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Absorbance Properties of the Nanoparticle-Reinforced Hybrid Mixture

Abstract: - It was used in the research. A hybrid mixture of epoxy with phenol-formaldehyde resin called RESOL was used with different mixing ratios and reinforced with alumina nanoparticles for the purpose of conducting an absorbance test for the research samples and comparing them with the original material from which certain parts were made. An oil container for the vehicle's internal combustion engine was chosen as part From the study to replace the alloy produced from the hybrid mixture of the material that was used in the research in order to save weight and improve the absorbent property, and the ANSYS simulation program was used and applied to the hybrid material produced in the research and compared to the materials from which the part was originally made.

Keywords: hybrid blend, Absorption, Phenol formaldehyde resin, epoxy resin.

I. INTRODUCTION

Composite materials have been used in multiple applications in large areas of life, as they are used in manufacturing parts for cars, ships, aircraft, and other applications. Therefore, the manufacture of any material for a specific application, is done by knowing the effect of the external environment on the manufactured material [1]. As the result of the negative effect of water on the wear test, the aim of this research was to conduct an absorbance test for the research samples [2]. Studies indicate that the purpose of immersing samples in boiled distilled water is to speed up the absorption process compared to the process of absorbing water at laboratory temperature, where samples are immersed for 15 minutes in boiling water according to each sample and 6 minutes in water at laboratory temperature, after which the percentage is calculated Percentage of absorption for all models immersed in water, where the mechanical properties are affected by the amount of water absorbed in the material[3]. Some studies showed that the mechanical properties of toughness and flexibility decrease after exposure to moisture or after water absorption [4], This is due to the fact that moisture has a role in weakening the bonds between the components of the base material and the reinforcing material by reducing the effectiveness of the bonding between the base material and the reinforcing material, or the reinforcement material may absorb larger quantities of the solution, causing the material to swell and thus separate from the base material [6 ,5]. Hydrolysis of polymers is a phenomenon with several mechanisms, the first of which is the mechanism related to increasing the permeability of water molecules, which leads to the phenomenon of swelling, and the second is the mechanism of not allowing part of the water to enter the body of the polymer and its compounds due to filling the precise cavity and the spaces between the elements of the structure, which leads to the phenomenon of saturation, Which usually depends on the temperature of the medium and the properties of the submerged samples [7]. The third mechanism is related to the spontaneous increase only with high temperature to increase the kinetic energy of water molecules. This process involves the movement of polymer chains one after another after a certain period of time, and this process is called polymer adsorption. The latter mechanism is a mechanism associated with passive swelling, which causes the polymer to dissolve in water as a result of injury [8]. Some specimens were observed from the first few minutes of immersion in boiling water. This may be due to the polymerization of some

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chains for some. After a certain time (5-15 minutes), and this depends on the endurance of each sample in which a decrease in the weight of the models occurred and the continuation of this decrease with increasing time. This may be due to the fact that in some cases the swelled polymer may cause enough stress to break down the chemical bonds between the atoms in the polymer chain and thus decompose the polymer chain into lower weight compounds as a result of polymerization. [9].

II. THE PURPOSE OF THE STUDY:

The purpose of the research is to study the adsorption property of a hybrid mixture of epoxy and phenol formaldehyde in different proportions, because moisture can lead to cracking of the layer between the base material and the reinforcing material, which reduces the bonding. between them. This is because the base material absorbs moisture in greater quantities, which causes the reinforcing material to swell and thus separate from the base material. The research also aims to improve the absorbent property of the hybrid mixture, and therefore the results of the research will be used to develop new materials that are more resistant to the effects of moisture.

II. HELPFUL HINTS

A. Figures and Tables

EXPERIMENTAL PROCEDURE:

Absorbance tests were carried out for samples containing epoxy resin and phenol formaldehyde with different weight fractions as shown in Table (1). Then calculate the percentage of absorbance for all samples immersed in chemical solutions, and the curves represent the relationship between the percentage of water gain in the mass (the percentage of water gain in the mass is drawn as the weight gain percentage), in addition to calculating the diffusion coefficient (D) for all samples immersed in chemical solutions. The bending test was also carried out according to the specification in the laboratory temperature at the University of Technology - Department of Applied Sciences, and the samples were examined twice and the average measured values were calculated. Figure (1) shows the samples after testing.

