ION EXCHANGE AND ADSORPTION
ISSN: 1001-5493

Vol. 23, Issue-02, 2023
pp.23-29

STUDY OF EFFECT ACIDIC SOLUTION (HCL) AT THERMAL CONDUCTIVITY OF BIO-COMPOSITE REINFORCED WITH AGRO WASTE AND EPOXY RESIN

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Abstract:
The effect of adding pomegranate and orange peel particles to the epoxy resin has been studied during thermal conductivity tests under natural conditions and immersion in an acid solution (HCl) for a period of (14 days) with normality (0.3 N). in weight fraction (0.04, 0.06, 0.08, 0.1) and in thickness (4 mm). Thermal conductivity test results under natural conditions (N.C) showed that epoxy reinforced with pomegranate peel particles increased with increasing weight percent (wt %), but thermal conductivity values (K) for orange peel particles decreased with increasing weight percentage, While immersion in acidic solution (HCl) exceeds the (K) values after immersion more than the value in (N.C)..
Key words : Pomegranate Shell , Thermal Conductivity , epoxy resin ,Acidic Solution (HCL)

1. Introduction:

Thin composite materials belong to the category of advanced materials that emerged at the end of the 20th century and flourished in many areas of industry to solve all the problems we face [1], as composite materials have become a sources of attraction for investors. and manufacturers. Therefore, its use has increased in various technological applications, with its ideal properties such as high strength and stiffness, low cost and low weight [2]. Due to the general requirements, the need to use composite materials with very high mechanical properties has arisen. Factors that affect composite properties include the size and shape of the reinforcement particles and their distribution in the substrate, as well as the nature of the bond between the particles supported by the substrate, as well as the interface area [3]. Due to environmental and sustainability concerns, the last decade has seen remarkable developments in green technologies, particularly in the field of materials science through the development of biocomposites. Among the possible alternatives, such as wood and plastics, the development of biocomposites from agricultural residues (including pomegranate peels, egg peels, orange peels and palm leaves) is currently attracting interest [4.5]. It is very rich in the production of fibers and agricultural particles and a large part of the agricultural residues is used as fuel. India produces more than 400 million tons of agricultural waste such as bagasse, corn cobs, peanut shells and other residues. [6]. Agricultural waste is excellent potential waste alternatives to replace plastic products due to its availability. In addition to its abundance and capacity for renewal, the use of agricultural residues is advantageous for the economy, environment and technology, due to its low density, low energy demand for manufacturing, low CO2 emission and high level of biodegradability, compared to thermoplastic. polymeric compounds. reinforced with inorganic fillers.[7,9].

Thermal conductivity(K) is one of heat transfer phenomena, where energy is transferred from one place to another due to temperature difference (the oscillation of particles of a substance), we can therefore define the thermal conductivity of a substance as a measure of a substance's ability to conduct heat and is usually expressed by the coefficient of thermal conductivity (K).

Thermal energy is transmitted through the material by different mechanisms, depending on the nature of the material, whether conductive or insulating, and on the movement of the molecules. In conductive solids, heat is transmitted through the material with free electrons in the crystal. In the case of insulating materials, there are no free electrons, therefore the heat is transmitted by a different mechanism, which is by elastic waves (elastic waves) resulting from the oscillations of the molecules, since these oscillations are transmitted to neighboring molecules. Due to its association with bonds, heat is transferred from the hot end to the cold end in the form of flexible quantum waves called phonons, and the phenomenon of heat conduction is subject to Fourier's law of conductivity thermal and is explained in the following relationship..[10]

$$Q = -K\,A\,\frac{dT}{dx} \quad \ldots\ldots\ldots(1)$$

The thermal conductivity can be calculated using the two equations [11].

$$K\,(T_B - T_A)\,/\,d_s = e\,[T_A + 2\,/r\,(d_A + l\,/\,4d_s)\,T_A + l\,/\,2r\,d_s\,T_B] \ldots (2)$$

(e) which represents the value of thermal energy transferred per unit area of disk per second ($W/m^2.K$) is calculated from the following equation (3): -

$$IV = \pi\, r^2 e\,(T_A+T_B) + 2\,\pi\, re\,[\,d_A T_A + d_S\, l\,/\,2(T_A+T_B) + d_B T_B + d_C T_C\,] \ldots (3)$$

Where (TA, TB, and TC) represent the temperatures of the three disks (A, B, and C), respectively.

