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Effect of the adding of rice husk on the Mechanical Properties for High Density Polyethylene (HDPE)

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ABSTRACT: *The mechanical properties of husk of rice composites were studied. The range of added the husk of rice has the values (0%, 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 husk of rice with 10% weight ratio. The properties (HDPE / husk of rice) composites were analyzed as a function of the husks amount. All prepared composites showed improved husks dispersion in the high density polyethylene matrix. All composites displayed lower elongation of break compared to pure HDPE. The best added ratio was 25% of HDPE weight which gave Proportional limits 155 N.*

Keywords: *Husks of Rice; Polymer composites; high density polyethylene,*

I. INTRODUCTION

Polyethylene is the most widely used among thermoplastics, especially for packaging and constructions applications[1]. Polyethylene in its many resin grades and densities, is by far the most widely used plastic 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 used in construction materials for home furnishings, domestic and industrial buildings, appliances, fabrics, and transportation vehicles [3].

Polyethylene (PE) is one of four most popular thermoplastics in the world. PE is generally divided into high-density polyethylene (HDPE), low-density polyethylene(LDPE), and linear low-density polyethylene (LLDPE) [4]. HDPE is usually produced as bottles, containers, film or sheet, inject molding, pipe, conduit, and other products. Over 50% of HDPE products are manufactured with blow and injection molding [5]. 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 poly ethylene today[3]. High density polyethylene is an important commercial polymer and it is widely used for different engineering applications[6]. 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]. A polymer composite is a combination of a polymer matrix and a strong reinforcing phase, or filler. Polymer composites provide desirable properties unavailable in matrix or filler materials alone[8]. 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 [9-11]. Fillers find application in the polymer industry almost exclusively, e.g. to improve mechanical, thermal, electrical properties and dimensional-stability[12]. The aim of this study is to find out the effect of adding husk of rice on mechanical properties of polyethylene.

II. EXPERIMENTAL

2.1. Material basis:

This research used polyethylene with high density (High 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 High density

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

2.2..Fillers.

In this research used the husk of rice fillers with polymer within the fillings natural organic[13], 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 husk of rice by candidate wired equal to or less than (250 μm).Figure (1) shows a photograph husk of rice and the table (2) shows the Chemical Composition of rice husks fibers.

Table (2) The Chemical Composition of rice husks fibers.

Chemical Composition	K_2O	Na_2O	CaO	MgO	MnO	Fe_2O_3	Al_2O_3	TiO_2	SiO_2	Ig.Loss
Wt. %	2.06	0.08	0.53	0.55	0.12	0.26	0.31	0.02	92.95	1.97

Figure (1): Photograph shows husk of rice.

2.3. Preparation of composites.

Husks of rice are mixed with HDPE 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 [14]. The dimensions of the dumbbell-shaped specimens are shown in Figure (2). The tensile strength was calculated Q by the following equation [15]:

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

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

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

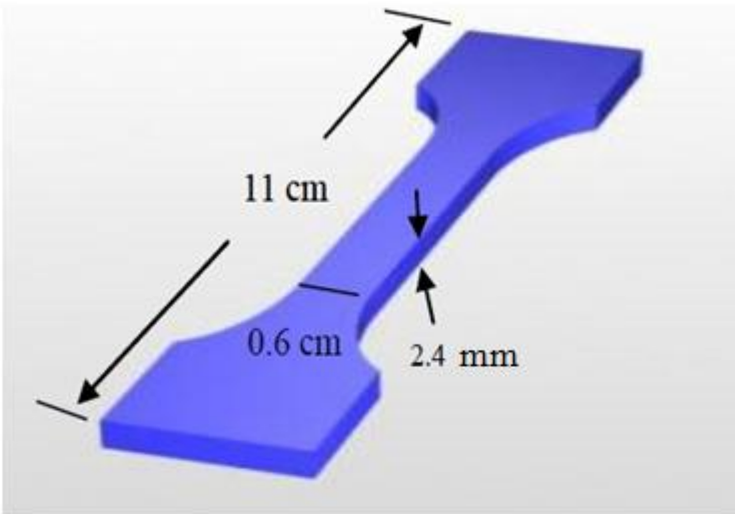

Figure (2) tensile specimen coupon dimensions centimeters.

