Global Scientific JOURNALS
GSJ: Volume 9, Issue 7, July 2021, Online: ISSN 2320-9186
www.globalscientificjournal.com

Study the effect of adding rubber pieces powder on the flame resistance for unsaturated polyester.

Ahmed J. Mohammed [1] and Ibrahim K. Ibrahim [2]

1- Department of Materials Science ,Polymer Research Centre / University of Basra / Basra / Iraq.

2- Department of Chemistry and Polymer Technology, Polymer Research Center, University of Basra, Basra, Iraq.

E-Mails: ahamd.jasim@yahoo.com

Abstract:

The flame resistance properties of rubber pieces powder extracted from the waste tires, composites were studied. (0%, 5%, 10%, 15%, 20% and 25%) (Wt. /wt) of added rubber pieces powder with the particular size (≤ 250 μm) where composite with unsaturated polyester 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 (0%), increasing weight preparation to(189Sec). And then begins to decline their behavior when increasing proportions weighted. While, the composite shows exception behavior at (25 %).

Keywords: Polymer composites, rubber pieces powder, unsaturated polyester, flame resistance, Additives, fire retardant, waste tires.

1. Introduction

Normal polymers are found in many forms such as horns of animals, tortoise shell, rosin from pine trees, rubber, and asphalt. Rubber was one of the most useful of the natural polymers [1]. Polymers consisting of a wide range of materials derived in part of organic materials which have its bases of raw materials (oil) [2]. 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. Fillers are solids added to the polymers to develop their properties and decrease the price and have the opposite effect of plasticizers as decrease the flexibility or increasing the volume of plastic material, which decrease the cost and improve some mechanical properties for the polymer materials [3-5]. The addition of the fillers to polymer materials is a speedy and low-cost way to improve the properties of the base materials. For this cause, particulate filled polymers have been a subject of increasing interest in science researches and industries. By this way, stiffness, strength, dimensional stability, hardness, thermal conductivity, and electrical properties can be obtained [6]. Rubber tires can also be used in civil and non-civil engineering applications such as in road construction, in geotechnical works, as a fuel in cement kilns and incineration for production of electricity or as an aggregate in cement-based products or in geotechnical field [7-9]. Polyesters are one of the most versatile synthetic copolymers, and the polyesters are produced in high volume that exceeds 30 billion pounds a year worldwide [9-11]. They are hetero chain macromolecules that possess carboxyl ate ester groups as an integral component of their polymer backbones. Polyesters have received a great deal of attention since the early work of Carothers, who initiated study on many step-growth polymerizations [12]. They are widely used commercially as fibers, plastics, composites and for coatings applications too [13-14]. The aim of this study is to find flame resistant properties of rubber piece powder extracted from the car tires (waste) were composite with unsaturated polyester.

2. Experimental

2.1. Material basis:

In this experimental study, polyester was used as a base material, this material of Turkish origin, and supplied by the company (Henkel A.S Turkish), the polymer density is about (1.5) g/cm3, the polymer polyester is used in various industries, and is a viscous liquid, the color of Brown with special effect. It has a viscosity of 1000 (p) at 25 °C. The solid state is transformed after the addition of the crucifixion, which is also a transparent viscous liquid (ketone, ethyl peroxide) and added a percentage (2%) and supplied by the same company.

2.2..Fillers.

rubber piece powder extracted from the car tires (waste), used in this research as the fillers, were cut into small pieces and then grind these small parts by machine grinding electric origin French 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 rubber piece powder. Table (1) shows the chemical composition of oyster shells powder. chemical composition of the used rubber powder is presented. The quantity of steel is generally about 15%, and it's more important for the heavy trucks tires. For this study steel and one part of textile were removed by magnetic separation and density.

Figure (1): Photograph shows of rubber piece powder.

Table (1) The chemical composition of rubber piece powder[15].

