Journal homepage www.jzs.univsul.edu.iq
Journal of Zankoy Sulaimani
Part-A- (Pure and Applied Sciences)

Study of the flame resistance of low density polyethylene composites with oyster shells powder extracted from the Caspian Sea in Iran.

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Article info

Original: 30 April. 2015
Revised:28 June. 2015
Accepted:30 August. 2015
Published online:20 March 2016

Key Words:
Polymer composites
low-density olyethylene
oyster shellspowder
flame
resistanceAdditives fire retardant

Abstract

The flame resistance properties of oyster shells powder extracted from the Caspian sea in Iran composites were studied. (0%, 2.5%, 5%, 10%, 15% and 20%) (Wt. /wt) of added oyster shells powder with the particular size ($\leq$ 250 μm) where composite with low density polyethylene and several factor were studied like average of average time of burning(ATB), rate of burning(RB), average extent of burning(AEB) and percentage of the time of burning(PTB). The obtained results showed that the average time of burning initiates strongly impacts with (5%), increasing weight preparation to(147Sec). And then begins to decline their behavior when increasing proportions weighted. While, the composite shows exception behavior at (20 %).

Introduction

Polymers are large molecules in which atoms are related together by covalent bonds along molecules, the polymers were prepared by process called polymerization where monomers react together chemically to form linear or branched chains or three-dimensional polymer lattice[1].Normal polymers are found in many forms such as horns of animals, tortoise shell, the rosin from pine trees, rubber, and asphalt. Rubber was one of the most useful of the natural polymers [2].Polymers consisting of a wide range of materials derived in part of organic materials which have its bases of raw materials (oil) [3]. The polyethylene used widely among thermoplastics, especially in the building materials, packaging and in domestic industries. Polyethylene is one of the types of polymers. Divides the Polyethylene into two main parts depending on the density, low-density polyethylene(LDPE) and high-density polyethylene (HDPE) [4-6].Low-density Polyethylene is produced by polymerization of gas ethylene under high pressure. LDPE is a partially crystalline solid, density (0.91 – 0.94 g/cm^3), proportion of crystallization be (50 – 60 %) and dissolves in the organic solvents above the(100 ºC) [7].Low-density Polyethylene(LDPE) is the materials non-toxic and used in the industrial applications. LDPE is one of the materials famous commercially on the widely range [8]**.** The composites of low-density polyethylene are used in different applications, as materials in the cars industry, also as packaging film and window frames [9-11].In this research oyster, shells powder extracted from the Caspian Sea in Iran composites was used as additives to low density polyethylene to see the possibility of these additives to resist flame and spread heat through the polymer matrix.

Experimental set-up

A. Material basis:

Low-Density Polyethylene used in this work, as the basis of the material. LDPE production in the form of powder by the State Company for Petrochemical Industries (Basra-Iraq). Table (1) shows the some of the properties of low-density polyethylene.

Table- 1: properties of Low density polyethylene***[12-13].***

Property	***LDPE***
Trade Name	*Scpilex (463)*
Density (g/cm3)	*0.921-0.924*
Melt Index (g/10 min)	*0.28-0.38*

B. Fillers

oyster shells powder extracted from the Caspian Sea in Iran used in this research as the fillers with polymer within the fillings natural organic[14],were cut into small pieces and then grind these small parts by machine grinding electric to the powder, and then were treated oyster shells powder by candidate wired equal to or less than (250 μm). Figure (1) shows the shape of the used oyster shell powder. Table (2) shows the chemical composition of the oyster shells powder.

Figure- 1: Photograph shows of oyster shells powder[13].

Table- 2:The chemical composition of oyster shells powder.