III. RESULTS AND DISCUSSION

Figure (3) shows the(stress-strain) curve of HDPE loaded with husks of rice 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.Figure (4) 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 husks of rice to the polymer, the highest value was when the proportion of the added polymer (25%) is (155 N) as it will be at this rate homogeneity strong between husks of rice with chains of polymeric polymer while less proportion limit of which (137 N) at the percentage (15%), and probably explains the decline in the husks of rice when the percentage (15%) of the additive to the heterogeneity of the model although the mixing models have been in the same circumstances. Figure (5) shows the effect of husk of rice 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 husks of rice us to works elongation of the polymer, and probably explains the decline in the husks of rice when the percentage (5%) 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. Figure (6) 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 (488%) and then decrease when the percentage(5 %) is(16.2 %), which is a polymer few flexibility and has a hardness high thereby acting husks of rice 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 (15 %) is (6.85 %), and the polymer when this ratio high flexibility and low hardness, and then decrease when the percentage (20%) is (3.1%) 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 husks of rice 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. Figures(7,8) 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 (27.35 MPa) when the percentage (10%) for tensile strength at break and (34 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 husks of rice when the percentage (20%) and the behavior of tensile strength at yield increase when the percentage (25%).This shows that the husks of rice works to improve the property hardness at percentage(10%).

IV. CONCLUSION

The natural filler like husks of rice can be added in form of 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 husks of rice improve the mechanical properties and increase the strength by increase the binding between the filler functional groups and the polymer. The husks of rice used as filler in this study improves the mechanical properties (stress - strain) and the best results with 10-15% content, the changing of added husks of rice 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% husks of rice is recommended for industrial applications.

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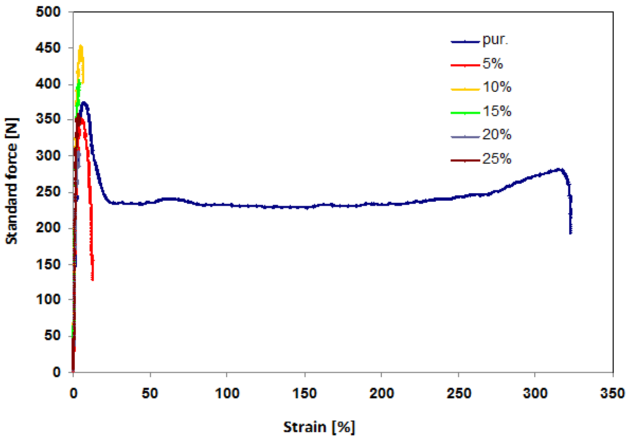

Figure (3) The stress - strain curves and husk of rice -HDPE composites.

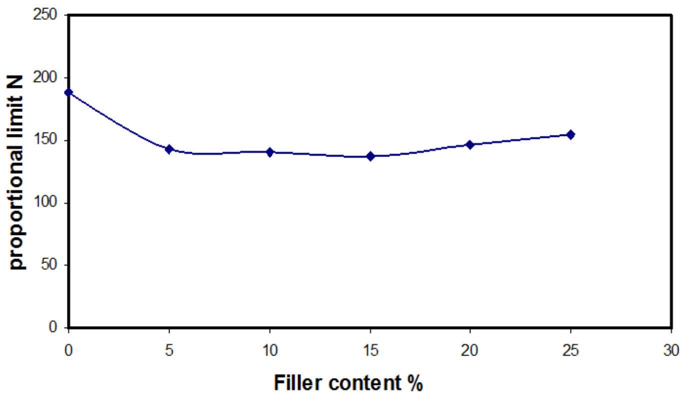

Figure (4) relation between the proportional limit and husks of rice HDPE composites

