Experimental Study of Thermal Conductivity of Neutral Particles Composite Materials

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Abstract

Through this study, thermal conductivity of polymer hybrid composites filled with natural particles will be studied experimentally. In this study, A modified hot wire method is used to measure the thermal conductivity of the composites consisting of polyester matrix filled with neutral particles of date and olive up to 15% by weight ratio. With the increase in the density of natural materials, date kernel powder and olive powder additives to polyester to form the compounds filled with it, there is an irregular increase in the thermal conductivity. With increasing the temperature, thermal conductivity decreases to give good insulated composite material.

Key Words: Neutral Particles, Composite Materials, Thermal Conductivity, Instructed, Olive, Hybrid, Data.

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Introduction

The technology of composite materials has been known for its simplest form, since several centuries, when it was used in building houses by mixing clay with sawdust for strengthening [1]. Numerous research of composite materials has been used in various fields, including transportation, aircraft, the use of lightweight materials [2-4], as well as in construction, roads [5], and even chemical uses and adhesives to produce new materials with good specifications [6]. Many scientists have used cellulosic residues to support and strengthen polymers to produce plastic materials characterized as being fortified with cellulose fibers [7]. Many experiments have succeeded using coconut shells and others with polymers for the purpose of producing new composite materials that contain a group of compounds and are called composite materials. Rice husks were also used on the basis of a source of a type of fiber used with polymers for the purpose of strengthening and supporting them in terms of their tolerance to climatic and external conditions in general [8-10]. Currently, composite materials are increasingly used in all areas of life, including technological applications (electronics, aerospace, transportation, and others). And all this because of the possibility of producing new materials with better properties that combine physical and chemical properties suitable for practical applications. In general, these compounds are manufactured with physical limitations with their properties not changing during use [11]. The resulting materials are generally solids produced from two or more materials with complementary properties. In heat applications, a high understanding of the thermal properties of basic materials, including the properties of thermal conductivity, is required in order to determine the good conditions for the formation of these materials [12, 13].

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Experimental, theoretical and numerical models have been used to measure the thermal conductivity of a heterogeneous material [14]. So that the experimental and theoretical work was carried out for the purpose of validating the numerical models. For heterogeneous materials, many theoretical and experimental models have been proposed to approach the solution of thermal conductivity equations [15, 16].

Experimental Work

1. Material

The polyester material with a group of natural materials powders, dates, olives and hybrid have been used in this work. The composite material was prepared by adding natural powders from date palm, olives with more than one concentration (5%, 10% and 15%) with half liter of polyester with the addition of the resin as a hardened material by 0.6% with the use of manual mixing and at room temperature to produce a composite material ready for pouring into the test molds

2. Preparation of Composite Material

To manufacture the composite material, which will be used later in mechanical tests, it will go through several stages, including cleaning and removing the outer layer of scales and impurities from the nuclei of natural materials that used date palm, and ground nut hunks and then they are exposed through a simple heating process for the purpose of drying them and getting rid of moisture inside the cores. As in the Fig. 1.

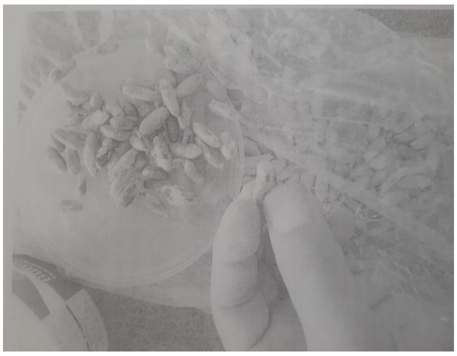

Figure 1. Neutral particles

After the process of cleaning and drying the nuclei of natural materials, these nuclei are broken into small pieces, and then they are ground with mill in the laboratory to obtain powder for these materials, after that different weight ratios (5%, 10% and 15%) of date palm, olives and buckthorn powders are added to a pint of A polyester material with a hardener of 0.6% and mixed well manually and poured into a glass block made of two pieces of glass with dimensions (12 * 30) cm to obtain after several hours on sheets of composite materials with dimensions (12 * 30) and thickness of 4cm to be cut in the form of Test samples In automatic machines as shown in Fig.2

Figure 2. Composite materials samples

3. Thermal Conductivity

The thermal conductivity of polyester composites with natural materials is calculated using a thermal conductivity analyzer (λm EP500e) shown in Figure 2. From the application of heat flow through the sample, the thermal conductivity of a sample with dimensions 200 mm x 200 mm x 30 mm taken between two plates is measured. Thermal conductivity is specified according to ASTMC177 [17,18]

4. Measurement Technique

The thermal conductivity of pure polyester and polyester compounds containing natural materials was measured by Shotherm QTM and modified hot wire technology. An electric current passes through a thin wire, generating a constant temperature (Q) per unit length of wire and per unit time (t), between two circular-shaped materials, the first being an insulating material with known conductivity and Fig. 3.