Material/element	Rubber	Carbon black	Textile	Oxidize zinc	Sulfur	Additives
Mass percentage	54 %	29 %	2 %	1 %	1 %	13 %

2.3. Preparation of composites.

In this research, a Hand-lay-out is used in the Preparation of models (polymer with fillings), where we start the blending process. As function of the percentages of rubber piece powder (5%, 10%, 15%, 20%, 25%), The base material is mixed with the crucifixion at room temperature, rotation of the mixture continuously and slowly and continue mixing for (5-8) minutes until the mixture homogenizes well, then we flow the liquid mixture in the shape(template) from one side of the mold so that it flows continuously, and regularly to the other side of the template and then put the shape(template) on a manual mechanical vibrator, then start with the process of shaking the shape for a period of (1-2) minutes to remove of the air molecules. The Shape (template) has been manufactured from transparent glass with a thickness (4 mm), and the sides are moving and attached to the base of silicon rubber that is easy to move. These aspects are variable depending on the size of the sample to be manufactured. The Shape (mold) used is rectangular and the dimensions are (length 11 cm, width 1.5 cm, height 4 mm).

2.5. ASTM: D-635.

The measurement of a rate of burning(R.B), an average extent of burning(A.E.B), the average time of burning(A.T.B) [16].

2.4. 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 [17].

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

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 Rate of Burning (RB) using the following relation:

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

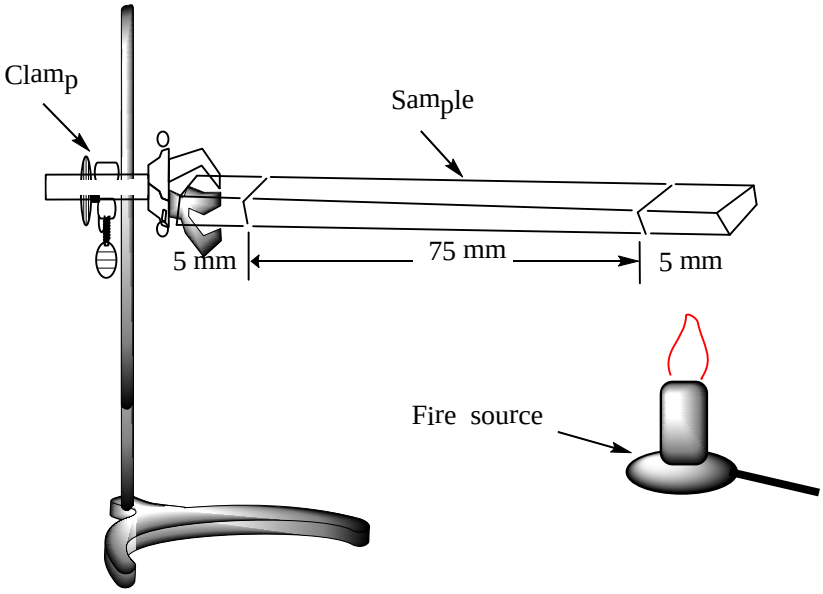

Figure (2) shows a diagram of device measured average time of burning.

3. 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. In this research rubber pieces powder was used as additives to unsaturated polyester to see the

possibility of these additives to resist flame and spread heat through the polymer matrix. Table (2) 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 rubber pieces powder. The behavior of (ATB) starts rapidly when the percentage (0%), about (189Sec), and then begins to decrease gradually when increasing percentages which illustrate in Fig. (3).

Table(2) shows values of the average time of burning, average extent of burning and rate burning as at action added rubber pieces powder.

Fig.(4) shows the average extent of burning with the percentages added to the rubber pieces powder. The line graph shows the (AEB) decline when adding more rubber pieces powder, the behavior of (AEB) initiates strongly effect when the percentage (0 %), about (7.4 cm), and then begin sharp decrease behavior when increasing percentages to the composites, which show that increasing the proportion of the rubber pieces powder gives a negative effect on the flame resistance and heat spread through the polymer

Additives % Test	Non	5	10	15	20	25
AEB (cm)	7.4	6.8	6.8	6.9	7	7.1
ATB (min.)	3:16	2:02	2:12	2:17	2:20	2:22
RB (cm / min.)	2.3	3.3	3.2	3.17	3.18	3.19

matrix, where we get low value when the percentage (15 %), about (6.9 cm). Fig.(5) show the effect of rubber pieces powder percentages with the rate of burning. There is significant decreasing the low rubber pieces powder weight, less than (5%), and then increase of additive influence unnoticeably more than (5%). The rate of burning of the prepared composite with the percentage added to rubber pieces powder is continuously increasing with increasing the weight percentage of additives direct proportionality (not inversely proportional), at the percentage (20%), the rate of burning appears at the low value, at (3.18 cm/min.). This is due to increasing amount of residual rubber, at the surface. Burning material, which isolates polymer matrix from an atmosphere, and this, is an important factor to increase unsaturated polyester for the resistance of burning [18]. The results shows in Fig.(6) indicate shows changes in the percentages of the burning

time as a function of the percentages added to unsaturated polyester and calculated by weight fraction of impure rubber pieces powder and pure. By observing Fig.(6), the behavior of percentage of the burning is direct proportionality (not inversely proportional) to the filler content, i.e. the percentage of the burning of increasing continuously with increasing the weight of the additive percentages arrived to (0.07) at (25%).