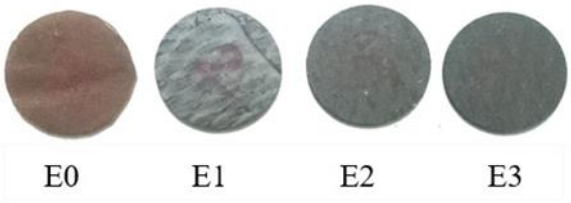

FIG. (1): THE SAMPLES FOR THERMAL CONDUCTIVITY TEST.

Table.1: COMPOSITION OF EPOXY- PHENOL FORMALDEHYDE HYBRID BLEND.

Sample No.	Composition
E0	**(Epoxy/Resole) (60/40)%**
E1	**(Epoxy/Resole) (70/30)%**
E2	**(Epoxy/Resole) (80/20)%**
E3	**(Epoxy/Resole) (90/10)%**

A water absorbance test of the prepared hybrid composites reinforced with alumina nanoparticles was performed by immersing the test samples in distilled water at laboratory temperature, then sampling periodically (after wiping

the water from the surface of the sample), and immediately weighing them using a sensitive balance for the content of absorbed water. As for the process of weighing the samples, it was done regularly in (24, 48, 72, 96, 120, 144, 168, 192, 216, 240, 264, 288, 312, 336, 360, 384, 408, 432, 456) and (480).) hour. When water absorbance is calculated by weight difference, weight gain is measured in percentage of samples over different time periods. In this study, ANSYS 3D finite element (FEM) software version 13 and oil pan model simulation were used in order to calculate maximum stress and deformation. The Finite Element Method (FEM) is a numerical analysis method [10], the basic idea of which is to estimate the field to be studied by representing it with a series of elements connected to each other by common nodes and the amount of load and type of element are chosen, in order to give the final shape of the field to be studied as well as choosing the boundary conditions to obtain the appropriate elemental distribution network [7] FEM is used to find out: stresses and deformations in complex shaped components,, the loading conditions, the boundary conditions and other important factors. Finite element technology gives the possibility of simulation with the field to be studied, where the behavior of the field is verified in real working conditions. The FEM solution method includes the following steps: -

• Divide the structure or field to be studied into elements with nodes (discretionary / network).

• Linking (grouping) elements into nodes to form an approximate form of equations for the domain (formation of element matrices).

• Solving system of equations involving unknown quantities in nodes.

• Calculating the desired quantities (stresses, strains...etc.) in the selected elements.

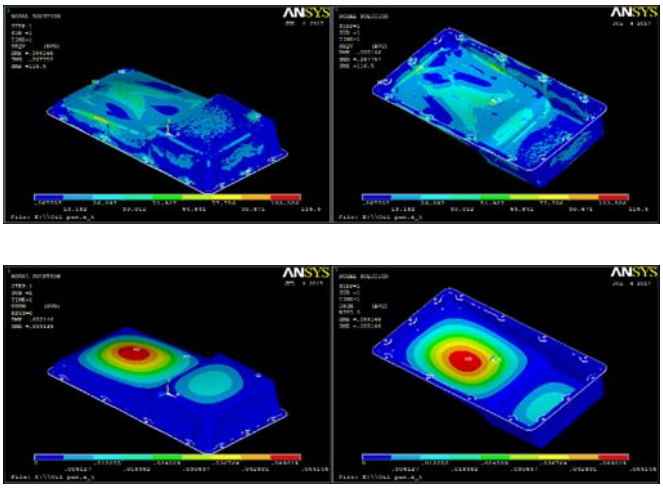

FIG.2: THE OIL BASIN MODEL (OIL PAN) IN THE CAR ENGINE, AS A MODEL FOR COMPARISON IN THE SIMULATION PROGRAM USED.

B. RESULTS AND DISCUSSIONS:

The amount of water absorbed greatly affects the properties of the composite material, so the mechanical properties of the material, represented by hardness and flexibility, decrease after exposure to moisture or after absorbing a quantity of water, because moisture has a role in breaking the bonds between the components of the base material and the reinforcing material by reducing the effectiveness of the bond between them, or that the reinforcing material It may absorb more water.

The core, which causes the material to swell and thus separate from the basic material, i.e. the breakdown of the bonding between the components of the composite material. Most polymers are resistant to weak acids and bases. However, strong acids and oxidants will degrade the polymer. Strong bases and organic solvents attack the

polymers and damage the material [10,8]. The resistance of plastics to both a chemically active medium and a physiologically active medium depends on the chemical composition, polymer structure, and temperature. Highly cross-linked polymers are not affected by solvents and cannot be dissolved unless the chemical bond between the polymer chains is broken. Accordingly, the polymers are not chemically active, the interaction between them (i.e. polymers and solvents) does not occur when solutions are used with them. Optical microscopy was used to study the morphology of the polymer mixtures. Photographs of the surface of the mixture were taken before and after immersion in water.

