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Using of sea straw (Posidonia Oceanica) as a filler with polyethylene and the study of its effect on the properties of the polymer

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Abstract

The purpose of this study was to investigate the effect of adding a filler (sea straw) to the polyethylene polymer, and this material was utilized as a filler with the local polyethylene produced by Ras Lanuf Oil and Gas Manufacturing Company and classed as linear low-density polyethylene (LLDPE) type LLF-181N. The employed fillers were ground and screened, the granule size was calculated, and polyethylene blends with sea straw in various amounts (0, 5, 10, 15, 20, 30) % were made. The mixing process for these proportions was performed on the Two Roll Machine, and an amount of 65 gm for each mixture was placed on special molds with a thickness of 2 mm, which were pressed and formed in a heat press machine at a temperature of 180 ° C and a pressure of about 8 bar, after which the samples were cut and formed in a funnel shape from both sides to be stretched through them. and these samples are placed in a special room for 40 hours before the test at a temperature of 23c and humidity of 50%, after which tests are conducted according to the American method (ASTM D638), and the results of hardness, impact strength, and mechanical properties, as well as the results of thermal analysis, proved that the best percentages of addition start from 10% to 20%, which are the best percentages for study.

Keywords: polyethylene, Posidonia, thermoplastic, thermosetting.

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استخدام (تبن البحر) كمواد مالئة مع البولي ايثيلين ودراسة تأثيرها على خواص البوليمر

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الملخص

استهدفت هذه الدراسة تأثير إضافة المادة المالئة (تبن البحر) إلى بوليمر البولي ايثيلين واستخدمت هذه المادة كحشو مع البولي ايثيلين المحلي والمنتج من قبل شركة رأس لانوف لتصنيع النفط والغاز والمصنف بالبولي ايثيلين الخطي منخفض الكثافة (LLDPE) النوع LLF-181N. تم طحن وغربلة المواد المالئة المستخدمة وتحديد حجم الحبيبات وتكوين خلطات من البولي ايثيلين مع مادة تبن البحر بنسب مختلفة (0, 5, 10, 15, 20, 30)%, تمت عملية الخلط لهذه النسب على جهاز الخلط Two Roll Machine ثم اخذ كمية مقدارها 65 جم لكل خلطة وضعت على قوالب

خاصة سمكها 2 مم تم كبسها وتشكيلها في آلة ضغط حراري عند درجة حرارة 180م° وضغط حوالي8 بار وبعدها يتم قطع العينات وتشكيلها في شكل قمعي من الطرفين ليتم الشد من خلالهما وتوضع هذه العينات في غرفة خاصة عند درجة حرارة 23م° ورطوبة 50% لمدة 40 ساعة قبل الاختبار ليتم بعدها إجراء الاختبارات لها حسب الطريقة الأمريكية (ASTM D638), وأثبتت نتائج قوة الصلابة وقوة الصدمة والخواص الميكانيكية وكذلك نتائج التحليل الحراري أن أفضل نسب إضافة تبدأ من 10% وحتى 20% وهي أفضل نسب للدراسة

الكلمات المفتاحية: تبن البحر، البولي ايثيلين، التلدين بالحرارة، صلب بالحرارة

Introduction

Fillers are solid materials of various compositions that are added to polymers to improve their mechanical and physical properties, resulting in an improved polymer with diverse qualities, which boosts its utilization as it works to improve plastic products [1]. It varies depending on the nature of the shape on it, and we note that thermoplastic materials can be manufactured using most known methods, whereas thermosetting materials require special methods of formation, and this is due to the unique feature of thermoplastic materials that they can be reshaped by heating without a chemical change in their composition, whereas thermosetting materials undergo a chemical reaction The influence of heat, pressure, and activating chemicals on the polymerization process during the process of generating the final product[2,3]. After being mixed in the Two Roll Machine, the produced material was melted in customized molds of various forms using the Compression Mold techniqueThe filler (sea straw) is being used to investigate the changes in the properties of the chemical compound (polyethylene) before and after adding the fillers using the pressure molding method. In various quantities, pure polyethylene samples and polyethylene-sea straw mixture samples were prepared [4]. Cohesion strength, elongation ratio, fracture point, toughness strength, impact strength, environmental cracking stress coefficient, and a study of thermal analysis of the filled plastic material as a result of the continuous use of the plastic material subjected to changing conditions were among the characteristics that were conducted on the used filled polymer, so that this material is a pioneer in the industrial field [5].