CONCLUSION

The main observations and conclusions that can be drawn from the results of this work are the following:

In this research, obtained the results showed that rubber pieces powder extracted from the waste tires as a suitable additive to the unsaturated polyester, and observe the increase of fillers ratios to the unsaturated polyester 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 rubber pieces powder is continuously increasing with increasing the weight percentage of additives direct proportionality (not inversely proportional), we confirm that the behavior starts strongly when the percentage (0%), about (189 Sec), and then the resistance of burning behavior begins decreasing when adding more weight percentages, the results also shows that in increasing in proportion of the rubber pieces 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 (2.2 min.).

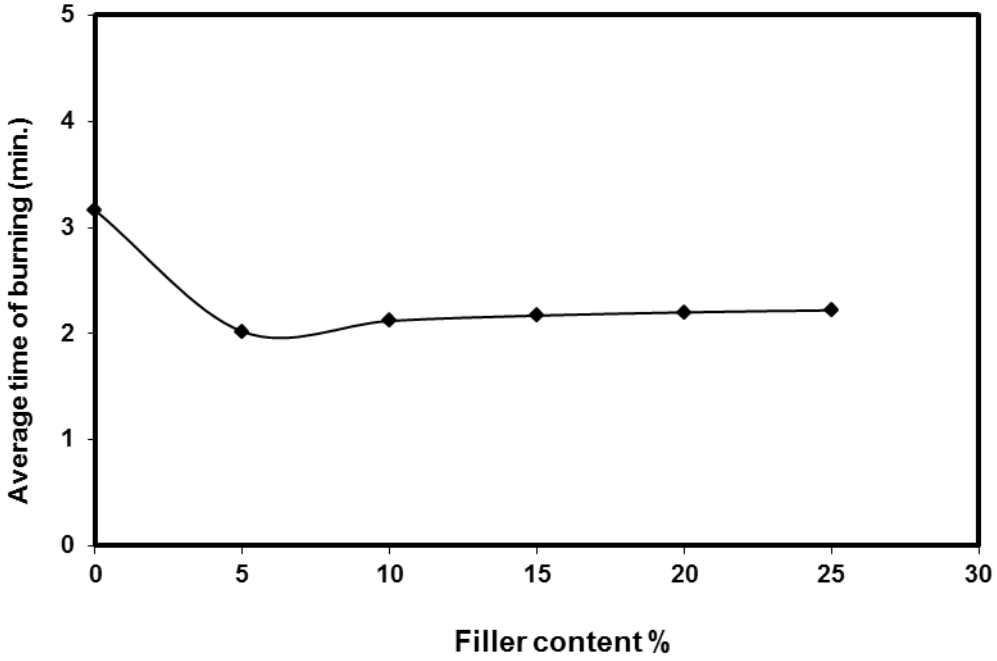

Figure (3) relation between the average time of burning and rubber pieces powder - unsaturated polyester composites.

