International Journal of Scientific Engineering and Applied Science (IJSEAS) – Volume-2, Issue-2, February 2016
ISSN: 2395-3470
www.ijseas.com

Study the effect of Luffa powder (natural additives)on the flame resistance of Low Density Polyethylene (LDPE)

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Abstract

In this present paper, experimental results on flame resistance of low density polyethylene added with various contents ratio of powder Luffa as a filler agent were reported .The ratio of doping were (2.5%,5%,10%,15%,20% and 25%) of weight where the size of powder Luffa particles used in this research was (<212 μm). Several parameters were studied like average time of burning(ATB), rate of burning(RB) and percentage time of burning(PTB). The obtained results showed that powder Luffa as a suitable additive to low density polyethylene and the increase of doping ratio leads to decrease in average of burning time at 20%, where this behavior is opposite to the 10% ratio hence there is an increase in time of burning and decrease of Rate of burning.

Keywords: : Low Density Polyethylene, Flame resistance, Luffa, Filler ,Polymer.

1. Introduction

The polyethylene (PE) used widely among thermoplastics, especially in the building materials, packaging and in domestic industries. Polyethylene is one of the types of polymers. Polyethylene is divides into two main parts depending on the density, low-density polyethylene(LDPE) and high-density polyethylene (HDPE) [1-3]. 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 [4,5].

Fillers are solids added to polymers to improve their properties and decrease the cost and have the opposite effect of plasticizers 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[6-8].

Fillers find application in the polymer industry almost exclusively, e.g. to improve mechanical, thermal, electrical properties and dimensional-stability[4]. The aim of this study is to find flame resistance properties of luffa powder composites.

2. **Experimental**

Low-Density Polyethylene (LDPE) 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[9]

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

Figure (1) shows the photograph of the Luffa powder.Table (2) shows the chemical composition of Luffa powder. The average Luffa particle size used in this work is (<212) µm. Six concentrations of luffa particles (2.5, 5, 10, 15, 20 and 25 weight%) are used in the LDPE compounds. Luffa as a fine powder is mixed with LDPE using Rheomix mixer 600 instruments attached to the Haake Rehochard meter with the following conditions; mixing time 15 min; mixing temperature 1600C ; mixing velocity 32 RPM. After that the final mold product is introduced in a laboratory compress under 5 tons at 1750C for 3 minutes in a square frame where the pressure rises gradually up to 15 tons for a (6) minutes and after this period the sample sheet is cooled up to reach room temperature . [10,11]

Fig. 1 Photograph of luffa.

Table 2:The chemical composition of powder Luffa.

Chemical composition	wt%
Ash	0.7±0.2
Extractives	.1±0.53
Total Klason Lignin	.2 ±1.015
Cellulose	.5 ±0.565
Hemi Cellulose	.5 ±0.517
Holo Cellulose	±183

Average Time of Burning (ATB) and Rate of burning (RB) 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), Rate of burning(RB) and percentage time of burning (PTE) using the following equations.

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The measurement of a rate of burning(R.B) , average time of burning(A.T.B) and percentage time of burning (PTE) by the following equations(1 , 2 and 3) [12,13].

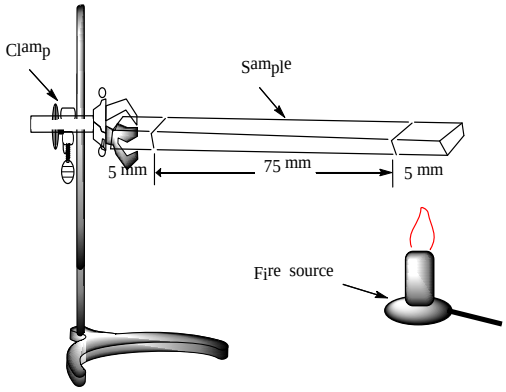

Fig. 2 shows a diagram of device measured average time of burning.

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

where:

t : time(s), s: second.

$$Rate\ of\ burning(RB) = \frac{Length(cm)}{Time\ o\ f\ burning(\min)}\ \ (2)$$

Length of the sample of use in this research

$$percentage\ time\ of\ burning\ (PTB) = \frac{(ATBa - ATBp)}{ATBp}$$

(3)

where

a=additive

p= pure

3. Results and discussion

shown from the table (3) and the figures (3 and4), The variation of the average time of burning(ATB) and rate of burning(RB) as a function to the percentage by weight of luffa powder is method to know how the effect of the ability of this additives in the resistive of the burning and spread in the polymer matrix. In general, the behavior of burning composite shows there is increasing in the average time of burning (ATB) and decreasing in the rate of burning(RB) of low density polyethylene (LDPE) with increasing percentage by weight of luffa powder. Unless, the percentage at 20%, it shows decreasing (ATB) and there is increasing (RB). This increasing due to additives which play an important role for increase burning spreading of burning material through the polymer matrix. On the other side, the ability of additives to burning of low density polyethylene increases with increasing temperature. The percentage 10% shows best average time of burning time(196sec.)and decreasing in the rate of burning, about(1.9 cm/min) respectively. This is due to the homogenously between the additives and polymer, in addition, the goal and ash which result by burning of Luffa powder were reduced the spread burning by absorption of generated heat during the burning. Overall, this process cases reducing in temperature surrounded polymer matrix.[13]

Table3:shows values of the average time of burning ,rate burning and percentage time of burning as at action added Luffa powder.