Material and methods

Tools and equipment used

1. Two Rolls Machine

This equipment combines the polymer or rubber components to create a homogeneous slurry ready for use between two rollers (molds). As a result, the polymer can be combined with additional elements to serve as auxiliary agents for stability, plasticization, and coloring.. The polymer is placed through the funnel at the top of the device between the protection clip above the two rollers and closed, and the temperatures of the two rollers are different in order to control the mixture, for example, when using polyethylene, the temperature of the first roller was T1 = 140 while the temperature of the second roller was T2 = 160, and during mixing the temperature of the first roller was T1 = 140 while the temperature of the second roller was T2 = 160. As a result of the heating, the dough becomes rubbery, and it is pressed to the appropriate thickness and breadth while passing through the two rollers using specific arms that control the opening and shutting of the two rollers gradually from zero to 2 mm and occasionally more. The dough is pulled out once it has been well mixed.

2. Compression Mould

This gadget weighs between 30 and 50 tons. It has a gap on the top side. There are two jaws inside the gap, a lower jaw and an upper jaw, and the sample is inserted between them inside a specific mold for formation. The device's temperature exceeds 300 degrees Celsius, and it contains automatic cooling units after formation (air / water)

3. Tensile Strength

After forming the samples and cutting them with a special device, a test for measuring their tensile and elongation properties is performed according to the standard method (ASTM D638), and to measure the tensile strength, special models with agreed-upon dimensions and standard specifications are used, so that either the piece is rectangular in a funnel-shaped form on both sides or the piece is rectangular in a rectangular form on both sides. With other shapes, the model is held in place with special clamps, then a pulling force and a constant speed (500mm/min, 5KN) are applied to it until the sample is cut, and the device translates these steps into the form of a curved graphic line that represents the relationship between the force applied to the model and the amount of elongation that occurs

4. (DSC)

This method evolved from the usage of old calorimeters, which assessed the specific and enthalpy heat of heat transfer instances in proportion to a certain temperature. Perkin-Elmer, an American business, invented this device. A small amount of the sample is placed in a closed aluminum crucible and heated. A similar empty crucible is placed in the device and on the side next to the heating unit as a reference sample. Heating commences at a uniform pace for both the sample and the reference sample within the desired temperature range. The temperature difference between the sample and the reference sample can be monitored using a particular device built within the device.

5 . ESCR

Use this instrument to test the compatibility of polymers for use in high-temperature applications and to check product quality. This method also covers measuring the sensitivity of ethylene polymers (polyethylene) when the sample is exposed to different stress conditions such as soaps, wetting agents, and oils. And antiseptics and other materials that polyethylene enters as preservative packages, as well as crushing to check their mechanical effect.

Ten samples with surface fractures of around 1 mm are placed in the clamp, which is then closed using a customized vise that takes 30 to 35 seconds to close. In the higher position of the closed clamp, a transport tool is placed.

- Use the local polyethylene polymer (LLF - 181N) made by Ras La Nouf Oil and Gas Manufacturing Company and classed as Linear Low-Density Polyethylene (LLDPE).

Table 1: Specifications of Low-Density Polyethylene (LLF - 181 N)

Property	American Standard Method ASTM	Unit	the value
Item	LLF - 181 N		
Constant heat resistance	93C°		
Elongation	90 – 800 %		
Melting factor 190C°، 2.16 kg	1238D	g /10 min	1.0
Density 23C°	1505D	g /cm³	0.918

- At a temperature of 25°C and a depth of 7.5 meters, a sea hay plant called Eelgrass Posidonia family was collected from the Libyan shores, and special environmental analyses were performed for the soil in which this plant is located in order to determine the percentage of organic carbon and the chemical and physical properties of soil quality.