Figure 3. Thermal conductivity test

This is done by applying a constant power to the heater and then the temperature rise (T) of the wire is measured by thermocouple and the time during heating is done. Q) according to the equation:

$$K=F(Q\ln(t2/t1)/T2-T1)-H$$

Where, F and H are path specific constants fixed by materials with known thermal conductivity, thermal conductivity accuracy of 5% and reproducibility of 2%. For each model the thermal conductivity is measured three times and within a temperature range of about 20°C to 120°C and averaged values are calculated.

Results and Discussions

1. Thermal Conductivity

Fig. 4 shows that increasing the amount of natural powders of dry manufactured samples of dates and olive kernels and in weight ratios increases the thermal conductivity of the polyester insulating material at different levels, as the date kernels increase the conductivity more than olive kernels and the composite ratio of the mixture between the two.

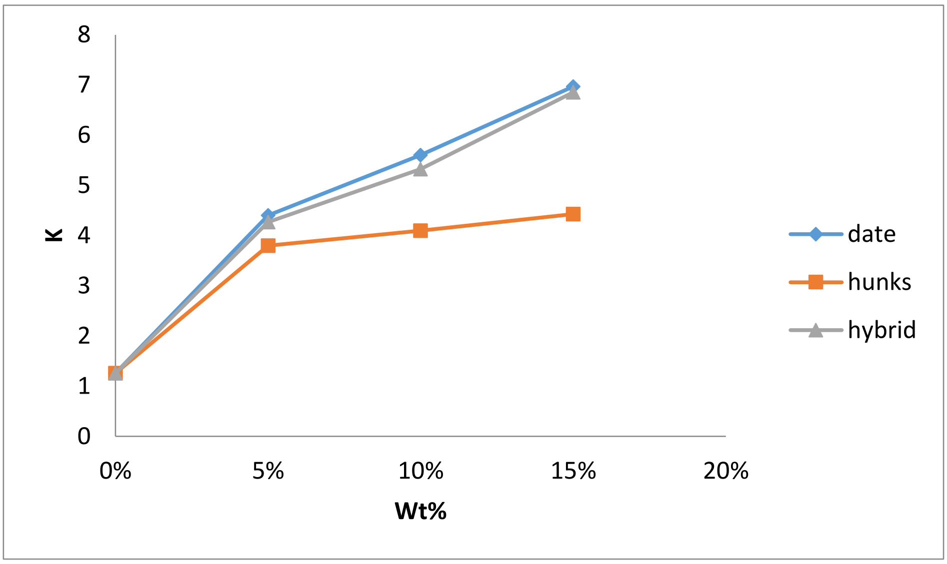

Figure 4. Thermal conductivity with weight ratio of Natural powders

And appear in table 1.

Table 1. Thermal conductivity with weight ratio

W%	K		
	Date	hunks	Hybrid
15	6.97	4.428	6.855
10	5.6	4.1	5.32
5	4.4	3.8	4.27
0	1.26	1.26	1.26

The Fig. 5 shows that increasing the amount of natural powders for the wet samples of dates and olive kernels and by weight ratios increases the thermal conductivity of the polyester insulating material at different levels, but by a lesser amount than the dry samples, with a decrease of up to 35%, with the same behavior as the date kernels increase the conductivity more than the olive kernels. It is the composite ratio of the mixture between the two.

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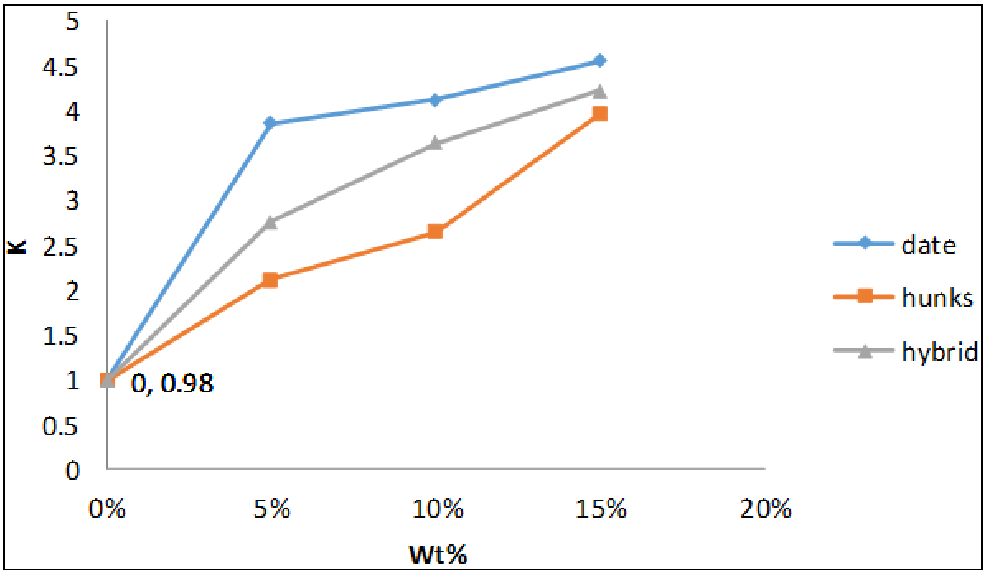