I: current(amps), r: disc radius (cm), d: thickness of disc (cm) V: voltage (volts)

Place the sample between the two discs (A, B) and pass the electrical energy on the circuit and leave it until the temperature of the two discs (A, B) reaches a state of thermal equilibrium, then the values (TA, TB, TC) are recorded. And let it (the discs) cool down gradually for a period of (40 minutes) and the experiment was repeated for all discs, as shown in fig. (1)

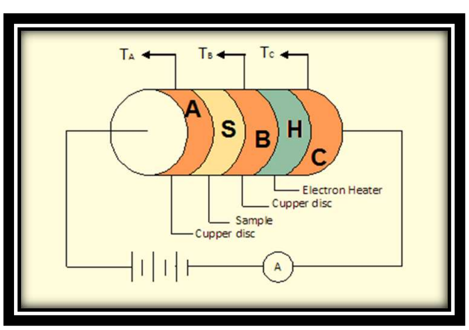


Fig. (1) The electrical circuit used in the heat conduction device

2. Experimental part:

2.1 Materials

The material used as a matrix in the preparation of composite materials is epoxy resin [(Polyprime EP from Hankl company) with a density of 1.03 g / cm3 and a low viscosity. The particle base and epoxy resin in liquid state are easy to mix, as it has high chemical resistance, high adhesion properties and low creep rate.Polymerization and solidification can occur by adding a solid of the same type of resin as the hardener which is a light, low viscosity, low density, transparent amber liquid. Resin hardeners have a long life (1:2). The time is 48 hours at room temperature, 2 weeks left to complete the curing (Full Curing) then the samples are cut according to the model used for evidence search. . Figure (2) shows the chemical equation for the preparation of epoxy resin

Fig (2)The chemical statement of Epoxy resin preparation

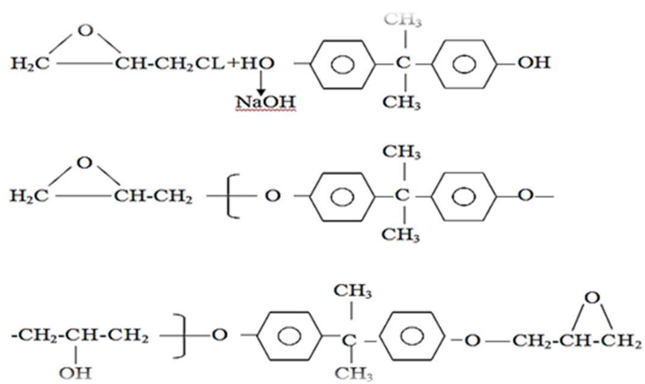


Fig. (3) The chemical equation for the preparation of epoxy resin [12]

2.2 Reinforcement Material

In this work two types of particles were used (pomegranate peel (PP) and orange peel (OP)). The reinforcing materials were cleaned, exposed to the sun, and then ground in a high-quality technical way to obtain particles with a particle size of approximately (45 microns) with weight ratios of (0.0.4, 0.06, 0.08, 0.1%). A vibrating sieve was used to obtain the appropriate particle size for the materials used.

2.3 Preparation of Samples

In the sample preparation process, Hand lay-up method was used in the process of preparing the samples this method includes the following steps as shown in Fig (4).

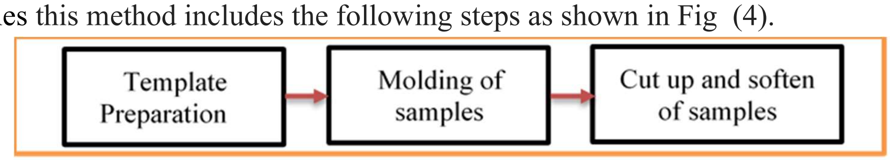


Figure (4) samples Preparation

The method used to prepare the samples is the Hand lay-up method .
First step: prepare the mold. The mold used in the casting process is the base of each pane of glass covered with a thermo paper mould (to prevent sticking of the resin to the pane and to enable easy machining by cutting) with a high degree of equator sealed sheets (ensuring a balance of stability by means of a flat surface) the sides of the mold by the pane of glass thick (4 mm).
Step two: forming the sample. The main method for sample preparation and casting consists of the following steps, as shown in Figure 5: the weighted amount of the required proportion of epoxy and hardener added in the ratio of (1:2), the weighted amount of the additives (PP and OP) micro in (0.02, 0.04, 0.06, 0.08)% by weight, a mixture of additives and matrix at room temperature. In a special bowl, mix with a blender until (1-10) minutes max.
Pour the liquid mixture to form a flow in the middle of the mold so that the flow occurs in all areas of the mold continuously and set the mold to fill to the desired level.It takes (48) hours to cure, then bake at 50°C for 5 hours to complete formability.

