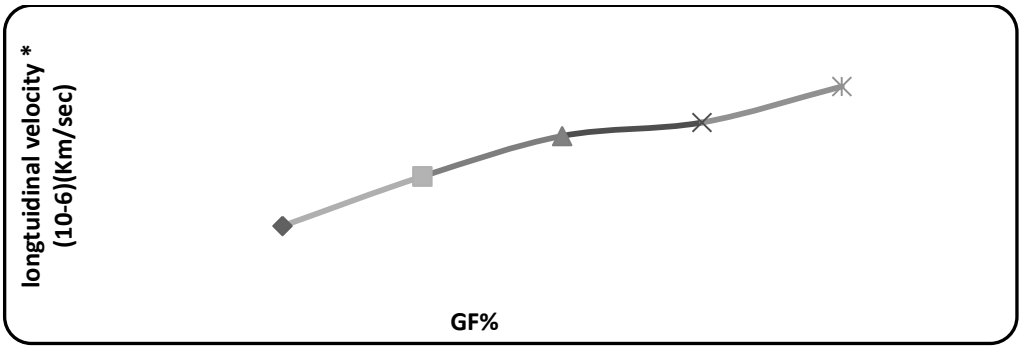

Fig (5): illustrate longitudinal velocity with GF percentage.

By observer figures (4 and 5). We can conclude that the behavior longitudinal velocity is increased shapely from behavior transverse velocity because transverse wave transmission is perpendicular to the direction of wave diffusion whilst longitudinal wave transmission is parallel to the direction of wave diffusion.

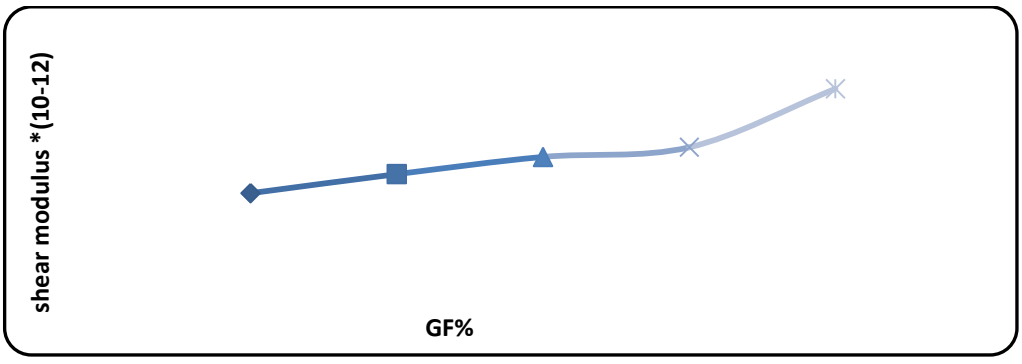

Fig (6): show shear modulus with GF percentage.

Shear modulus is increase with increasing GF ratio as in fig (6) because increasing GF ratio increase both density and transverse velocity and according to equation (3) shear modulus is increase.

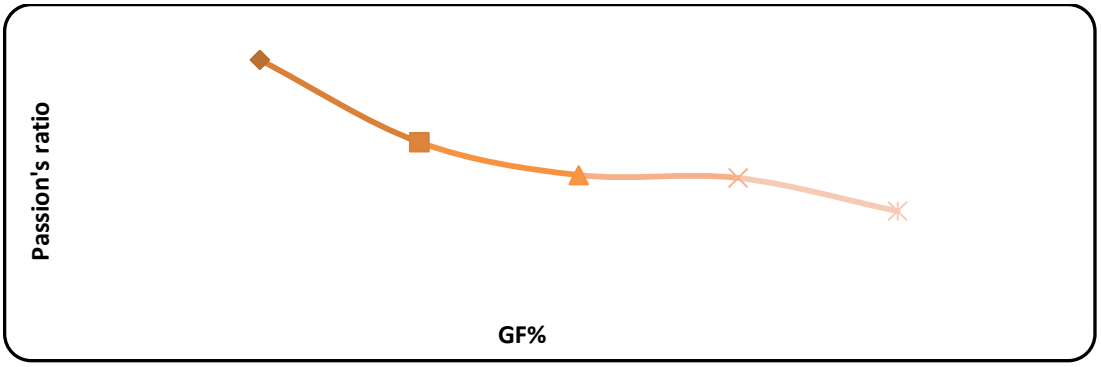

Fig (7): illustrate passion's ratio with GF percentage.

From fig (7) passion's ratio decrease with increasing GF ratio because increasing density makes composite materials rigid .therefore passion's ratio is decrease until reaching 15%GF ratio where no further decrease occurs with increasing GF ratio.

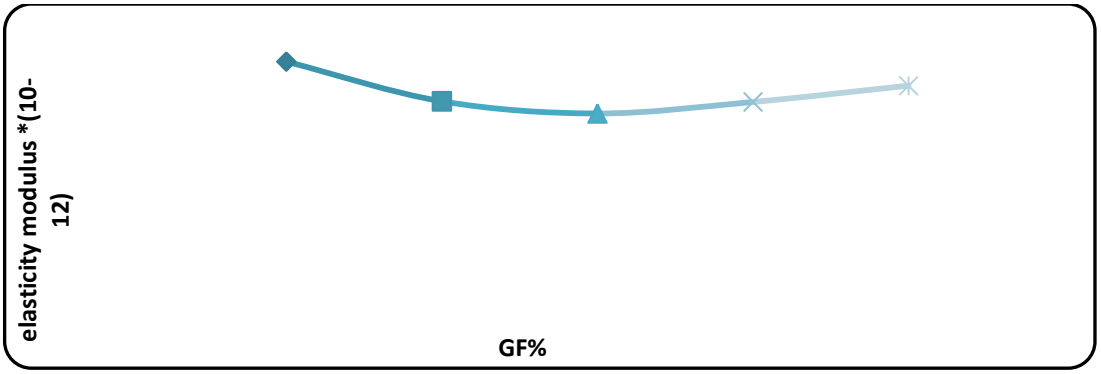

Fig (8): illustrate elasticity modulus with GF percentage.

Equation ($E=2G(1-\sigma)$) shows that elastic modulus depends on shear modulus and passion's ratio, since passion's ratio is considerably decreased and shear modulus is increased therefore elastic modulus is decreased[19].

Conclusion:

1. Density of composite, transverse velocity and longitudinal velocity is increased with increasing GF ratio. This later is due to increase in composite density.
2. Shear modulus is increase with increasing GF ratio because increase both density and transverse velocity and according to equation ($G = \rho * v_T^2$).
3. passion's ratio is decrease until reaching 15%GF ratio where no further decrease occurs with increasing GF ratio.
4. Elastic modulus is decreased according to equation($E=2G(1-\sigma)$)**.**

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