The absorbance test was performed for samples immersed in distilled water at laboratory temperature. When observing Figure (3), The weight of all samples after immersion in distilled water increases for all weight ratios 30% and 40%. Accordingly, the samples were weighed every 24 hours during the first four days of immersion, because the composite material absorbs the largest amount of water at the beginning of immersion. Where the amount of water absorbed during the immersion period is calculated and then the samples are weighed every (24) hours for a period of (21) days. The calculation of the amount of distilled water absorbed is as follows:

The figure also indicates the water absorption of the compound mixtures. It can be seen that there is a slight increase in weight in the mixtures, which means that these mixtures are not sensitive to change with environmental conditions. This may be due to the highly bonded molecular matrix and reinforcement resisting the penetration and inclusion of other particles such as oils.

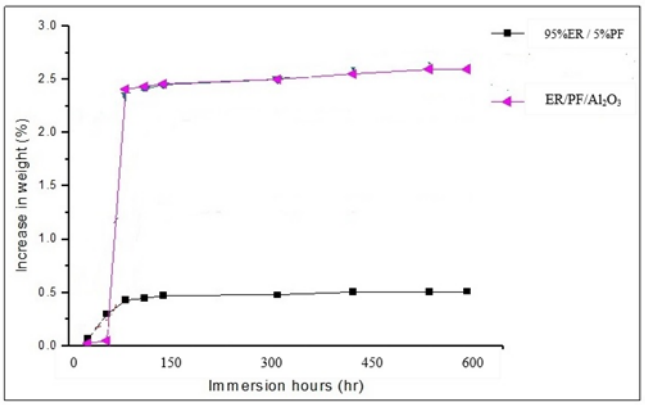

FIGURE (3): SHOWS THE ABSORBANCE OF DISTILLED WATER FOR THE HYBRID MATERIAL SUPPORTED BY ALUMINA NANOPARTICLES OF NANO-AL2O3

Figure (4) shows the composite mixtures (epoxy, resole and alumina nanoparticles) added (ER3 + Al_2O_3 + CF), the test showed a good distribution and compatibility between the components of the hybrid mixture and the alumina nanoparticles, which can give an improvement in the strength of the composite.

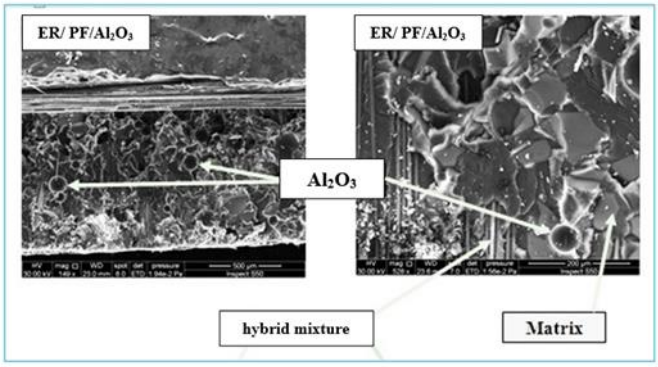

FIGURE 4: MICROSTRUCTURE OF THE NANOPARTICLE-REINFORCED HYBRID MIXTURE

VI. CONCLUSIONS:

1- Polymers are damaged by strong acids and oxidants as a result of decomposition of the polymer by strong bases and organic solvents.

2- The reinforcing material may absorb larger amounts of the base material, which causes the reinforcement material to swell and thus separate from the base material and the breakdown of the bonding between the components of the composite material.

3 - Reinforcement with alumina nanoparticles increases the absorbance resistance of the hybrid mixture.

VII. FUTURE WORK:

As a future work of this paper, the future study could investigate the effect of different types of water (for example, tap water, sea water, etc..) for the purpose of improving the properties of the composite material and being more resistant to the effects of moisture.

future work for this paper could focus on developing more sustainable and eco-friendly composite materials. This could involve exploring the use of natural fibers and materials, as well as investigating new methods for reducing the environmental impact of composite production processes.

Another area for future research could be the development of composite materials with enhanced durability and longevity. This could involve studying influence of various environmental factors on composite materials, such as temperature, humidity, and UV exposure, and identifying ways to increase their resistance to these factors.

Finally, future work could focus on the integration of composite materials with emerging technologies, such as 3D printing and smart materials. This would open up new possibilities for the design and production of high-performance, customized composite materials with advanced functionalities.

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