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Study the effect of the adding of Ash of Palm Fronds on the Mechanical Properties for High Density Polyethylene (HDPE).

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Abstract:

The mechanical properties of (HDPE - ash of palm fronds) composites were studied. The range of added powder of ash of palm fronds has the values (0%, 1%, 2%, 3%, 4%, 5%, 7.5% and 10%) of polyethylene weight and the best ratio was (10 %). The mechanical properties of (HDPE / ash of palm fronds) composites were analyzed as a function of the added powder amount. All prepared composites showed improved powder dispersion in the high density polyethylene matrix. More composites displayed lower elongation of break compared to pure HDPE. The results lead to that the strength at breaks will be affected little till the percentage (3%) is (6.8 Mpa), and increased after that with increasing the percentages, also indicate a lowered in young's modules (Young modulus) which at the percentage (3%). The highest value of the proportional limit was when the proportion of the added polymer (2%) is (431.2 N) while the less proportion limit of which (372 N) at the percentage is (4%).

Keywords: polymer, Mechanical properties, Ash of palm fronds; Polymer composites; high density polyethylene, Fillers.

1. Introduction

Polymer composite is a combination of a polymer matrix and a strong reinforcing phase materials, or filler. Polymer composites provides desirable properties unavailable in matrix or filler materials alone [**1**]. Polyethylene in its many resin grades and densities, is by far the most widely used plastics in the world. Its relatively low cost, when compared to other commercial plastics such as Polycarbonate and Nylon, and its wide range of material properties have facilitated the utilization of polyethylene (PE) in many product applications and manufacturing processes[**2**]. Polyethylene is the most widely used among thermoplastics, especially for packaging and construction applications. Polyethylene is used in construction materials for home furnishings, domestic and industrial buildings, appliances, fabrics, and transportation vehicles [**3-4**]. Polyethylene (PE) is one of four most popular thermoplastics in the world, it is generally divided as densities to low, middle and high density polyethylene (HDPE)[**5**]. High density polyethylene is an important commercial polymer and it is widely used for different engineering applications[**6**]. HDPE is a highly flammable compound, Finding a method to reduce the flammability of HDPE is of great scientific interest to researchers and industry because of the wide and varying uses of polyethylene today[**4**]. High density polyethylene (HDPE) is a commodity polymer broadly used for many industrial products. One of the most demanding applications of HDPE is the production of pipes and fittings for the transportation of water or gas under pressure [**7**]. Mechanical properties depend strongly on the chemical as well as on the super molecular structure of the polymeric material, from the mechanical properties is a stress - strain curve of the polymeric material [**8**]. Mechanical properties of polymeric materials are important for nearly all applications in industry, technology, and the household. Particularly, stiffness, strength, and toughness are decisive properties in many uses[**9**]. Studied Nadhim A. Abdullah and et al, Mechanical properties for a Polymer material reinforcement with husk of rice composites. The obtained results showed that the maximum observation increase in Young modulus (797 Mpa) is (25%) and the best added ratio was (25%) of HDPE weight which gave Proportional limits (155 N) [**10**]. Studied Nadhim A. Abdullah et al. the mechanical properties of high density polyethylene (HDPE) modified with local cheap fillers. The obtained results showed that the adding of sawdust as a filler to HDPE decreasing the elongation by 80% relative to its original value were this decrease was rapidly in filler range (5%-25%) and explained in the term of decreasing the polymeric chains distance [**11**]. Studied Iftekhar Ahmad et al. [**12**], Mechanical Properties of Fly Ash Filled High Density Polyethylene, we results obtained The tensile strength could be increased by up to 22% by using 14 µm fly ash particles. Better strength might be expected by using further reduced size of fly ash particles. Tensile modulus increased with fly ash concentration with about 160% increase at 40% filler. Tensile elongation drastically reduced at fly ash concentration greater than 10%. The K. Naresh Kumar et al. [**13**], we Studied Experimental Investigation on Mechanical Properties of Coal Ash Reinforced Glass Fiber Polymer Matrix Composites, The obtained results showed that the maximum tensile strength is obtained for 20 % (weight) of coal ash among all the different weight percentages and maximum flexural strength is obtained for 16 % (weight), the maximum Compression strength is obtained for 12 %(weight). Arijit Patra, et al. [**14**], Investigation on Mechanical and Physical Properties of Fly Ash Reinforced Epoxy Resin Composite, From the experimental observation it has been found that the toughness and hardness maximum for 40% fly ash contained composite but tensile strength is better for 30% fly ash based composite. The aim of this study is to find out the effect of adding of the ash of palm fronds rice on mechanical properties of polyethylene.