Table 2: Chemical and physical properties of the soil in which hay is found

Feature	Analysis results
The percentage of organic carbon in the soil	% 0.22
PH	7.50
Salinity	% 37.3
dissolved oxygen	3.9 mg/l
ammonia (NH_3)	% 0.011
nitrite (NO_2)	% 0.014
nitrates (NO_3)	% 0.743
Phosphates (PO_4)	% 0.021
Paper bundle density/m²	169

Figure 1: Sea straw (Posidonia Oceanica

Results and discussion
Polymer properties tests
- Hardness strength test

The hardness test was performed using an (ASTM D2240) hardness strength device, which provides a measurement of the hardness of the mixture by the amount defined in the standard unit (Shore-A) for mixtures consisting of polyethylene (LLDPE) and sea straw (Posidonia).

Table 3: Strength of strength of polyethylene mixtures with sea straw (Posidonia)

Filler (Posidonia) %	Polymer%	Hardness Strength (Shore-A)
0	100	96.00
5	95	95.50
10	90	96.00
15	85	95.00
20	80	97.00
30	70	96.00

According to the findings of evaluating the hardness strength of polyethylene mixes with sea straw (Posidonia), the best hardness value is 97 at the addition ratio of 20, which is better than the other ratios.

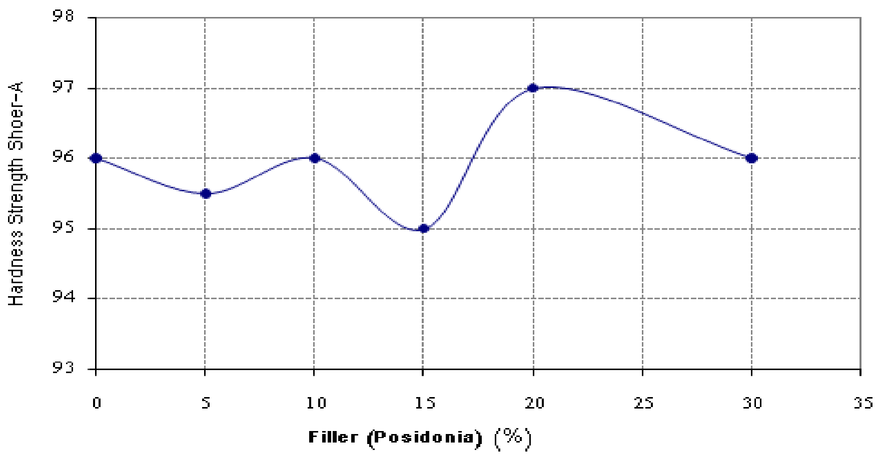

Figure 2: The relationship between the stiffness strength (Shore-A) and the percentage of addition of Posidonia in the mixture

- Impact strength test

To test the tolerance of these mixes to sudden impact, shock strength measurements were performed on polyethylene (LLDPE) and filler with sea straw (Posidonia) mixtures using a shock strength equipment (ZWICK & Co. KG Einsingen bei ULM).

Table 4: Shock strength of polyethylene mixtures with Posidonia samples.

Filler (Posidonia) %	Polyethylene %	Shock strength %
0	100	00.25
5	95	25.00
10	90	24.00
15	85	23.00
20	80	26.00
30	70	25.00

We can see from the previous table of impact strength test results that the largest impact tolerance was for a mixture of 20% sea straw (Posidonia) and 80% polyethylene polymer, with a value of 26%.