Chemical composition	Total Fat 13 g	Cholesterol 71 mg	Sodium 417 mg	Potassium 244 mg	Carbohydrate 12 g	Protein 9 g	Calcium
wt.%	*20*	*23*	*17*	*6*	*4*	*18*	*6*

C. Preparation of composites

Oyster shells powder mixed with LDPE using the device (Mixer and extruder) attached to (Haake) under following conditions; time 15 min., temperature 160 °C and velocity 50 RPM., this is a special operating system requirements for the device(Mixer and extruder). The final mold product is introduced in a laboratory compress under temperature (175 °C) and pressure (5 tons) for a period of (3 minutes) then raise the pressure (15 tons) for a period of (10 minutes).

D. Average Time of Burning ATB

Average Time of Burning (ATB) and Average Extent of Burning (AEB) for each sample measured in this work by a device measuring the Burning Rate, 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. Figure (2) shows a diagram of a device measured average time of burning (ATB), and the average time of Burning (ATB) and average extent of burning (AEB) using the following equation [15].

$$\text{Average Time of Burning (ATB)} = \frac{\Sigma\,(t - 30\ s)}{number\ of\ specimens} \qquad (1)$$

where:
t : time(s), s: second.

$$\text{Average Extent of Burning (AEB)} = \frac{\Sigma\,(100\ mm - unburned\ lenght)}{number\ of\ specimens} \qquad (2)$$

From equations (1,2), can be calculated the following equation:

$$\text{Rate of Burning(RB)} = \frac{Average\ Extent\ of\ Burning\ (AEB)}{Average\ Time\ of\ Burning\ (ATB)}\ \frac{cm}{\text{min.}} \qquad (3)$$

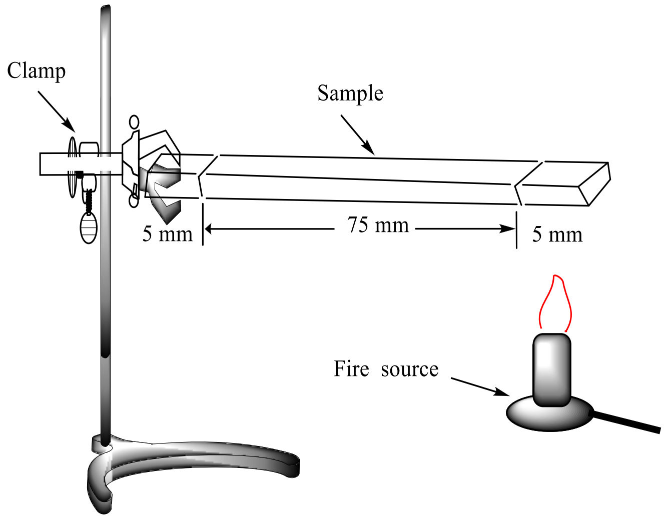

Figure- 2: Device of the Flame resistance measurement

E. ASTM: D-635

Standard Test Method, this fire test response test method covers a small-scale laboratory screening procedure for comparing the relative linear rate of burning(R.B) and average extent of burning(A.E.B) and tested in the horizontal position[16].

Results and discussion

It is well known that many polymers emit heat when they are burning, which reduces the ability to use, especially in places where large contingent of flame and the best way to take problem by using additives that increase the flame resistance of polymer. Table (3) shows the values of the average time of burning (ATB), the average extent of burning (AEB), and rate burning as the percentages of added to the oyster shells powder. The behavior of (ATB) starts rapidly when the percentage (5%), about (147Sec), and then begins to decrease gradually when increasing percentages which illustrate in Fig. (3).