2. Experimental:

2.1. Materials:

This research used high density polyethylene (HDPE) as the basis of material, with product by the general company for petrochemical industries (Basra-Iraq) in the form of powder, and Table (1) shows some of the characteristics of this pure polymer used in this research. Ash of palm fronds which is used as a natural fillers with polymer in this research was protected in a steps process[**15**], after cut into the palm fronds small pieces, it was completely burned in air, then the product ash powder filtering by candidate wired equal to or less than (75 µm) to receive a fine and homogeneous powder.

Table (1) some of the properties of High density of polyethylene

Property	**HDPE**
Trade Name	Scpilex (M624)
Melt Index	5-7 (g/10 min)
Density	0.961 (g/cm^3)

2.2. Preparation of composites.

Ash of palm fronds was mixed with HDPE by using mixer 600 instrument attached to Haake Rehochard under the following conditions; mixing time 15 minutes in 160°C temperature and mixing velocity 50 RPM., by using the cross section (mixer 400) with description 16 R.P.M, 60°C for 10 minutes. The final mold product is introduced in a laboratory compress under 5 tons at 175 °C for 3 minutes in a square frame. The pressure then rises gradually up to 15 tons for 10 minutes and after this period the sample were cooling to reach room temperature. Samples dumbbell in shape were prepared for measuring the mechanical properties by using the Zwick Rell instrument. Figure (1) shows a photograph of the sample of the dimensions of the dumbbell-shaped specimens.

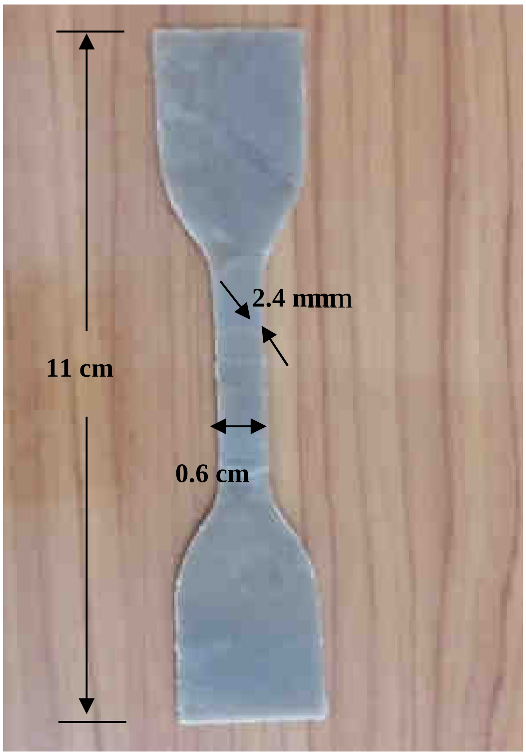

Figure (1) Photograph of the tensile specimen coupon dimensions centimeters.

2.3. Mechanical testing.

A universal testing machine Zwick Rell (2.5 KN) was used. The tensile modulus was calculated as the ratio of stress to elastic strain in tension for both pure and modified polyethylene.

The tensile properties were tested according to the ASTM Standard D-638: Standard Test Method for Tensile Properties of Plastics [**16**]. A photograph (Figure (2)) showing a mechanical measuring device (Tensile), the sample thickness is (2.4 mm) and the weight ratios of each sample. The tensile strength Q was calculated by the following equation [**17**]:

$Q = F / A$ (N/mm^2) ....(1)

Where:

F = force (N) .

A =sample section area (mm^2).

(Young's modulus) Y = stress/strain ....(2)

Figure (2) a photograph showing a mechanical measuring device (Tensile).