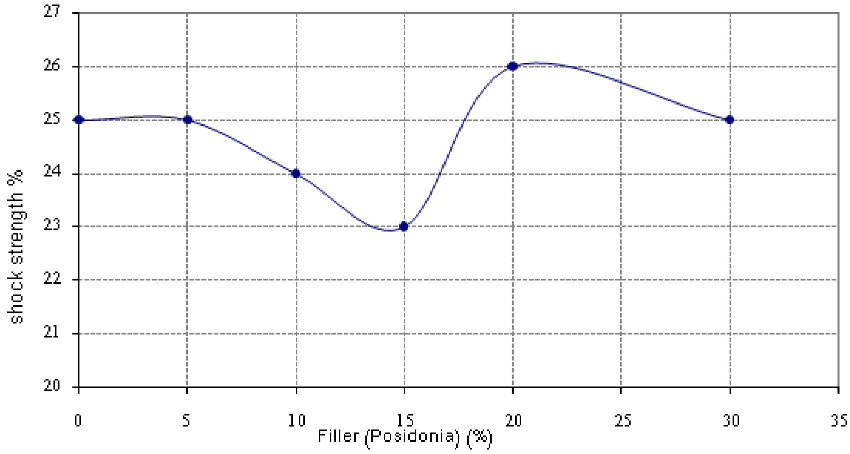

Figure 3: The relationship between the shock strength (%) and the percentage of addition of sea straw in the mixture

- Tensile and elongation test

The tensile and elongation properties of polyethylene polymer (LLDPE) and mixes of the same polymer with sea straw (Posidonia) were assessed in terms of cohesion strength, elongation ratio, maximum flexibility, and breaking point with a tensile test in this study. The percentage of addition to the filler is measured using an ASTM D638 procedure for a series of samples.

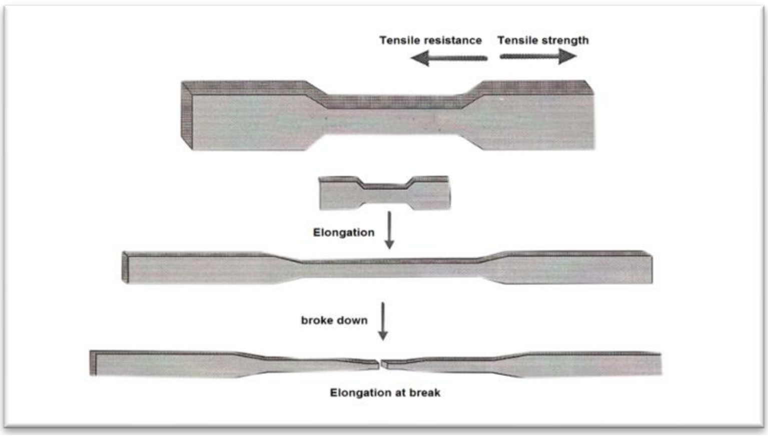

Figure 4: Measure tensile and elongation properties

Table 5: Tensile strength and elongation characteristics of low-density polyethylene (LDPE) blends with Posidonia

Filler (Posidonia) %	Polyethylene %	maximum flexibility N/mm²	breaking point N/mm²	Elongation %	Cohesive strength KN/mm²
0	100	11.60	19.02	602.84	0.20
5	95	12.26	12.29	360.21	0.17
10	90	12.65	12.77	66.36	0.21
15	85	12.07	12.15	40.32	0.23
20	80	11.64	11.77	25.27	0.31
30	70	10.55	10.57	12.02	0.27

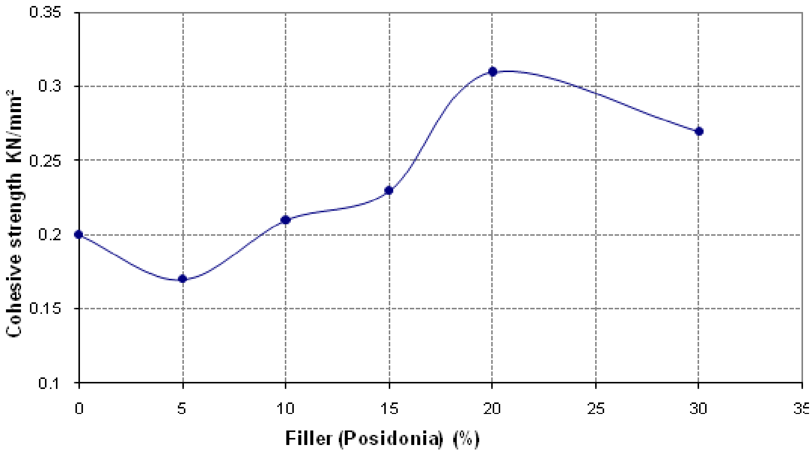

Figure 5: The relationship between the cohesion strength and the percentage of addition of Posidonia in the mixture

