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Study the effect of adding powder Walnut shells on the Mechanical Properties and the flame resistance for Low Density Polyethylene (LDPE)

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ABSTRACT

The mechanical properties of walnuts shells composites were studied. The range of added walnuts shells has the values (0%, 2.5%, 5%, 10%, 15%, 20%, and 25%) of polyethylene weight and, the best fibers ratio was 10 % and 15 %. Obvious improvement in the mechanical parameters was recorded when adding walnuts shells with 10% weight ratio. The properties (LDPE /walnuts shells) composites were analyzed as a function of the powder amount. All prepared composites showed improved powder dispersion in the low density polyethylene matrix. All composites displayed lower elongation of break compared to pure LDPE. The best added ratio was 15% of LDPE weight which gave Proportional limits 140 N.

Keywords: *Polymer composites; low density polyethylene; shells powder walnuts*.

1. INTRODUCTION

Low density Polyethylene (LDPE) is a famous commercial polymers used in a many industrial applications. Electrically, it's known as insulating material. It's compatible properties, such as, good insulation together with its excellent mechanical properties (high tensile strength) make it as a candidate their utilizing in different applications as an active material replacing other materials [1]. Polyethylene is a widely used thermoplastic found in everyday life. With easy availability, low cost and good process ability, polyethylene is also a promising candidate as a matrix material for composites [2].

Different parameters, concerning this response, have been measured and investigate, such as, young's modulus, elongation, tensile strength stress at a yield and break. The polymer characteristics can be controlled and altered by adding different additives such as antioxidants, ant blocking agent, slip agent, antistatic agents, stabilizers, color compounds and fillers [3]. The addition of fillers to polymers is a fast and cheap method to modify the properties of the base materials. For this reason, particulate filled polymers have been, and are, a subject of increasing interest in both industry and research. In this way, strength, stiffness, electrical and thermal conductivity, hardness and dimensional stability, among other properties, can be tailored to the required values [4].

Fillers are solids added to polymers to improve their properties and decrease the cost and have the opposite effect of plasticisers as decrease the softer polymer, or known as organic or inorganic added to the polymer either for the purpose of increasing the volume of material plastic, which reduces the cost or may improve some mechanical properties .[5 -7].Fillers find application in the polymer industry almost exclusively, e.g. to improve mechanical, thermal, electrical properties and dimensional-stability. LDPE composites are used in various applications as decks and docks, packaging film, pipes, tubes, window frames or, in the last years, also as materials in the automobile industry [8-13].

The aim of this study is to find out the effect of adding Walnut fibers on mechanical properties of polyethylene.

2. EXPERIMENTAL

2.1. Material Basis

This research used polyethylene with low density (Low Density Polyethylene) as the basis of material and 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.

Table (1) some of the properties of polyethylene and low density

Property	LDPE
Trade Name	Scpilex (463)
Density (g/cm^3)	0.921-0.924
Melt Index (g/10 min)	0.28-0.38

2.2 Fillers

In this research used the Walnut shells fillers with polymer within the fillings natural organic[14],were cut into small pieces and then grind these small parts by machine grinding electric origin French to the powder , and then were treated powder shells walnuts by candidate wired equal to or less than (250 μm).Figure (1) shows a photograph Walnut shells. Table (2) shows the chemical composition of shells walnuts.

Figure (1): Photograph shows shells powder walnut

Table (2)The chemical composition of shells walnuts.

Chemical composition	Cellulose	Ash	Toluene Solubility	Lignin	Cutin	Chlorine	Nitrogen
wt.%	40- 60	0.9-1.5	0.5-1.0	20-30	0.8-1.59	0.10	0.10

2.3 Preparation of Composites

Walnuts shells are mixed with LDPE using mixer 600 instrument attached to Haake Rehochard meter under following conditions; mixing time 15 minutes, mixing temperature 160 °C 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 is cooled up to reach room temperature. Samples dumbbell in shape are prepared for measuring the mechanical properties by using Zwick Rell instrument.

2.4. Mechanical Testing

A universal testing machine Zwick Rell 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 [15]. The dimensions of the dumbbell-shaped specimens are shown in Figure (2). The tensile strength was calculated Q by the following equation [16]:

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

Where F = force (N) , and A =sample section area (mm^2).

