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Study the Effect of Thermal Properties of Polymer with Added Dioctyl Phthalate (DOP) Fillers

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ABSTRACT: An investigation was conducted to analyze the impact of incorporating Dioctyl Phthalate (DOP) at various weight ratios (1, 3, 3, and 5 wt.%) on the thermal conductivity coefficient of the polyurethane polymer. Thermal conductivity coefficient of the samples was calculated using the Holmarc's Lee's Disc apparatus device. The results indicated that addition the Dioctyl Phthalate (DOP) ratio leads to an improvement in the thermal insulation ability due to decrease in the value of thermal conductivity special at the ratios (3,5) wt%, which is (0.101,0.099) w/m.ko respectively. Also,The results indicate that the increasing of the Dioctyl Phthalate (DOP)special at the ratios (7) wt%, which is (0.133) w/m.ko lead to the ability due to decrease of thermal insulation , via increasing the value of the thermal conductivities of the sample.

KEYWORDS: polyurethane foam, perlite stone powder, combustion characteristics, polymer.

INTRODUCTION

Polyurethane is widely used in several industries, including construction, packaging, and furniture. The remainder of the polyol chain, which is flexible, and hydrogen bonds, which are rigid, make up polyurethane [1]. polyurethane is one of the important polymers in many applications and Tritosil Polyurethane is one component with Highly resistant to seawater-diluted acids and alkalis, odorless, Non-sag, -moisture-cure polyurethane sealant designed to skin and cure rapidly, outstanding UV resistance and long term durability[2]. Since the Inflexible PU foam's hardness rises with density, foam with better properties is produced. More specifically, an increase in density of (1000 g/cm3) suggests an increase in hardness of approximately (100 Pa) [3]. Adding materials (fillers) to polymers is a rapid and inexpensive approach to changing the properties of basic materials; as a result, the mixture (polymers with fillers) was and still is of interest to interest of researchers in the field of scientific research, particularly in the industry [4]. When certain fillers are added to polymers or a mixture of similar polymers to form a new polymer, a new system is formed that differs in its attributes and characteristics in terms of performance and has an appropriate and relatively low cost, but when chemically different polymers are mixed, the final product lacks integration and compatibility and does not have good characteristics [5-7]. Fillers are solid materials added to polymers to improve mechanical properties and reduce cost, and they have the opposite effect of plasticizers in that they minimize ductility and elongation rate while increasing tensile strength and Young modulus, or know that they are organic or inorganic materials added to the polymer. It can either be used to increase the volume of the plastic material, lowering the cost of usage (inert fillers), or it can be used to improve mechanical qualities (effective fillers) [8-10]. The inclusion of fillers in polyurethane formulations is a well-established technique for improving their mechanical properties and overall performance. The choice of filler and compatibility with the polyurethane matrix play an important role in determining the success of the material for a particular application. As research progresses, new fillers and processing methods continue to emerge that increase the potential of polyurethane-based composites in various industries, from automotive to construction.

Experimental

Materials and Methods

The trimethylamine (TEA) was used as a catalyst in the reaction of 1:1 weight percent isocyanate and (polyol) provided by Sigma-Aldrich Company. The raw materials for preparing polyurethane (isocyanide and commercial polyester polyol) were dissolved in a commercial organic solvent to prevent the materials from hardening and to increase the time required for manufacturing different ratios of Dioctyl Phthalate (DOP) waste from (General Company for Petrochemical Industries) (0,1,3,5,7) were added to the reaction mixture of 1:1 (polyester polyol: isocyanides) and mixed well for 15 minutes until complete homogeneity was achieved, after which the mixture is poured into moulds for measuring mechanical properties[11-12].

The Polyurethane samples were prepared with Dioctyl Phthalate (DOP) at laboratory temperature. Then, we have been added different weight ratios (1, 3, 5, and 7) wt% of

(DOP) waste to the polymer mixture. The mixing procedure was continued for the mixture was evenly distributed, then, the final product was poured into a cylinder mold,

Evaluation of thermal characteristics:

Thermal conductivity coefficient (K) of the samples was calculated using a done by the Holmarc's Lee's Disc apparatus model HO-AE-LD18 (Kochi, India, Holmarc Opto-Mechatronics Ltd manufactures). Fig.1. shows the Hilmarc's Lee's Disc apparatus for thermal conductivity measurement. Eq. (2) was used to calculated thermal conductivity (K) using Fourier's law.

$$K = -\frac{q\,x}{A\,\Delta T} \qquad (2)$$

Where: K is thermal conductivity (W/m.K°), q is heat energy (W), T is temperature (°K), x is thickness of test specimen (m), and A is area of test specimen (m^2). At the steady state, the thermal conductivity K is calculated using Eq.(3).

$$K = \frac{MC\,\frac{dT}{dt}}{\pi r^2\,(T_2 - T_3)} \times \frac{(r+2h)x}{2(r+h)} \qquad (3)$$

Where M is the mass of the metallic disc, C is the specific heat capacity of the metallic disc, h is the height of the metallic disc, r is the radius of the metallic disc, $\frac{dT}{dt}$ is rate of cooling of the metallic disc at T_3.($T_2 - T_3$) is the temperature difference across the sample thickness (x), Diameter = 76.2 mm, Thickness = 4 - 6 mm for Sample dimensions.