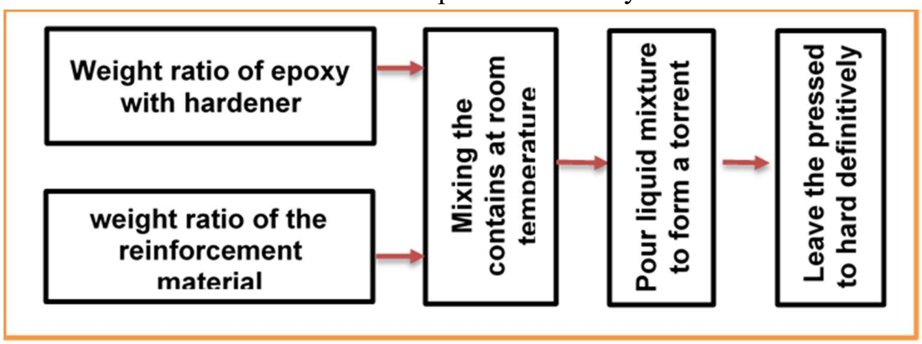
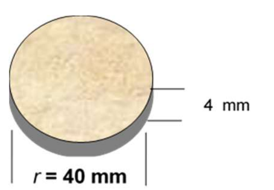


Figure (5) Modeling of samples

Step 3: Cut specimens in diameter according to ASTM schedule 5 specimen for smooth plate refining (silicon carburetors) and different grades of fineness

Table 5 Standard dimensions for thermal conductivity according to ASTM

Standard Specifications	***Standard dimensions for test samples***	***Test***
Lees' Disk		**Thermal conductivity**

3. Thermal Conductivity Device

here are two basic systems for determining the thermal conductivity (K) of materials:
1-Searl method: It is used to calculate the value (K) for samples of materials with good thermal conductivity such as copper (prepared in the form of rods) and whose measurement principle is an application of Fourier's law which is illustrated in relation (1).

2- Lee's disk method: It is used to measure the value (K) of materials with low thermal conductivity prepared in the shape of a circular disk, as shown in figure (1).

The values of (K) for polymers are between (0.15 and 0.45) w/(m.k), while for metals they are above (100 w/(m.k))

After activating the electrical source with a voltage of (6.3 volts), and the current in the electrical circuit is approximately (0.23 A), the temperatures of the discs are recorded after reaching thermal equilibrium after about (about 90 minutes).

Thermal conductivity values are calculated by applying equations (1) and (2)

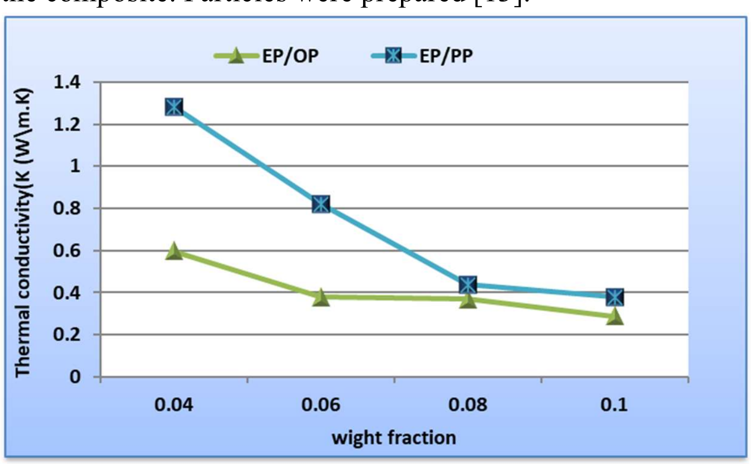
.

4. Results and Discussion

Thermal conductivity is the passage of energy from one place to another due to the irritation of the atoms or molecules of the material as a result of the change in temperature. The Lee's disc instrument is used to calculate the thermal conductivity of the tested samples.

