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Study the Characteristics Thermal and Mechanical for Unsaturated Polyester Resin Forced by Asbestos Fiber

Abstract- *In this work prepared and study a polymer composite, where use polyester resin with asbestos fiber ratio (5%, 10% and 15%). First study effect of changing reinforcement percentage by asbestos fiber on coefficient thermal conductivity (k) of polymer composite. Result show decrease in the coefficient thermal conductivity (k) of composite materials with increase of weight percentage of asbestos fiber. Second, study effect of it above reinforcement ratio on the some of mechanical properties (Impact, tensile, fracture and hardness) for polymer composite. The result indicate increase value of mechanical properties with increase weight percentage of asbestos fiber. The impact strength was (2.7 kj/m2) for pure resin where reach to maximum value (7.83 kj/m2) at 15wt% of fiber .Hardness and tensile reach to maximum value at 15% weight percentage for asbestos fiber. The result illustrate improvement mechanical properties after reinforcing by asbestos fiber and these properties rises with increased in reinforcement percentage.*

Keywords *composite materials, polyester, thermal conductivity, asbestos fibers, asbestos wool*

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1. Introduction

In view of the developments of industrial applications, this happened in recent years and need to use composite materials in popular and polymer-compounded materials especially. Compounded materials is made by combine two or more materials, two materials work together to give the composite unique properties [1]. The composite material can be split in to two major categories: matrix material and reinforcing materials .Matrix material are classified to natural and synthetic as polymer [2]. Composites Polymer divided to: Macro-composites, Micro-composites and Nano composites [3]. Polymer are widely used in the industrial for having many properties physical and mechanical and easily forming [2] .

Hassn [4] Investigate the physical and thermal properties of fiber types(s) reinforced with Araldite resin by changing weight reinforcement percentage (20%, 40%, 60%).Where the result show enhancement of Low mechanical properties and increasing thermal coefficient values after reinforcement by Araldite resin.

Parsath et al. [5] investigated the mechanical properties of polyester resin reinforced by glass fiber type (E) in different weight fractions (10%, 20%, 30%, 40%).The obtained result enhancement of mechanical properties of pure polyester .Salaman [6] study effect of reinforcement by carbon fibers on thermal conductivity and mechanical properties for polyester resin after reinforcing by variation percentage of carbon fibers, show the improvement in thermal conductivity and mechanical properties (impact strength, compression strength, hardness).

Mounika et al. [7] study thermal properties of bamboo fiber reinforced composite materials by change weight fraction, temperature and fiber angles, the results indicate the thermal conductivity of materials declining with increase in fiber content.

Mohammed [8] Explain the performance of sunflower and water-melon seed shells powder on mechanical characterization of polyester ,these properties included each of flexural strength, impact resistance , compressive resistance and hardness .The results indicate the flexural strength, hardness and compressive resistance increased with multiplying of the shells powder.

Salih et al. [9] study mechanical properties of unsaturated polyester resin reinforced by two types of metal powders Copper and aluminum. The obtained results increase in values of tensile strength and fracture Toughness .

Mohammed [10] studied effect of glass fiber (wave roven) on tensile behavior, flexural strength and impact strength of epoxy composite, the result shown woven glass fiber improving of mechanical properties. The work aim to preparation of substances composite from

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polyester resin and reinforced with different weight percentage of asbestos fiber (5%, 10%, 15%), and study effect reinforced by asbestos fiber on mechanical properties and thermal properties for resin.

2. Practical Part

I. Materials Used.

The materials used in preparation of samples research was unsaturated polymers (up) resin and Asbestos fiber reinforcement. Polymer resin manufactured by Saudi Industrial Resins Company (SIR). Reinforcing materials (asbestos fiber).Asbestos fiber material resistant to heat and corrosion, Asbestos product by company (PHII.ADEL.PHIA, U.S.A).

II. Preparation of Samples

The samples test were prepared using hand lay-up method. The foremost-required resin mixture prepared by mixing unsaturated polyester with asbestos fiber. Asbestos were added to polyester and adding hardener to mixture at room temperature for treating which 2% from weight of resin then they homogeneously mixed. The mixed of composites was poured into the mold according to test. Table 1 shows the weight of polyester and asbestos wool in the specimen. The dimensions of test samples were showed in the Table 2.

Table 1: ratio volume of polyester and asbestos wool in the test specimen

Sample	Polyester	Asbestos wool wt%
1	100	0
2	95	10
3	90	15
4	85	20

3. Test Thermal and Mechanical

I. Thermal Conductivity Test

Thermal conductivity of the composites material was measured by using (Lee's Disc) in laboratory department of material engineering in university technology , the test specimen were prepared of size 30 mm in diameter and 13 mm in thickness. Following equations (1and 2) correspond to the calculation of the thermal conductivity [11], Figure 1 the advice using in test.

$$\lambda.\left(\frac{T_2-T_1}{d}\right) = e\left[T_1 + \frac{2}{r}\left(d_1 + \frac{1}{2}d\right)T_1 + \frac{1}{r}dT_2\right] \quad (1)$$

$$i * v = \pi r^2 e(T_1 + T_3) + 2\pi r e\left[d_1T_1 + d\frac{T_1+T_2}{2} + d_2T_2 + d_3T_3\right]$$
(2)