3. Results and discussion

Figures(3,4) the relation between the Stress at yield and Stress at Break with a percentage added to the polymer, shown in figure (3) The behavior of stress at break begin the low effect when percentage (1%) of the additive, and then to increase to (35 MPa) when the percentage (2%) for tensile strength at break and (37.2 MPa) with Stress at yield, and we note that Stress at yield and Stress at Break decreases when you increase the percentage of added the Ash of palm fronds when the percentage (3%) and the behavior of tensile strength at yield increase when the percentage (7.5%).This shows that the Ash of palm fronds works to improve the property hardness at percentage(10%). **Figure (5)** the relation between the percentage of elongation at break with the concentration of additive, the elongation of the polymer begins at the percentage (1%) of the polymer pure (6.7%) and then decrease when the percentage (2 %) is (6.2 %), which is a polymer few flexibility and has a hardness high thereby acting Ash of palm fronds to fill the spaces between the chains main polymer limited movement of the chains and thus less elongation and then increases until it reaches the maximum value to them when the ratio (3 %) is (6.7 %), and the polymer when this ratio high flexibility and low hardness, and then decrease when the percentage (10%) is (2.7%)[**12**], polymeric chains that are not constrained by any be free movement as a result of lack of homogeneity of the mixture, including the nature of the Ash of palm fronds characterized by rigidity, which in turn increase the stiffness of the polymer and reduce elongation increased concentration of additive and worked to increase the density of the polymer. **Figure (6)** shows the effect of Ash of palm fronds on modulus of elasticity (Young modulus) which is known as a proportion of stress to elongation for solids only, shown in figure increase Young modulus progressively with increasing concentration of additive and this leads Ash of palm fronds us to works elongation of the polymer, and probably explains the decline in the Ash of palm fronds when the percentage (1%) of the additive to the heterogeneity of the model although the mixing models have been in the same circumstances, and this indicates that the polymer has the recipe high flexibility and decrease in hardness at this percentage, the maximum value to them when the ratio (10 %) is (1048.15 MPa), while the ratio (1 %) is (502.8 MPa). **Figure (7)** shows the proportional limit(A yield strength or yield point of a material is defined in engineering and materials science as the stress at which a material begins to deform plastically. Prior to the yield point the material will deform elastically and will return to its original shape when the applied stress is removed) with percentage added Ash of palm fronds to the polymer, the highest value was when the proportion of the added polymer (2%) is (431 N) as it will be at this rate homogeneity strong between Ash of palm fronds with chains of polymeric polymer while less proportion limit of which (352 N) at the percentage (7.5%), and probably explains the decline in the Ash of palm fronds when the percentage (7.5%) of the additive to the heterogeneity of the model although the mixing models have been in the same circumstances.

Conclusion:

The natural filler like Ash of palm fronds can be added in form of powder filler where their effect on mechanical properties depends on the concentration. This effect on the mechanical properties due to the functional groups and the ability of ash of palm fronds improve the mechanical properties and increase the strength by increase the binding between the filler functional groups and the polymer. The ash of palm fronds used as filler in this study improves the mechanical properties (stress - strain) and the best results with 2-10% content, the changing of added ash of palm fronds ratio certainly made a big changes to those mechanical properties like stress- strain, toughness and elongation due to the type of interaction between the polymers chains. HDPE with (10%) ash of palm fronds is recommended for industrial applications.

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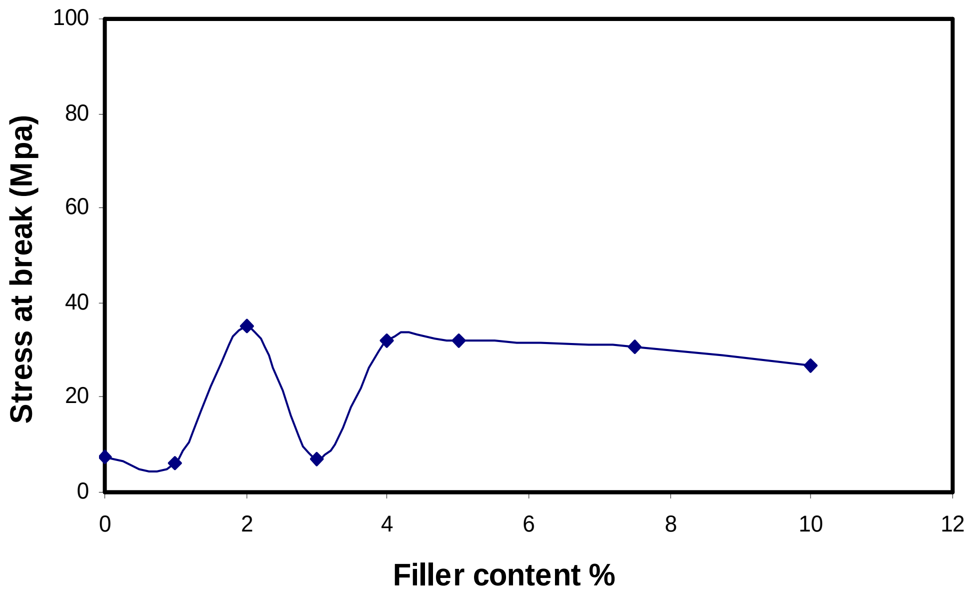

Figure (4) Stress at Break and Ash of palm fronds -HDPE composites.