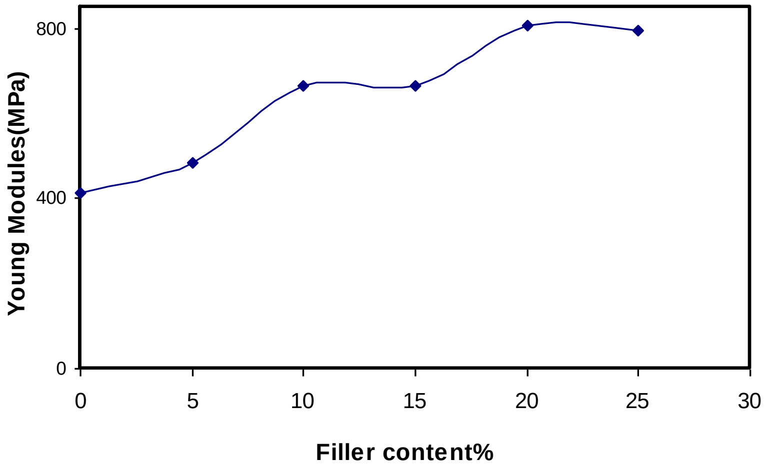

Figure (5) Young modulus and husks of rice -HDPE composites

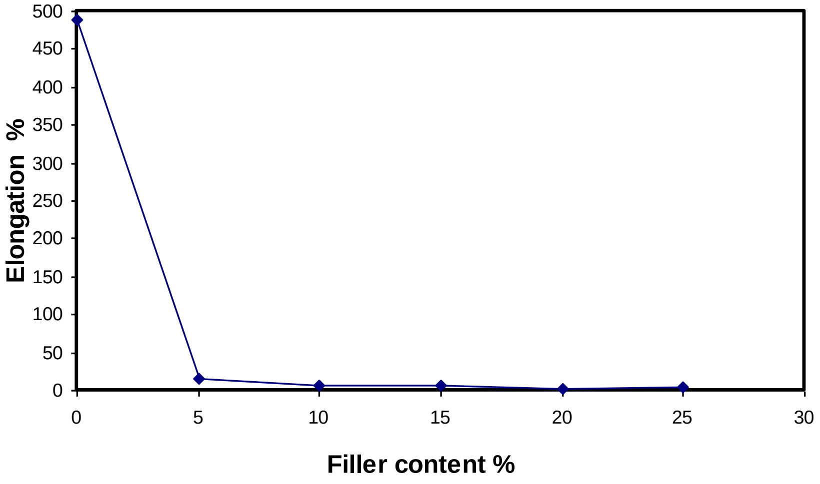

Figure (6) Elongation at break and husks of rice -HDPE composites

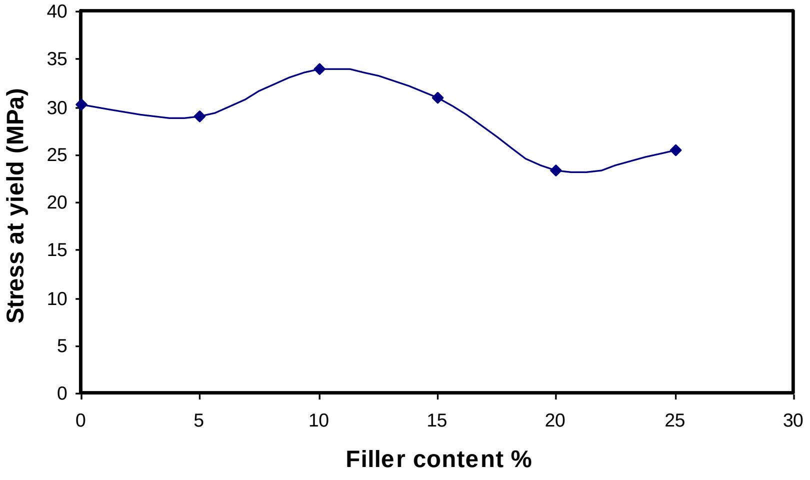

Figure (7) Stress at Yield and husks of rice -HDPE composites

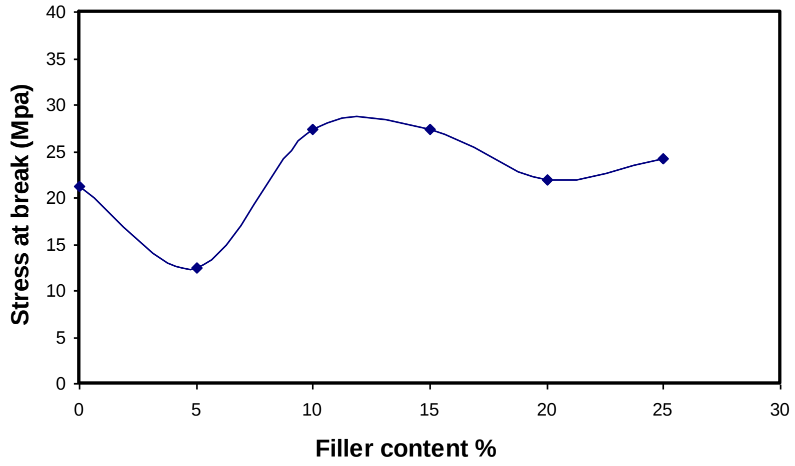

Figure (8) Stress at Break and husks of rice -HDPE composites