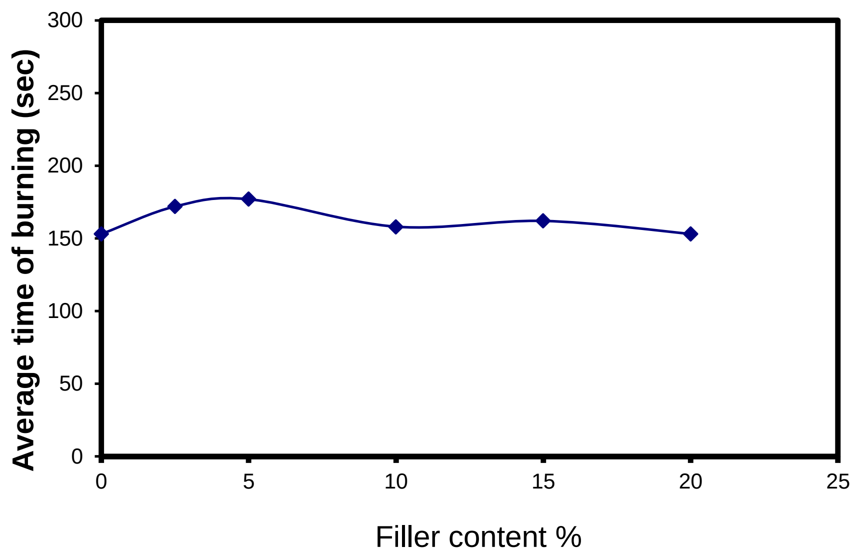

Figure- 3: relation between the average time of burning and oyster shells powder -LDPE composites.

Table(3) shows values of the average time of burning, average extent of burning and rate burning as at action added oyster shells powder.

Test \ Additives %	Non	2.5	5	10	15	20
AEB (cm)	10	9.7	9.3	9	8.7	8.5
ATB (min.)	2.03	2.22	2.27	2.08	2.09	2.03
RB (cm / min.)	4.926	4.369	4.096	4.326	4.162	4.187

Fig.(4) shows the average extent of burning with the percentages added to the oyster shells powder. The line graph shows the (AEB) decline when adding more oyster shells powder, the behavior of (AEB) initiates strongly effect when the percentage (2.5 %), about (9.7 cm), and then begin sharp decrease behavior when increasing percentages to the composites, which show that increasing the proportion of the oyster shells powder gives a negative effect on the flame resistance and heat spread through the polymer matrix, where we get low value when the percentage (20 %), about (8.5 min.). Fig.(5) show the effect of oyster shell powder percentages with the rate of burning. There is significant decreasing the low oyster shell weight, less than (5%), and then increasing of additive influence unnoticeably more than (5%). The rate of burning off the prepared composite with the percentage added to oyster shells powder is continuously decreasing with increasing the weight percentage of additives (inversely proportional), at the percentage (20%), the rate of burning appears at the low value, at (4.187cm/min.). This is due to increasing amount of residual ash, at the surface. Burning material, which isolates polymer matrix from an atmosphere, and this is an important factor to increase low-density polyethylene for the resistance of burning[17].

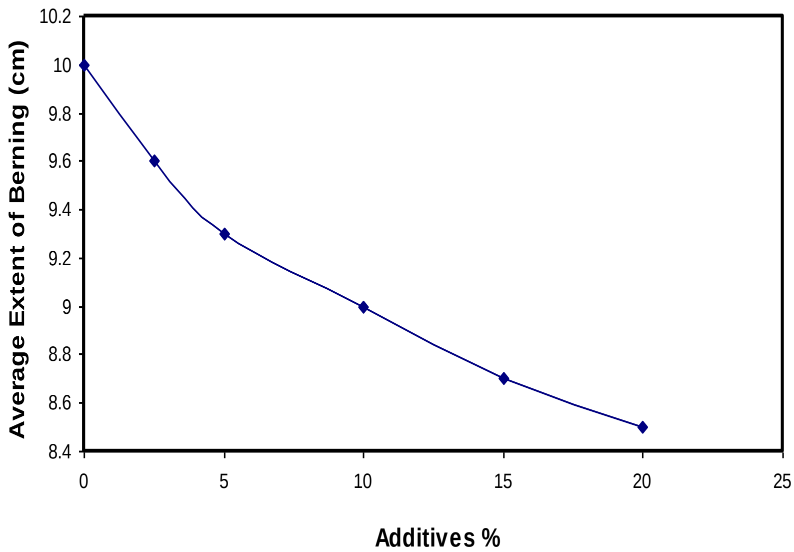

Figure- 4: relation between the average extent of burning (AEB)with oyster shells powder -LDPE composites.