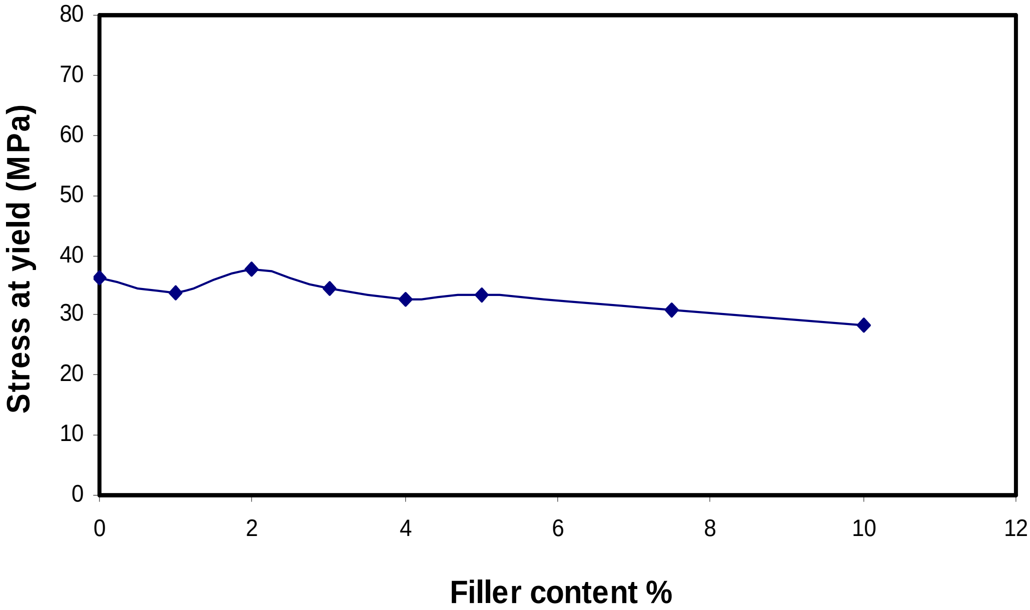

Figure (3) Stress at Yield and Ash of palm fronds -HDPE composites.

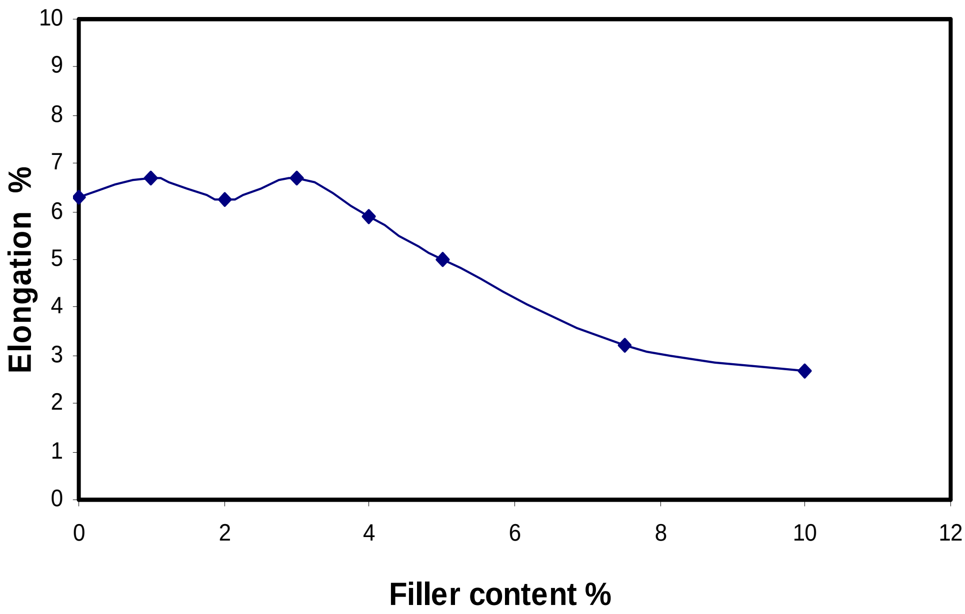

Figure (5) Elongation at break and Ash of palm fronds -HDPE composites.