Additives% / Test	0	2.5	5	10	15	20	25
ATB (sec.)	118	168	181	196	170	166	178
RB (cm / min.)	3	2.3	2.1	1.9	2.2	2.3	2.2
PTB%	-	0.42	0.53	0.66	0.44	0.40	0.51

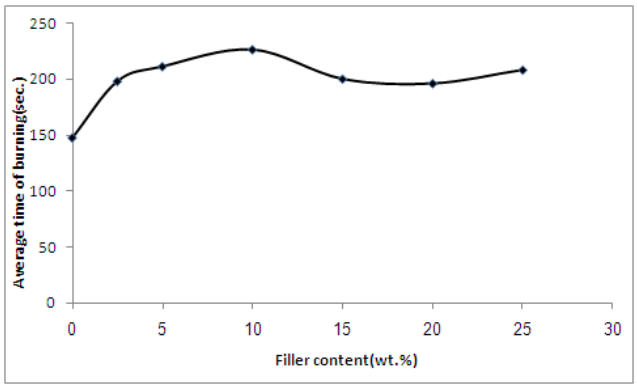

Fig.3 relation between the average time of burning and luffa powder -LDPE composites.

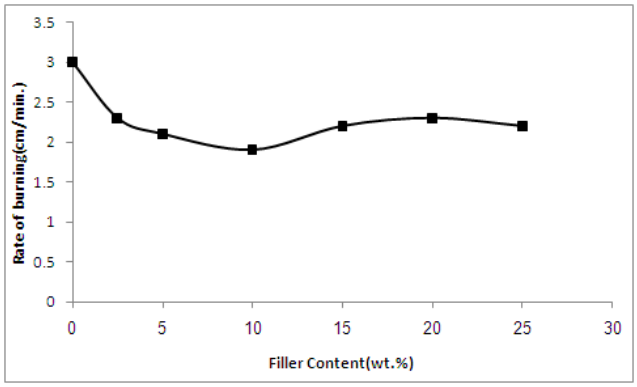

Fig. 4 relation between rate of burning with luffa powder -LDPE composites.

Figure(5) shows the percentage time of burning as a function to percent the addition (equation3) and it finds that the percentage 10% was give best retardant about (0.52%) . This is due to homogenous of luffa powder and low density polyethylene, as this referred previously. This attributed to reduces analysis ability of the luffa powder through the burning process at that mentioned percent which decrease the heat spread process through the polymer. This process know as thermal insulation between the burning parts and non burning parts. When this barrier breakdown, the burning process was accelerate . This process was observed with percentage 20% which of heat spread process was noticeably increased from the burning place to another area of non burning parts. As result, the free radicals in gas phase formatted by burning hydrocarbons. These materials are strong active components at solid state evaporating by heat and reacting with oxygen. Overall, this process is exothermic which lead to transform active parts from the condensed phase to gas phase. This is a continuity process unless, it is stopped by the formation of stable products. [14].

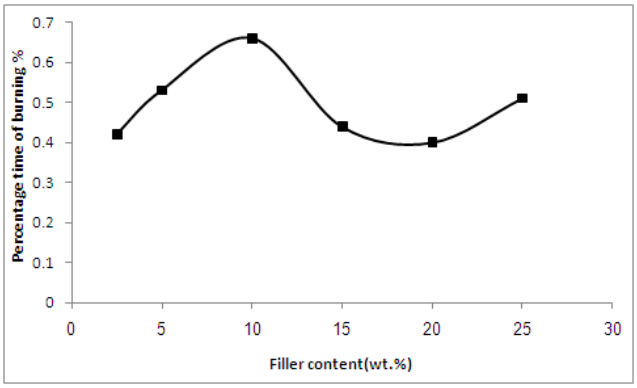

Fig.5 relation between the percentage time of burning and Luffa powder -LDPE composites.

4. Conclusions

The obtained results show that the change of the average time of burning (ATB), rate of burning (RB)of polymer were directly linked with the percentage by weight of the additives, which were negatively effected by the high percent of the additives, and positively affected with low percent to comparing with non additives low density polyethylene. Also, for the 10% of the additive shows good in the thermal insulation between the parts of the combustion polymer and other parts.

While , high percent of additive give decreasing in insulation with noticeably show at 20%.

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