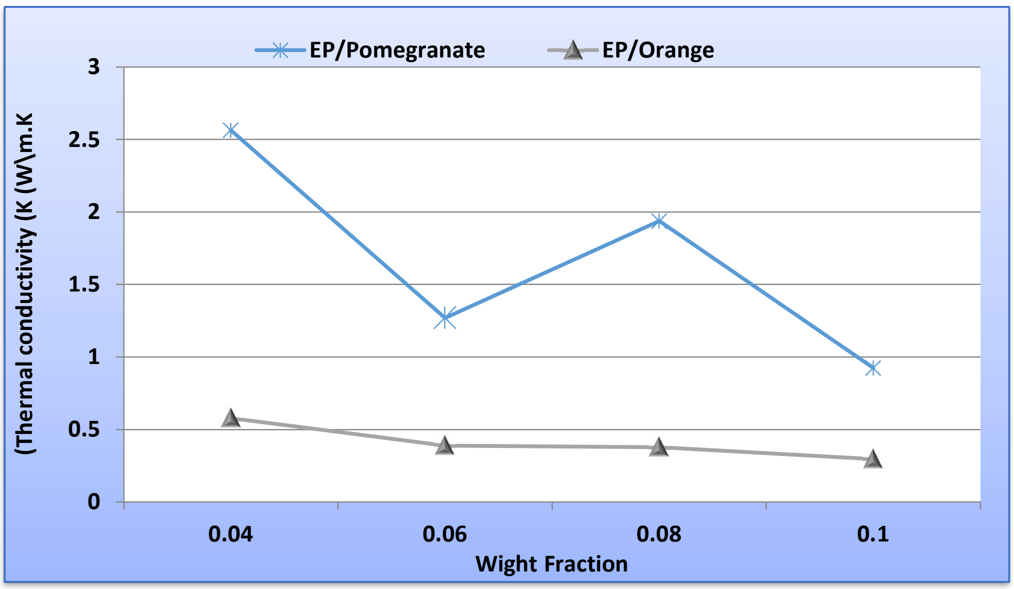
The values of thermal conductivity are calculated by applying the equations (1) and (2). to measure thermal conductivity of samples in natural condition and after immersion (14 day) in a acidic solution of normality (0.3N).

From figure (6) shows a decrease in the thermal conductivity values of the composite material with an increase in the weight percentage of pomegranate peel particles (PP) and orange peel (OP) in (NC). This was characterized by a gradual decrease in thermal conductivity, and it was the lowest value at the weight ratio (0.1) and amounted to (0.2887) W / µg for orange peel (OP). While the lowest value was for pomegranate peel at the weight ratio (0.1), which was (0.3774) (PP).This decrease is due to the fact that the thermal conductivity of the composite material is affected by the interface between the substrate and the supporting material and the irregular structure of the base material, which consists of heat-insulating polymer materials with low thermal conductivity . in the heterogeneous random structure. This results in a random dispersion of thermal energy as it is transmitted through the random structure of the polymer composite. Besides, there are also randomly dispersed particles in the structure of the core material, which in turn leads to the random diffusion of thermal energy as it travels through the random structure of the polymeric composite material, which leads to a decrease in the thermal conductivity of the composite. Particles were prepared [13].



Fig(6) Thermal conductivity value at natural condition(N.C) with weight fraction for (EP/PP & EP/OP) composites.

Figure (7) shows the relationship of thermal conductivity with the percentage weight of (EP / PP & EP / OR) compounds after immersion in HCl We noticed that the values of thermal conductivity (K) in the case of immersion in the acidic solution (HCl) are greater than the values in the normal state (C, N). because acidic solution (HCl)enter through the interface and there are already cracks in the material,, acting in weak and strong molecular bond of the matrix and the relaxation bonds lead to an increase in the plasticity of the matrix where it occurs Heat transfer by rotational motion and vibrations of molecular chains, and due to loosening bonds, the scalability of moving molecular chains increases, as well as the reactivity of chemical decomposition solutions. Materials that increase thermal conductivity. This agrees with [14].



Fig(7) Thermal conductivity relation with weight percentage for (EP/PP & EP/OR) composites in Hcl

5. Conclusions

Decrease in the thermal conductivity values of the composite material with an increase in the weight fraction of particles of pomegranate peel (PP) and orange peel (OP) in (N.C). Whereas after immersion in chemical solutions (HCl), this (K) increases with immersion time by a very small percentage. The composit showed (EP/OP) the best thermal conductivity value in weight percent (0.1) was (0.2887W/m.k) and the lowest value was (1.2839W/m.k) in weight percent (0.04) for (EP/PP).

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