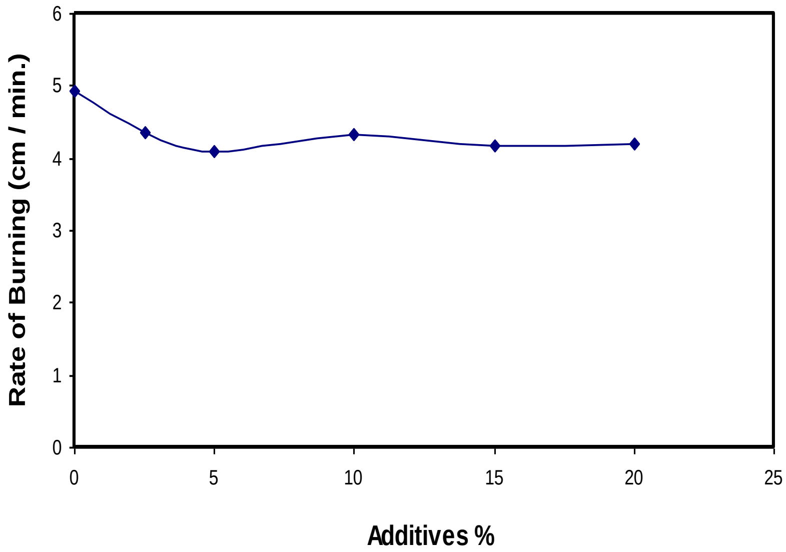

Figure- 5: relation between the rate of burning (RB) with oyster shells powder -LDPE composites.

The results shows in figure (6) indicate shows changes in the percentages of the burning time as a function of the percentages added to oyster shells powder, and calculated by weight fraction of impure oyster shell powder and pure. By observing fig.,(6), the behavior of percentage of the burning is inversely proportional to the filler content, i.e. the percentage of the burning of reduction continuously with increasing the additives weight percentages.

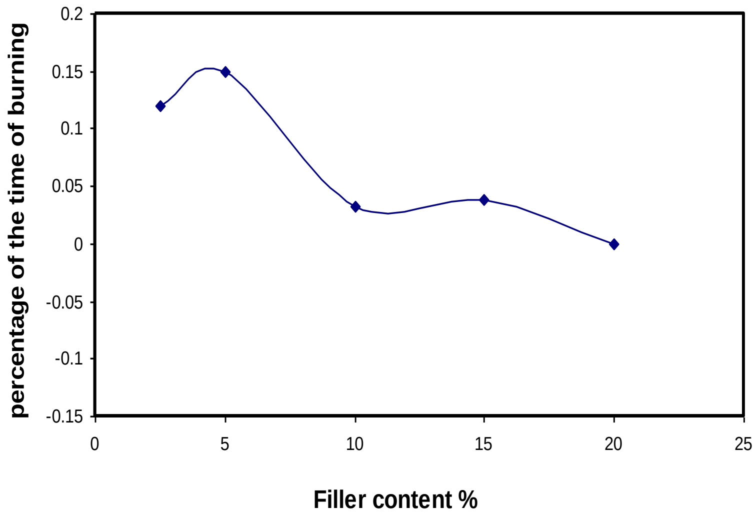

Figure- 6: relation between the percentage of the burning and oyster shells powder -LDPE composites.

Conclusion

The results showed that oyster shells powder as a suitable natural additive to the low density polyethylene, the results shows that in increasing in proportion of the oyster shells powder gives negative effect on the flame resistance and heat spread through the matrix polymer where we get a low value when the percentage (20 %) which is (8.5 min.), and observe the increase of fillers ratios to the low density polyethylene leads to decrease in average of burning time at fillers ratio (10 %), the rate of burning of the prepared composite with the percentage added to oyster shells powder is continuously decreasing with increasing the weight percentage of additives (inversely proportional), we confirm that the behavior starts strongly when the percentage (5%), about (147 Sec), and then the resistance of burning behavior begins decreasing when adding more weight percentages.

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