FRICTION AND WEAR PERFORMANCE OF HIGH DENSITY POLYETHYLENE / STYRENE - BUTADIENE RUBBER POLYMER BLENDS

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Abstract: In the present work, the friction and wear property of high density polyethylene / styrene - butadiene rubber polymer blends was studied. SBR addition in the HDPE was 5, 10, 15, and 20 wt. In this study indicate that HDPE / SBR polymer applied to the abrasion test indicate that road and load values to increase the effect of wear, but this effect by increasing the rate of SBR additives lead to a reduction in wear is observed that value as %. The result showed that the addition of fillers to the composite changed the friction coefficient and wear rate.

Keywords: Friction, high density polyethylene, polymer composites, SBR, wear

Introduction

Polymeric materials have been replacing metallic materials used as friction wear parts for many years. It is often found that, however, the single unmodified polymer could not satisfy the demands arising from situations where a combination of good mechanical and tribological properties is required [Huang, 20071]. Tribology is the science that deals with design, friction, wear and lubrication of interacting surfaces in relative motion [Institute of Composite Materials, 1998]. A scientific understanding of the mechanism of friction and wear is still lacking, because wear is complex phenomenon and its mechanism depends on many parameters like the chemical and physical properties of polymer, composition, load, velocity etc. [Chen, 2006]. Wear and friction properties of the polymer composites are investigated in tribological field.

Table 1. Mechanical properties of HDPE-SBR polymer composites [Ersoy, 2013]

Samples	Elasticity Modulus (MPa)	Yield Strength (MPa)	Tensile Strength (MPa)	Elongation at Break (%)	Hardness (Shore D) (m^2)	Izod Impact Strength (kJ)
%100 HDPE	314.596	25.46	25.814	274.132	55.9	17.76
HDPE/SBR (%90-10)	263.052	20.042	20.792	15.172	53.4	45.78
HDPE/SBR (%80-20)	206.464	17.276	18.208	16.604	50.7	53.44
HDPE/SBR (%70-30)	199.626	15.074	15.992	17.336	44	58.06
HDPE/SBR (%60-40)	160.326	11.518	12.366	18.344	39.8	60.48

Methods

In this study used HDPE as YY (I 668 UV) and SBR polymer and their compose blends. Its specific gravity is 0.938 g/cm3. melt flow rate (190 ºC /5.0 kg) is 1.0 g10/min. These were composed at 10 min.. 180-220 ºC at 20-30 bar pressure and a rotation rate of 30 rpm by Microsanco-rotating twin-screw extruder. Injection temperature was 180-220 ºC. 110-130 bar. 10 s. The composite dried at 105 ºC for 24 hours after extrusion. These composite was produced five different ratio as 10. 20. 30 and 40 of percent of SBR fillers. Mechanical properties of HDPE-SBR polymer composites were at Tab. 1 [Ersoy, 2013].

Static and dynamic coefficient of friction test was done according to the ISO 8295 method. The dimensions of the tested specimens were 80x200x4 mm and the dimensions of the sled specimens were 63x63x4 mm. Speed was selected as 100 mm/min. The static coefficient of friction was determinate with standard dynamic frictional force using the equation.

The wear tests were done according to the DIN 53 516 method with Devotrans DA5 abrasion test equipment. The friction coefficients and wear rates reported in the present study were the averages of at three

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measurements. The thickness of the test specimens was 7.0 mm and diameter was 15.5 mm. The mass loss of the specimen was measured after the wear test in order to calculate the specific wear rate.

Results

Obviously the tribological processes involved in this investigation are complex. The effects of applied load sliding distance and fillers content on the tribological behaviors of HDPE and its composites were examined. The values of sliding distance-wear loss relationship were obtained and are shown in figure 1 where it seems that the wear loss for various specimens sliding distance against the sand paper (#60) under 10 N load and 0.32 m/s abrasion speed which inhere to applied load-wear loss relationship (Fig. 1).