Where

λ: coefficient of thermal conductivity; e: heat loss of (sec) in unit area; d1, d2, d3: thickness of the discs; d :sample thickness

r: radius of disc; T1,T2,T3: temperature at disc1,2,3 respectively in (K ^{o}); i: current; v: voltage on the heater [11]

Table 2: Shapes and dimension of samples

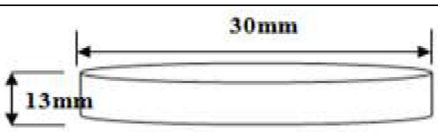
The test	Sample shape	Standard specification
Tensile Test		ASTM E8/E8M-09
Impact Test		ASTMD-256
Thermal Test		
Hardness Test		

Figure 1: devise measure thermal conductivity

II. Impact Test

Impact strength test applied to specimen dimension (10×10×55) mm according to ASTMD-256 at room temperature and using a hammer energy (2J).The impact resistance (g c) (KJ/m^2) is calculated from fracture energy (u_c) and cross section area (A) by the relation[11].

$$gc = \frac{uc}{A} \quad (3)$$

Fracture Toughness K c calculated from the equation (4) [11].

$$KC = \sqrt{g_c E} \quad (4)$$

III .Hardness Test.

Hardness test was conducted with TH-715 (Digital Micro Vickers Hardness Tester) shown in Figure 2 in laboratory department of metallurgy and production engineering. The maximum load was 2.942 N and time was15 seconds used in this test.

V. Tensile Strength Test.

Tensile test was carried out according to ASTM E8/E8M-09 at room temperature using the tensile specimens prepared has used microcomputer controlled electronic universal testing machine (WDW-200E) made in chine following.

Figure 2: Digital Micro Vickers Hardness

4. Results and Discussion

I. Measurement of Thermal Conductivity

Thermal conductivity of polyester resin reinforced with different percentage weight of asbestos fiber (0%5%, 10%, 15%) are illustrative in Figure 3. The results explain the thermal conductivity of unsaturated polyester resin decreases with increases of asbestos fiber content and when comparison value of thermal conductivity of polyester without any adding the value is (0.577 w/m°c) and when add asbestos fiber percentage (5%) decreases value thermal. Conductivity of composite substance were reach to (0.436 w/m°c) .The thermal conductivity begin to decreasing with the increases of weight fractions whish application in this work were the value of thermal conductivity is (0.331 w/m°c) at weight fracture 10% and still decreasing to the value to (0.211 w/m°c) at the weight fracture 15% ,due to fiber asbestos which distinguish low thermal conductivity.

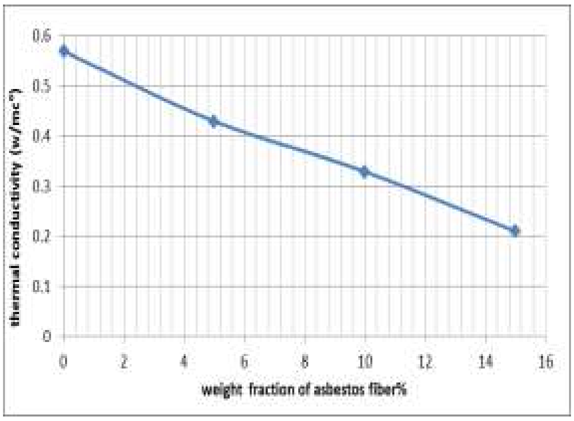


Figure 3: Effect of weight fraction on thermal conductivity of composites

II. Measurement of Impact Strength Test.

Figure 4 explain value of the impact strength with variation weight percentage of asbestos fibers, the impact resistance consider low of the polyester resin because polyester from brittle substances and weakened resistance to impact strength , but after reinforcing by asbestos fiber the impact strength will be increased due to the fiber will carry the maximum part of the effect impact energy which exhibition on the composite substances. The impact strength will continue to increase with increasing of the percentage fiber, which accepted with result obtained by Almosawi [12], as show in Figure 5, which explain relationship between fracture toughness with fibers reinforcing percentage. As mentioned above, polymer from brittle material, therefore fracture toughness will be low but after add asbestos fiber to the unsaturated polymer resin. The fracture strength will be raised due to the high modulus of elasticity of fiber asbestos will assist to carry a large total of fracture energy and raise the fracture strength .