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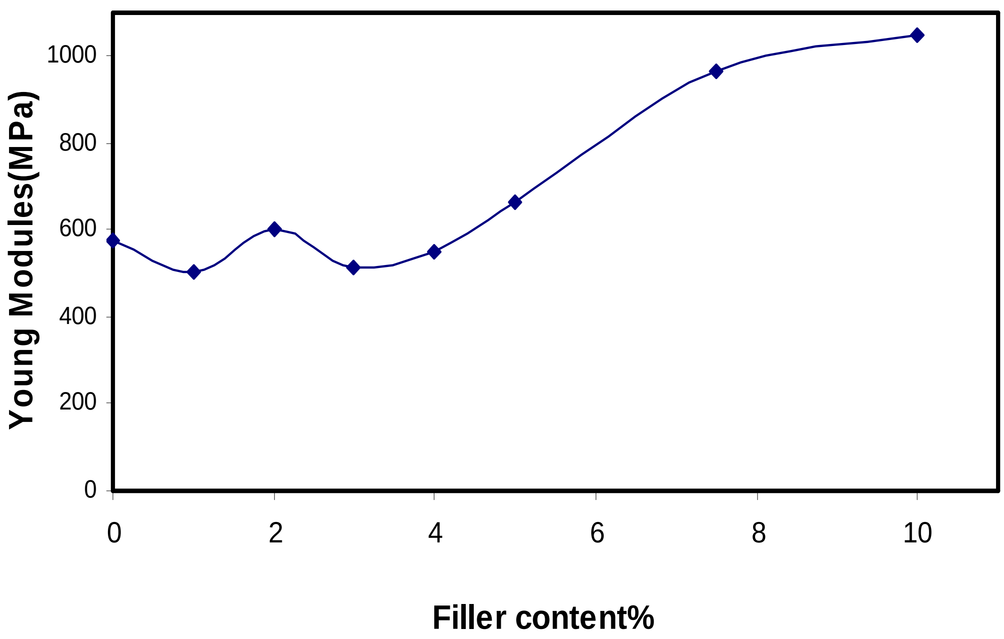

Figure (6) Young modulus and Ash of palm fronds -HDPE composites.

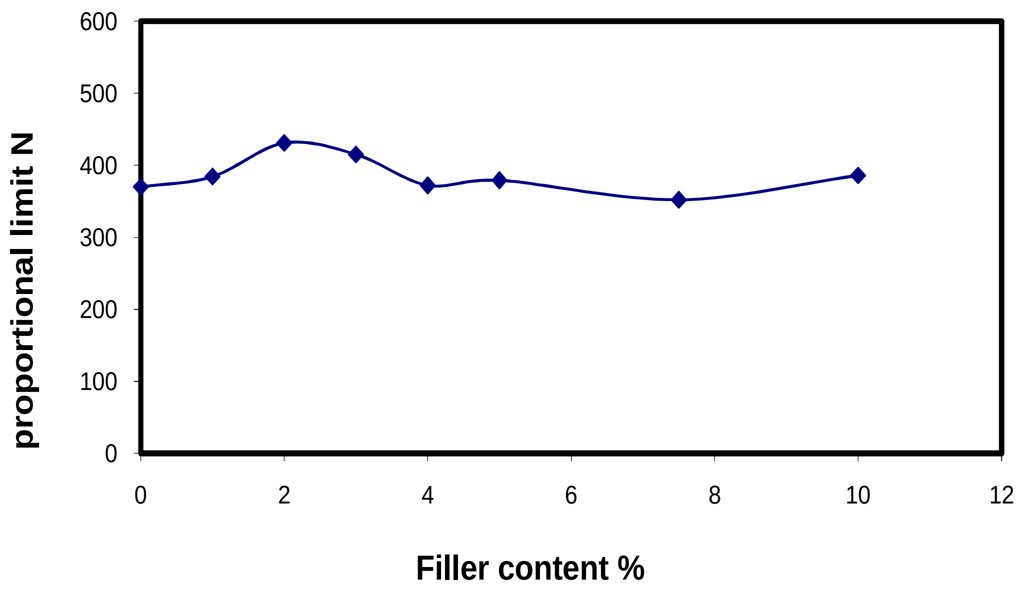

Figure (7) relation between the proportional limit and Ash of palm fronds -HDPE composites.