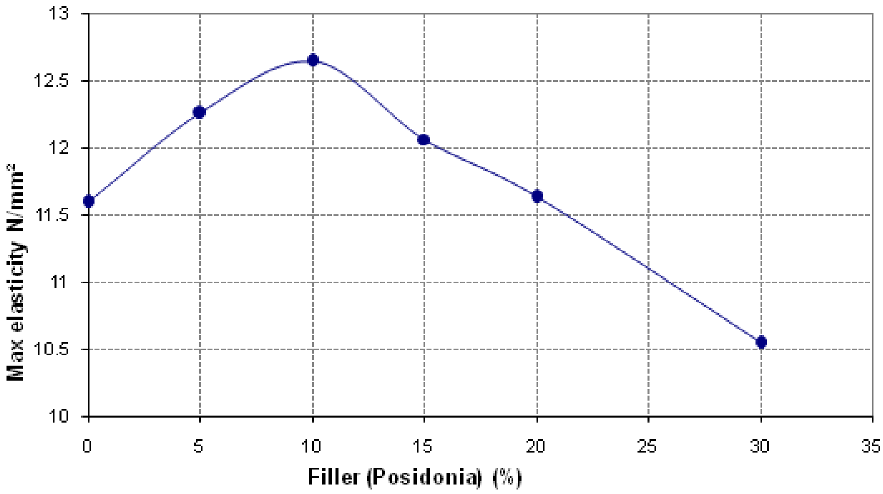

Figure 6: The relationship between the maximum elasticity and the percentage of addition of Posidonia in the mixture

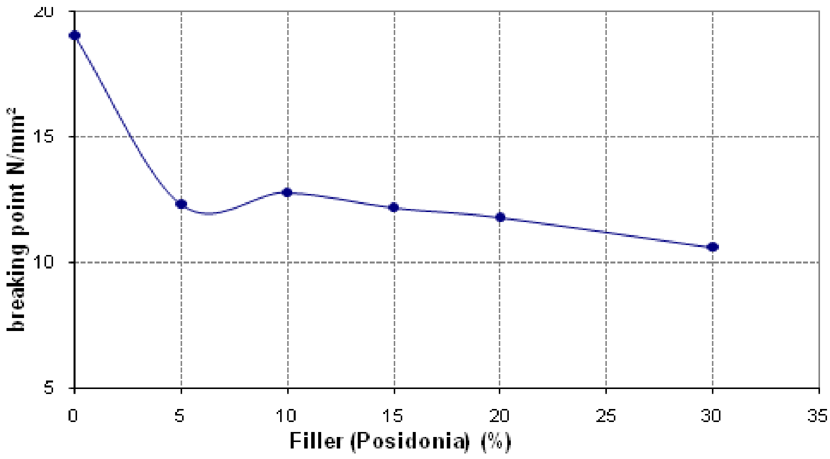

Figure 7: The relationship between the breaking point and the percentage of addition of Posidonia in the mixture