Figure 5. Thermal conductivity of wet with weight ratio of Natural powders

And this appear in table 2.

Table 2. Wet thermal conductivity with weight ratio

W%	wet k		
	Date	hunks	Hybrid
15%	4.55	3.96	4.22
10%	4.12	2.65	3.64
5%	3.86	2.11	2.75
0	0.98	0.98	0.98

The Fig. 6 shows that with an increase in the average temperature of the hybrid sample of natural materials with a concentration of 15%, the conductivity will decrease until it reaches 4.6 at an average temperature of 115 degrees Celsius. Temperatures and maintains the temperature of the second level while increasing the temperatures of the first level.

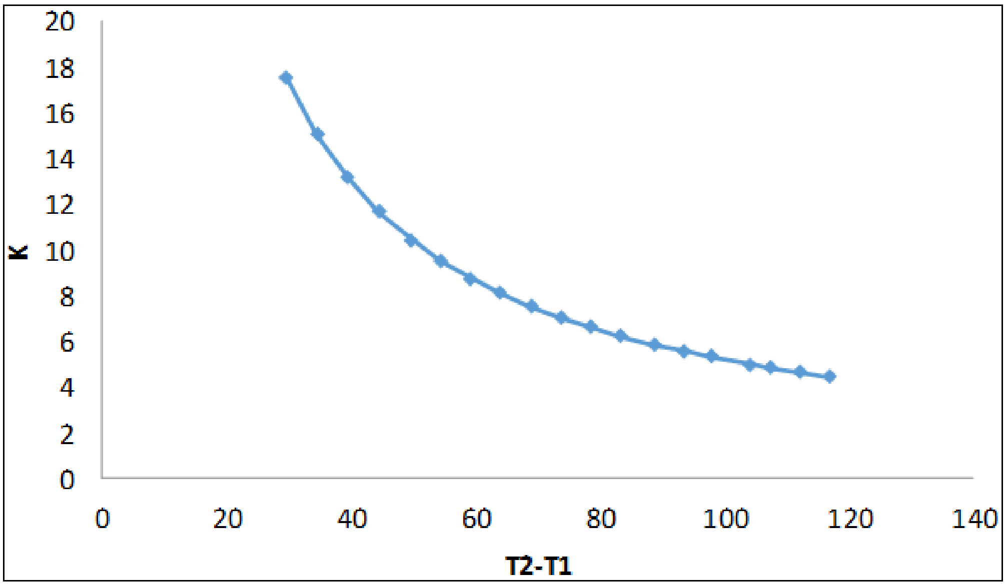

Figure 6. Thermal conductivity with temperature

As show the value in table 3.

Table 3. Thermal conductivity with time and temperature

Time	T2	T1	K
09:39	50	20.4	17.53104456
09:40	55	20.5	15.04112808
09:40	60	20.5	13.13718782
09:40	65	20.5	11.6610993
09:41	70	20.3	10.44102453
09:41	75	20.4	9.504009504
09:42	80	20.8	8.765522279
09:42	85	20.9	8.095458953
09:43	90	21	7.520564042
09:43	95	21.1	7.021906887
09:43	100	21.3	6.593633023
09:44	105	21.7	6.229518835
09:44	110	21	5.830549651
09:45	115	21.5	5.549934962
09:45	120	22.1	5.300499683
09:46	125	20.6	4.970487729
09:47	130	22.6	4.83164729
09:48	135	22.7	4.620827417

Conclusions

From the results obtained, it is possible to conclude some basic points

1. Adding natural particles in certain proportions leads to improvement of thermal conductivity.
2. Decreases of thermal conductivity at wet samples.
3. A decrease thermal conductivity and increasing the insulated properties at increasing Temp. of the composite materials.

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