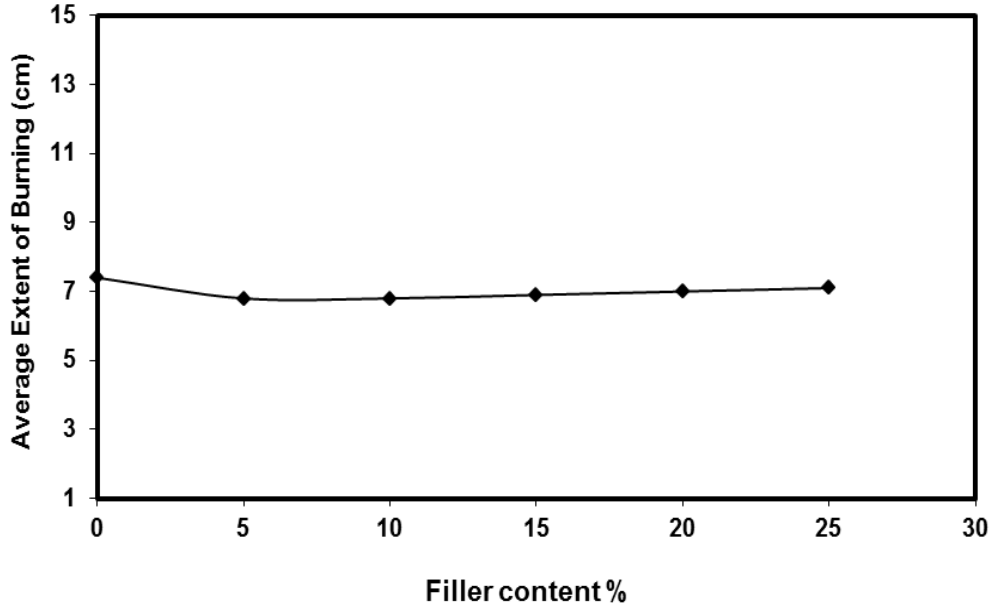

Figure (4) relation between the average extent of burning (AEB) with rubber pieces powder - unsaturated polyester composites.

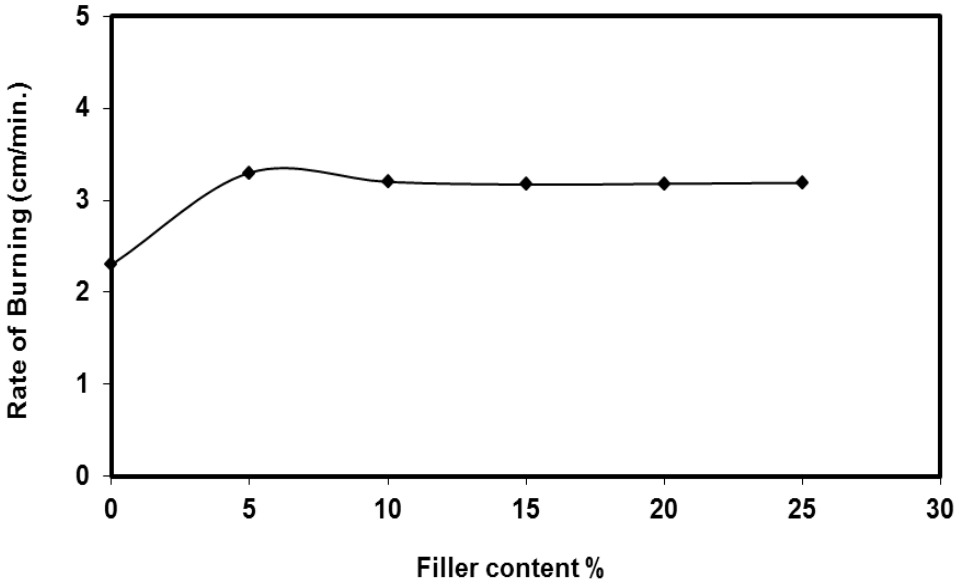

Figure (5) relation between the rate of burning (RB) with rubber pieces powder - unsaturated polyester composites.

.