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

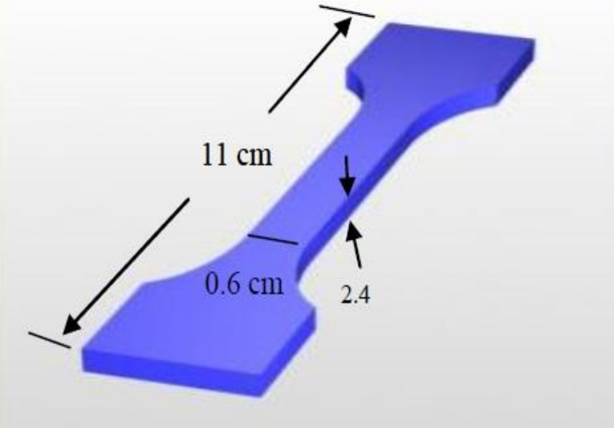

Figure (2) tensile specimen coupon dimensions centimeters.

2.5 Average Time of Burning ATB

In this research was measured average time of Burning (ATB) and the Burning Rate for each sample by a device measuring the Burning Rate, according to the standard method 81 ASTM D635 - calculating the time required for combustion model to a distance of 75 mm from sample, also re-measurement three times for each sample was extracted average values.

3. RESULTS AND DISCUSSION

The mechanical properties of low density polyethylene are shown in Figure(3), where the stress - strain curves of polymer composite that reinforced with different ratios of shells Walnut. Figure (2) shows the (stress - strain) curve of LDPE loaded with shells powder Walnut shells percentage measured at a constant rate loading at room temperature. Stress- strain curve has been dependent in description instead of load-elongation curve because it describes the material characteristics and is less dependent on the arbitrary choice of specimen profile. It's well known that polyethylene belongs to where this behavior has characterized with low modulus and low yield stress. According to the break down classification, the stress-strain curve is exemplifying the second behavior of the fracture nominally cold drawing . In this type three regions can be distinguished; first is the linear region, second is the yield region, third is the elongation region up to the break. In the first region, (linear region), where the deformation was not very large, Hook's Low is obeyed which characterized the instantaneous and recoverable deformation associated with the bending and stretching the inter atomic bonds between the polymer atoms. Also there is no permanent displacement of molecules relative to others. Linear region can reflect the elastic limit region of the polymer, in which the uniform extension due to stress increased with a constant rate. The proportional limit was 146 N but this value reduced to 76 N when we add the hemp by 20% of polyethylene weight. The values were increased to 138 N, 140 N and 141 N with increasing the added filler ratio to 2.5%, 5% and 15% respectively. It is worth to mention that the highest percentage of hemp fibers is 25%, where this result can be explained in term of the homogenization process between the polymer and the additive becomes very difficult due to the difficult gliding polymeric chains with particles of filler. The best added ratio was 15% of LDPE weight which gave Proportional limits 140 N.

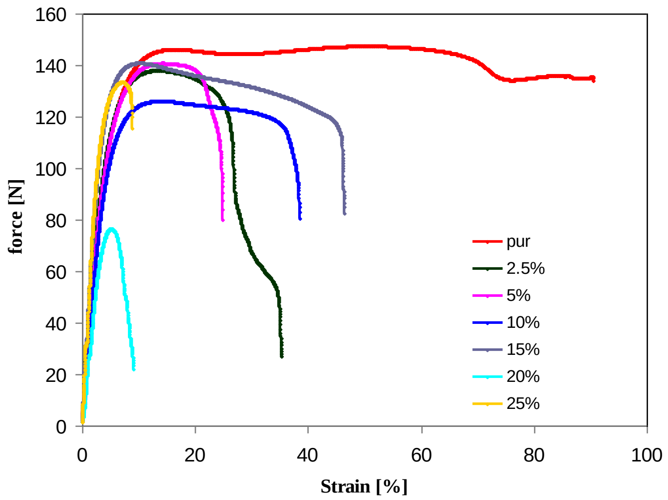

Figure (3) The stress - strain curves and shells Walnut -LDPE composites

Figure (4) the relation between the percentage of elongation at break with the concentration of additive,

the elongation of the polymer begins at the percentage (0%) of the polymer pure (109 %) and then decrease when the percentage (2.5%) is (35.5 %) which is a polymer few flexibility and has a hardness high thereby acting shells powder Walnut 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 (10 %) is (44.2 %), and the polymer when this ratio high flexibility and low hardness, and then decrease when the percentage (20%) is (7.8 %) 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 shells powder Walnut 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.