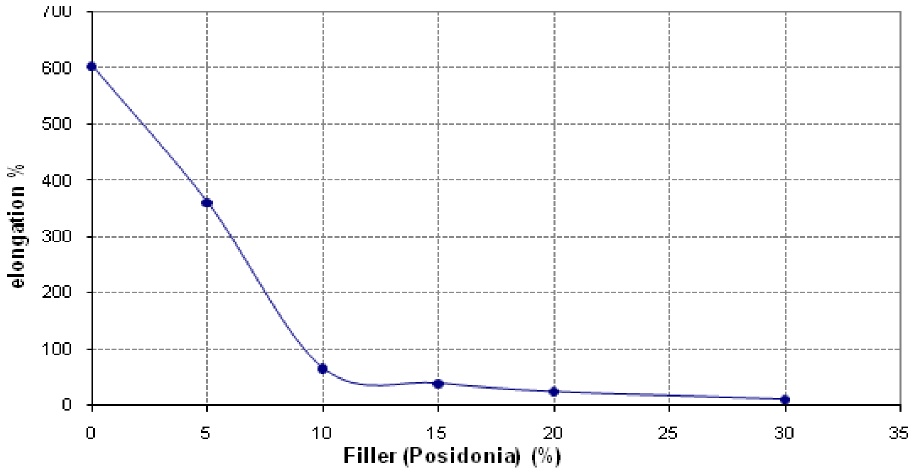

Figure 8: The relationship between the elongation ratio and the percentage of addition of Posidonia in the mixture

- Environmental Cracking Resistance (ESCR) Test

Environmental cracking resistance testing for ethylene polymers (ESCR) using the severe technique (ASTM-1693). Linear low density with sea straw (Posidonia) was studied for its resistance to environmental conditions as a raw material within the manufacturing range, and all mixing ratios did not crack after 240 hours, encouraging the industrial usage of these materials.

- Thermal analysis test.

The Differential Scanning Calorimeter (DSC) method was utilized in this test for polyethylene blends with Posidonia to detect changes in enthalpy (ΔH), oxidation time, and crystal melting point (Tm).

Table 6: Differential Calorimetry (DSC) Analysis Results of Polyethylene Mixtures with Posidonia

Filler (Posidonia) %	Polyethylene %	fusion start C°	Melting end (Tm) C°	Oxidation Induction Time (min)	enthalpy (ΔH) mCal/mg
0	100	121.45	129.58	0.42	18.95
5	95	118.93	129.31	1.29	15.82
10	90	118.13	128.76	1.99	12.60
15	85	121.77	129.49	2.37	11.82
20	80	119.07	130.70	3.03	12.66
30	70	118.62	129.86	3.93	11.80

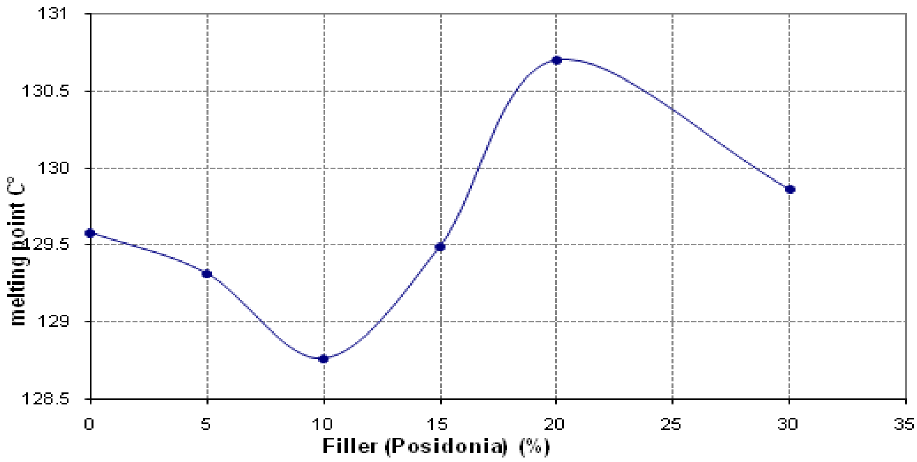

Figure 9: The relationship between the melting point (Tm) and the proportions of Posidonia in the mixture