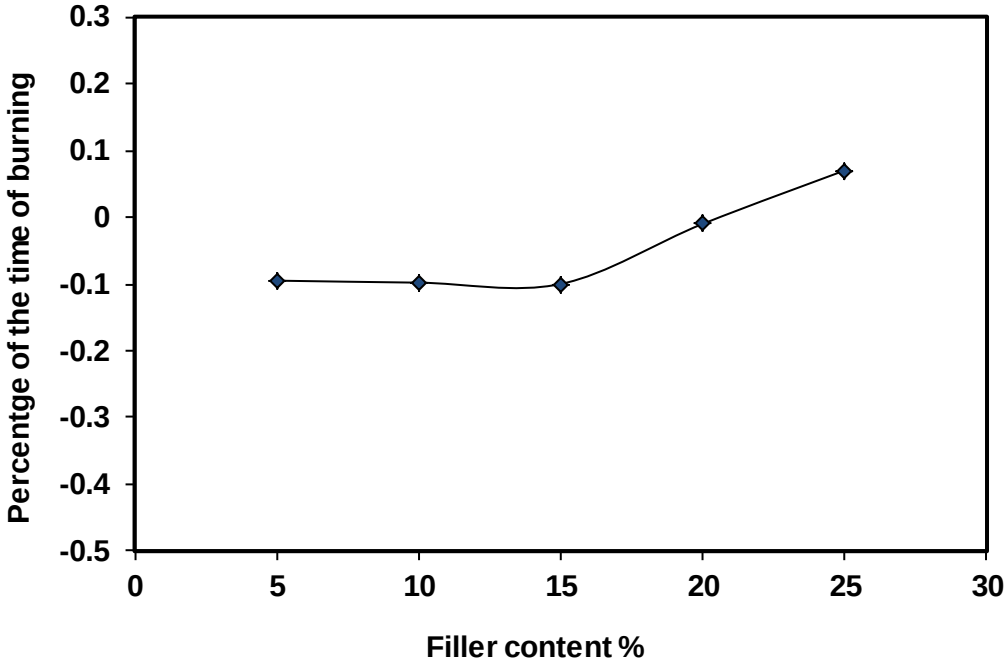

Figure (6) relation between the percentage of the burning and rubber pieces powder - unsaturated polyester composites.

References:

1- David A. Katz, " POLYMERS" Chemist, Educator, Science Communicator, and Consultant1621 Briar Hill Road, Gladwyne, PA 19035, USA.1998.

2- James D. Idol and Richard L. Lehman, "Polymers" The CRC handbook of mechanical engineering / edited by Frank Kreith, Yogi Goswami. –2nd ed. August, 2004.

3- A. Riad Said, Nur al-Din Companion "Department of Applied Sciences, University of Technology, Baghdad, Journal of Engineering and Technology, 29, 15-25, (2011)

4- W. Callister," Materials science & Engineering an introduction", Jone Wiley, 6th Ed. (2003).

5- H.A. Hamadi, Nadhim A., Wael A.S. and Abdullah K. Journal of al-qadisiyah for pure science, 16, 1-10, (2011).

6- A.G. Supri & Siti Shuhadah," Properties of low-density polyethylene (LDPE) eggshell powder composite: the effect of ethylenediamine-isophthalic acid", International Journal of General Engineering and Technology (I GET), Vol.1, Issue 2 Nov 9-18,(2012).

7- V. Corinaldesi, G. Moriconi, "Durable fiber reinforced selfcompacting concrete", Cement and Concrete Research, Vol. 34, No. 2, pp. 249–254, 2004.

8- V. Corinaldesi, A. Mazzoli, G. Moriconi, "Mechanical behaviour and thermal conductivity of mortars containing waste rubber particles", Materials & Design, Vol. 32, No. 3, pp. 1646–1650, 2011.

9- H. Trouzine, M. Bekhiti, A. Asroun, "Effects of scrap tyre rubber fibre on swelling behavior of two clayey soils in Algeria", Geosynthetics International, Vol. 19, No. 2, pp. 124-132, 2012.

10- I. Goodman; Encyclopedia of Polymer Science and Engineering; 2nd ed.; 12; Wiley; New York; (1988).

11- 2- V. V. Karshak and S. V. Vinogradova; Polyesters; Pergamon; New York; (1965).

12- Bjorksten Research Laboratories; Polyesters and Their Applications; Reinhold; New York; (1956).

13- I. Goodman; J. A. Rhys; Polyesters; Saturated Polymers; Iliffe Books; London; 1; 1965.

14- I. Goodman; 2nd ed.; 16: 159; Wiley: New York, (1968).

15- Melik Bekhiti, Habib Trouzine and Aissa Asroun,' Properties of Waste Tire Rubber Powder", Engineering, Technology & Applied Science Research Vol. 4, No. 4, 2014, 669-672.

16-Astm Standard D-638, Standard test method for tensile properties of plastics [Internet]. West Conshohocken (PA): ASTM International (2008).

17- John F. Cochran and Mapother D. E. (1958) "Superconducting Transition in Aluminum". Physical Review. 111 (1): 132–142.

18- B. V. Kokta, R. G. Raj, D. Maldas and C.Daneault, Journal Appl. Polym. Sci. , 37, 1089 -1103 (1989).