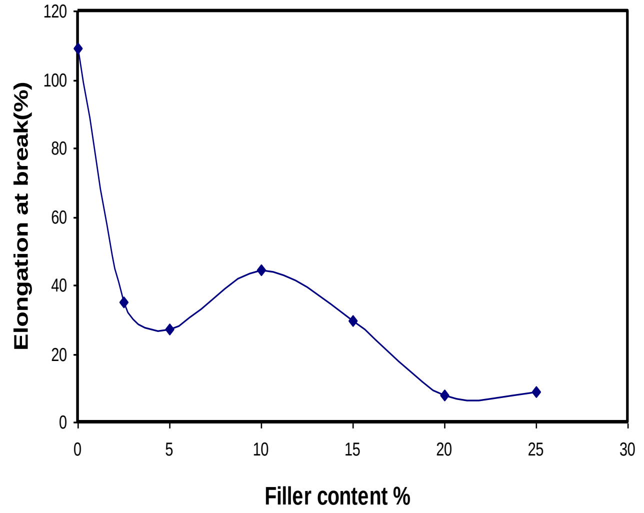

Figure (4) Elongation at break and shells powder Walnut -LDPE composites

Figure (5) shows the effect of shells powder Walnut 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 shells powder Walnut us to works elongation of the polymer, and probably explains the decline in the shells powder Walnut when the percentage (10%) 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. Either when the percentage (15% and 25%) have a recipe polymer hardness and lack of elasticity.

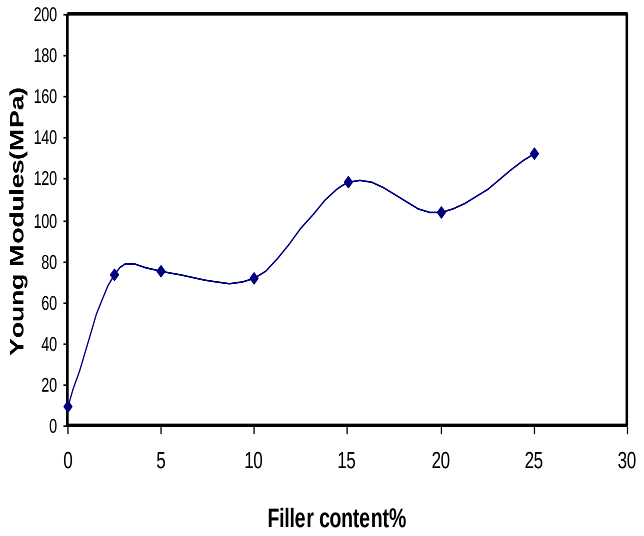

Figure (5) Young modulus and shells powder Walnut -LDPE composites

Figures(6,7) the relation between the Stress at yield and Stress at Break With a percentage added to the polymer, shown in

Figure (6) The behavior of stress at break begin the low effect when percentage (5%) of the additive, and then to increase to (7.51 MPa) when the percentage (15%) for tensile strength at break and (10.8 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 shells powder Walnut when the percentage (20%) and the behavior of tensile strength at break increase when the percentage (25%).This shows that the shells powder Walnut works to improve the property hardness at percentage(25%), where polymer to the extent of hardness at this rate the effect of distribution of homogeneous material nature solid.