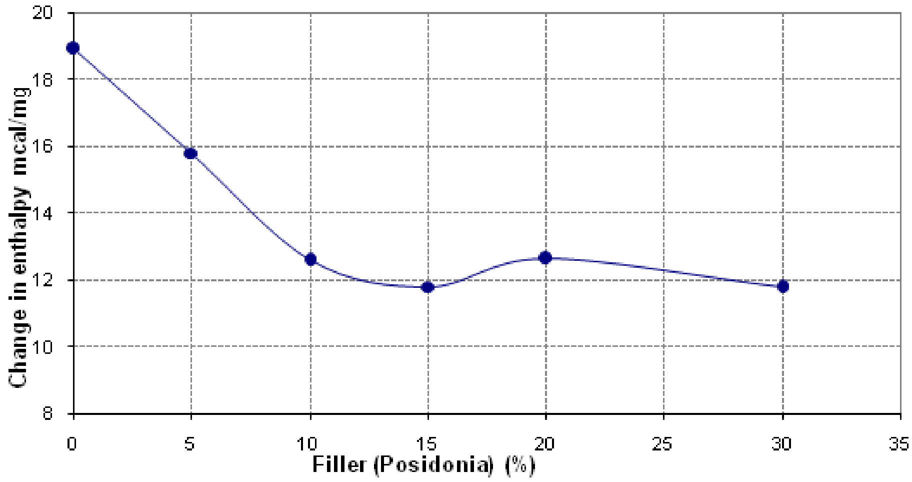

Figure 10: Relationship between the change in enthalpy (ΔH) and the proportions of Posidonia in the mixture

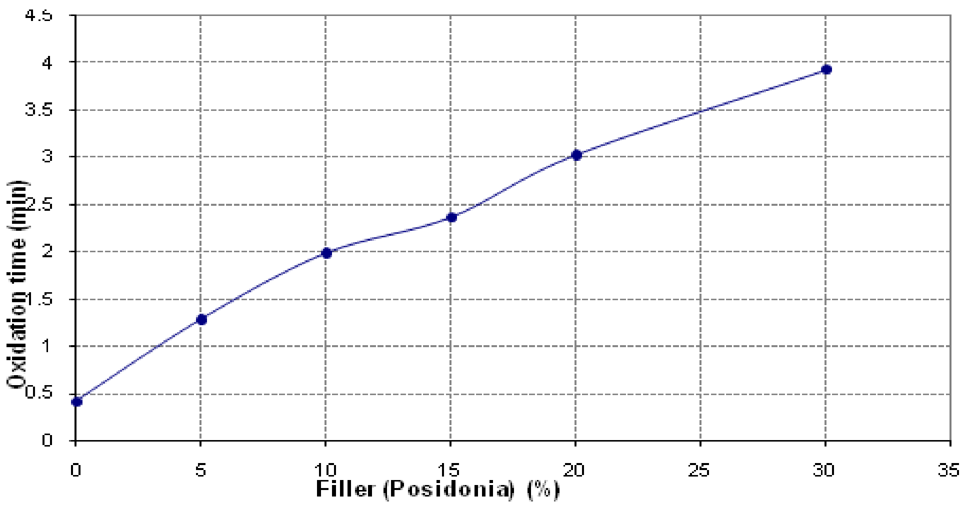

Figure 11: The relationship between the oxidation events time (OIT) and the proportions of sea straw in the mixture

Conclusion

By investigating the effect of adding sea straw filler to the linear low-density polyethylene polymer and tracking the results of polyethylene tests such as tensile and elongation properties, toughness, and shock resistance, It was discovered that some tests, such as the environmental cracking coefficient and the thermal analysis test (DSC), yielded favorable results and were compatible with the results of the used polyethylene polymer, while others yielded negative results. According to the findings, the best addition rates range from 10% to 20%, which are the best percentages for the study. When studying the effect of any additive, whether it is fibers, minerals, or any synthetic or natural material when added to any polymer, this material cannot meet all of the characteristics in terms of elongation, cohesion strength, hardness, and other characteristics in one filler at the same time. When employed, this material has strong elongation and flexibility, but it has low shock resistance and tolerance to the surrounding environmental conditions. When all of the features are present in a single substance, there is no chance for study and discovery, and the usage of this material is limited to others, necessitating the presence of benefits and drawbacks for renewal and consumption. Simultaneously, the constant and ongoing search for alternative materials with even a little positive percentage, in order to improve the quality and marketing of the plastic product.

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