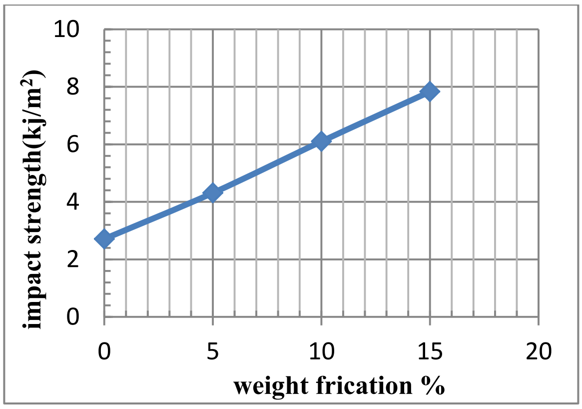


Figure 4: Variation of the impact strength of polyester with weight fraction of asbestos fiber

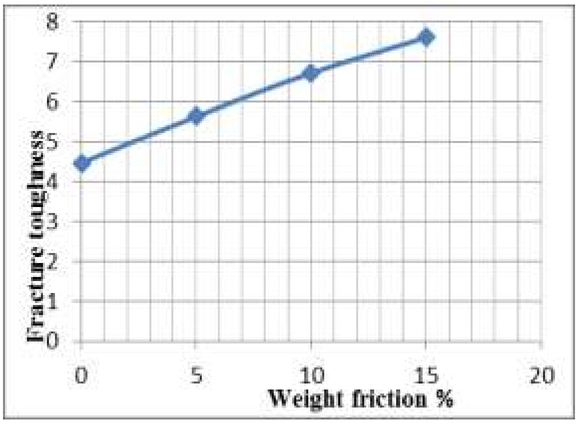


Figure 5: Fracture toughness with weight fraction

III. Measurement of Hardness Test.

Figure 6 illustrate the relation between hardness with different weight percentage of fiber, we show the hardness of resin very low but add of weight percentage of Asbestos of resin, the hardness of composite will be increased, because increasing the surface area of in contact with unsaturated polyester and decreasing the movement of polymer molecular which lead to raise of strength of material to scratch and increasing of the material strength to plastic deformation. Notices composites materials having highest value of hardness when at the volume fracture 15%the value is (153.2map) compeer with for pure unsaturated polyester was (72.45map).

V. Measurement Tensile Strength Test.

Consider of unsaturated polyester resin from brittle materials before reinforcement was shown in Figure 7 where we observed low tensile strength when exposed to load, which accepted with result obtained by Al-Mosawi et al. [13]. After reinforcing by asbestos fiber this property will be enhanced as illustrates in Figure 7, which represent the tensile strength of unsaturated polyester after reinforcing with (5%, 10%, 15%) Asbestos fiber, where the tensile strength of resin increased with increasing percentage fiber addition due to the asbestos fiber will with stand the maximum part of load. The result show the tensile strength of pure polymer 160 n/m^2 and reached to 277 n/m^2 when reinforced by 15-weight percentage.

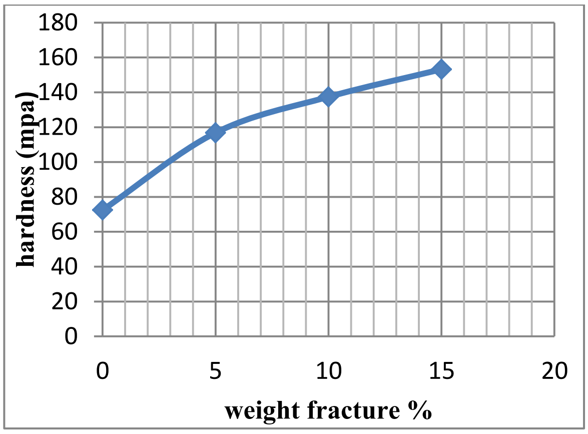


Figure 6: The effect of asbestos fiber on hardness of unsaturated polyester

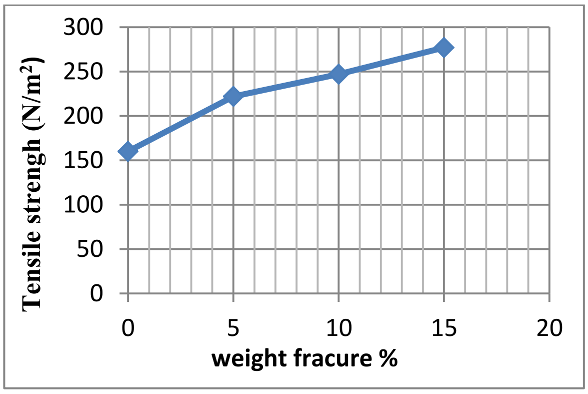


Figure 7: Tensile strength with weight fraction

5. Conclusions

1) Thermal conductivity coefficient (k) of the composite material decrease with increasing in weight percentage of asbestos fiber.
2) The study indict asbestos fiber good thermal insulation.
3) Mechanical characteristic (tensile, impact, hardness) of unsaturated polyester resin enhancement after reinforcement by fiber.

Appendix:-

Table 3: calculation result of thermal conductivity

Sample	Polyester resin	Asbestos fiber (wt)	Thermal conductivity (w/m°c)
1	100	0	0.577
2	95	10	0.436
3	90	15	0.331
4	85	20	0.211

Table 4: calculation result of mechanical properties

Sample	Polyester resin	Asbestos wool	Hardness	Impact (Kj/m^2)	Fracture (gpa)	Tensile (N/m^2)
1	100	0	72.45	2.71	4.47	160
2	95	10	116.8	4.31	5.63	222
3	90	15	137.4	6.1	6.71	247
4	85	20	153.2	7.83	7.60	277

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