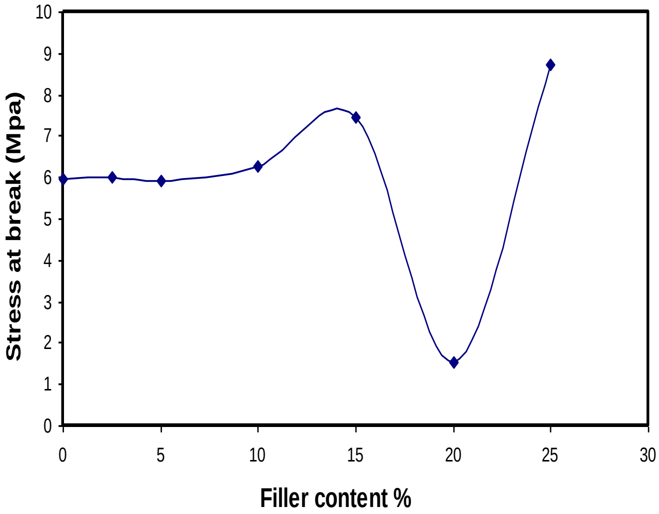

Figure (6) Stress at Break and shells powder Walnut -LDPE composites

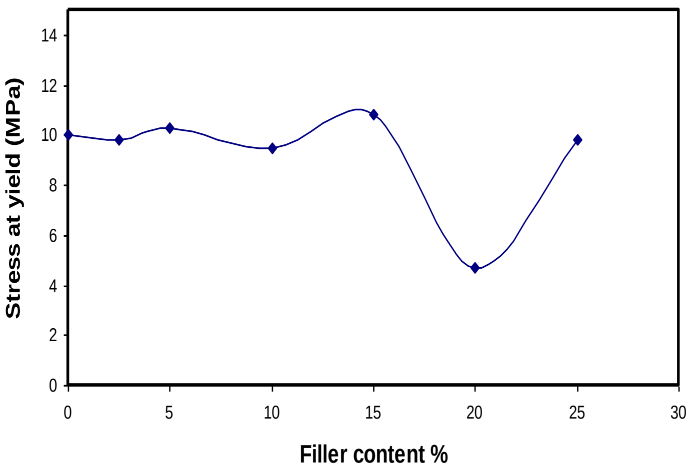

Figure (7) Stress at Yield and shells powder Walnut -LDPE composites

Figure (8) shows the average time of burning with the percentages added of shells powder Walnut, to note that the behavior starts strong impact when the percentage (5 %) to (182 Sec) and then begin decrease behavior when increasing percentages, which demonstrates that increasing the proportion of the shells powder Walnut have a negative effect on the flame resistance and heat spread through the matrix polymer where we get low when the percentage (20%) which is (101 Sec).

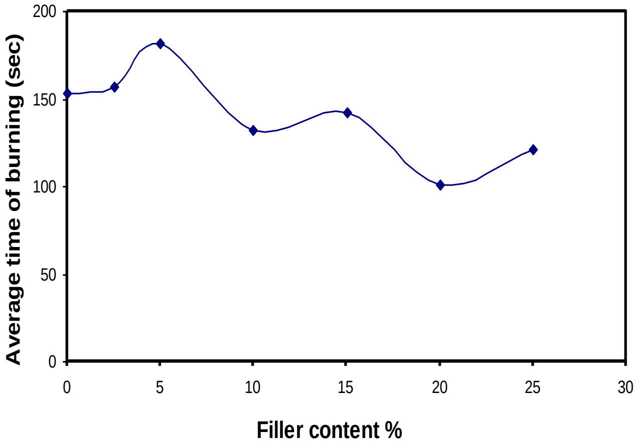

Figure (8) relation between the average time of burning and shells powder Walnut -LDPE composites

Figure (9) represents the proportional limit with percentage added shells powder Walnut to the polymer, as we note that the highest value was when the proportion of the added polymer (15%) is 141 N as it will be at this rate homogeneity strong between shells powder Walnut with chains of polymeric polymer while less proportion limit of which 76.5 N at the percentage (20%), and probably explains the decline in the shells powder Walnut when the percentage (20%) of the additive to the heterogeneity of the model although the mixing models have been in the same circumstances.

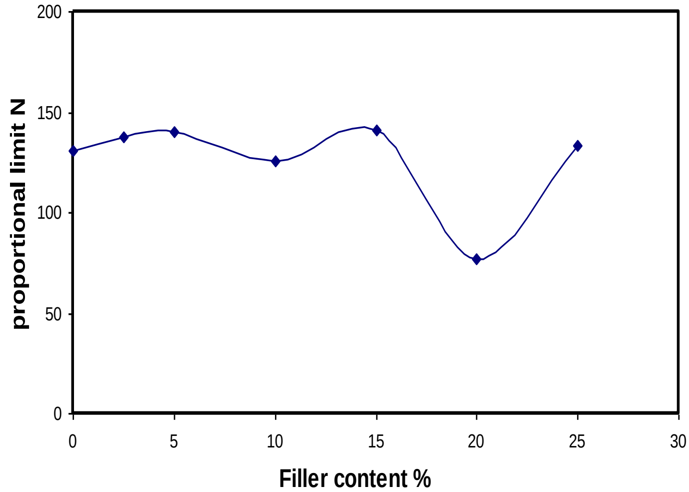

Figure (9) relation between the proportional limit and shells powder Walnut -LDPE composites

CONCLUSION

We have shown in this study that the mechanical behavior for low density polyethylene was improved by adding shells powder Walnut with different filler content. It was found that modulus of elasticity has increases with increasing filler content. The shells powder Walnut used as filler in this study improves the mechanical properties (stress - strain) and the best results with 5% and 10% content, the changing of added walnut 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, fillers shells powder Walnut and the filler polymer interaction. The increase in tensile at the yield and break may be related to the increase in the material homogeneity. Polymer phase was diluted by stiffer material (shells powder Walnut). This interpreted the weak end observed in mechanical properties above 10% percentage.

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