Fig. 1. The Hilmarc's Lee's Disc apparatus for thermal conductivity measurement.

RESULTS AND DISCUSSION

Fig. 2 shows the relationship of thermal conductivity with the weight ratios of Dioctyl Phthalate (DOP) waste added to polyurethane. The discrepancy in the results is sometimes attributed to the inhomogeneous distribution of the Dioctyl Phthalate (DOP) waste with the polymer, which leads to asymmetry in the number of gaps per unit volume, and thus the difference in the results, which leads to a difference in the values of the thermal conductivity coefficient for some unit series samples. The figure also shows that the coefficient of thermal conductivity increases with increasing weight percentage of the additives, and that the coefficient of thermal conductivity of the pure polymer (without any addition) has the lowest value, which is (0.105 W/m.Ko), then it starts to increase with the increase in the concentration of the additive, especially at (7%), which is(0.113 W/m.K°)[13]. The increase in the coefficient of thermal conductivity of the polymer with filler concentrations is attributed to two main reasons: First, increasing the concentration of Dioctyl Phthalate (DOP) waste with the polymer works to reduce the gaps and pores inside the sample. Second, the additives have a higher thermal conductivity coefficient than that of polyurethane which is(0.19 W/m.K°) [14], so they increase the thermal conductivity coefficient of the resulting samples [15]. Also, The below table (1), indicate the values thermal conductivity and weight ratios Dioctyl Phthalate (DOP) added to polyurethane polymer.

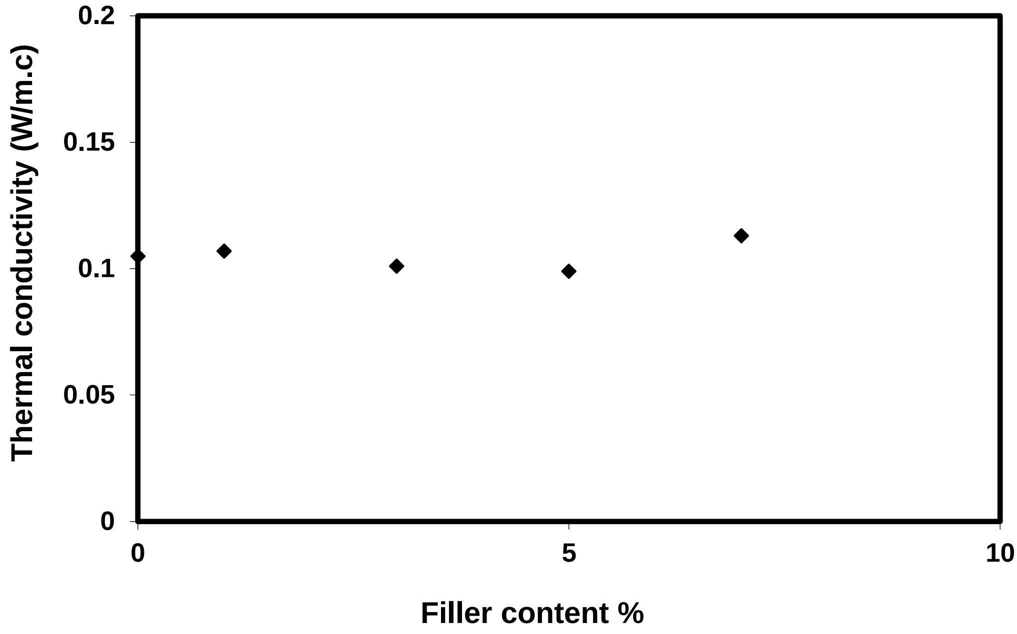

Fig. 2: The relationship between thermal conductivity and weight ratios Dioctyl Phthalate (DOP) added to polyurethane polymer.

Table 1: Indicate The values thermal conductivity and weight ratios Dioctyl Phthalate (DOP) added to polyurethane polymer.

No.	Sample	thermal conductivity (W/m.K°)	Temperature(C°)
1	0%	0.105	30
2	1%	0.107	30
3	3%	0.101	30
4	5%	0.099	30
5	7%	0.113	30

CONCLUSION

The values of the coefficients of thermal conductivity decrease with the increase in the weight percentage of the materials added to the polymer special at the ratios (3,5) wt%. The practical study indicates that a percentage (3%) improved the thermal insulation properties. The results indicated that addition the Dioctyl Phthalate (DOP) ratio leads to an improvement in the thermal insulation ability due to decrease in the value of thermal conductivity special at the ratios (3,5) wt%, which is (0.101,0.099) w/m.ko respectively. Also,The results indicate that the increasing of the Dioctyl Phthalate (DOP)special at the ratios (7) wt%, which is (0.133) w/m.ko lead to the ability due to decrease of thermal insulation, via increasing the value of the thermal conductivities of the sample. Additionally, the incorporation of (DOP) waste with polyurethane is a viable method for enhancing thermal conductivity in applications, especially at 7%.

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