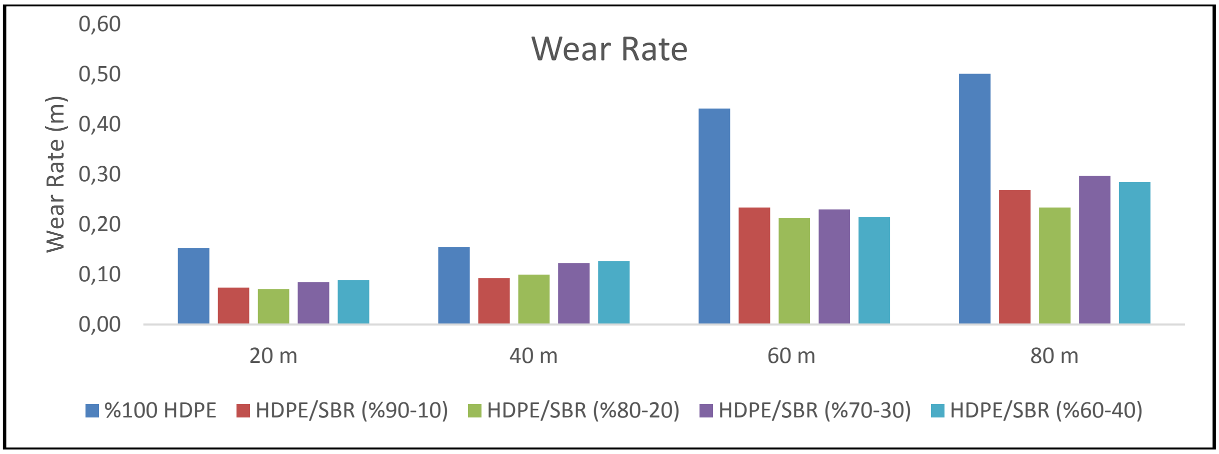

Figure 1. Effect of sliding distance (m) in wear rate.

The process was more than 40 m and the load was more than 10 N. the wear loss began to decrease slightly. At Fig. 1 which shows wear rate of polymer composite SBR contribution has led to decrease. SBR contribute has critical load on wear rate of HDPE. HDPE/SBR has a low mechanical strength which are easily deformed. The contact area and wear loss of the counterpart are proportional to applied load. But other side. the less deformation of the composite. The smaller friction force and wear loss of the friction counterpart is due to the increase contact area between the friction counterparts.

Applied load-wear loss relationship of HDPE polymer composites which is shown at Fig 2. According to the graphic; SBR contribute cause to decrease of the pure HDPE which could be attributed to the good adhesion between elastomers and polymer matrix. At graphic; 5N load had not effect on wear rate for all samples.

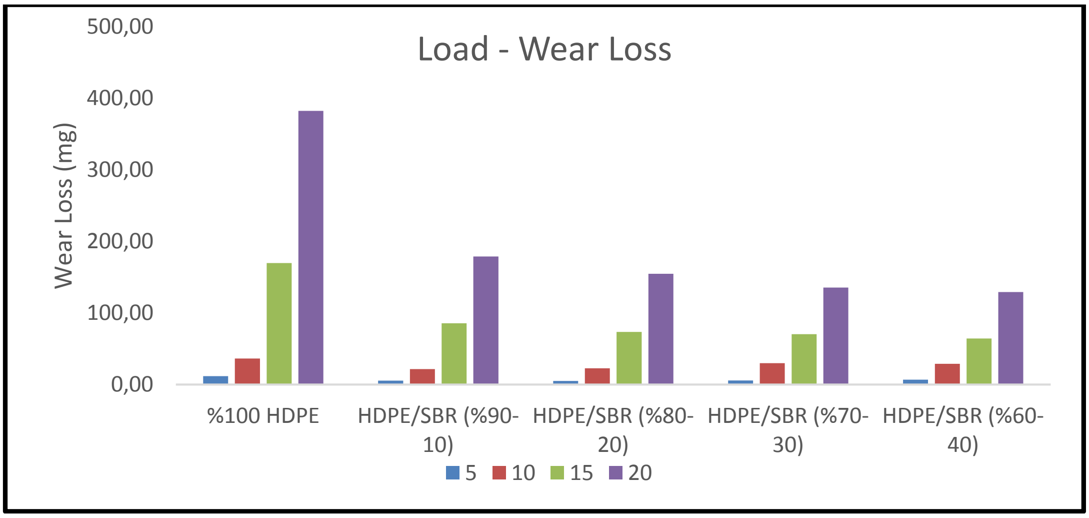

Figure 2. Applied load-wear loss relationship of HDPE polymer composites

They were examined 10 N loading. Here we identified that SBR contribute cause to decrease to wear rate. While 15 N loading had to increase of pure HDPE wear rate. But the effect was limited because SBR contribute failed suddenly this factor. At least 20 N loading increases to pure HDPE wear rate where this effect peak to very high. SBR contribute led to increase same. but this rising was not as pure HDPE. The low level of filler may decrease the hardness of the matrix and bonding strength between the elastomer and polymer matrix. SBR contribute being pulled out and reduced the wear rate. Therefore. SBR was suitable for the high load tribological application.

According to the results of the wear rate of HDPE/SBR polymer composites at different loads and sliding distances.

SBR elastomer is soft and same is a polymer with viscoelasticity and very weak intermolecular forces generally having low Young's modulus and high failure strain compared with other materials. In these composites. the adhesive would be good on HDPE surface. In this case HDPE / SBR blend which could increase the wear rate of the composites. So. a high level of the filler led to decrease to wear rate of the composites. SBR contribute was suitable for tribological application for HDPE matrix.

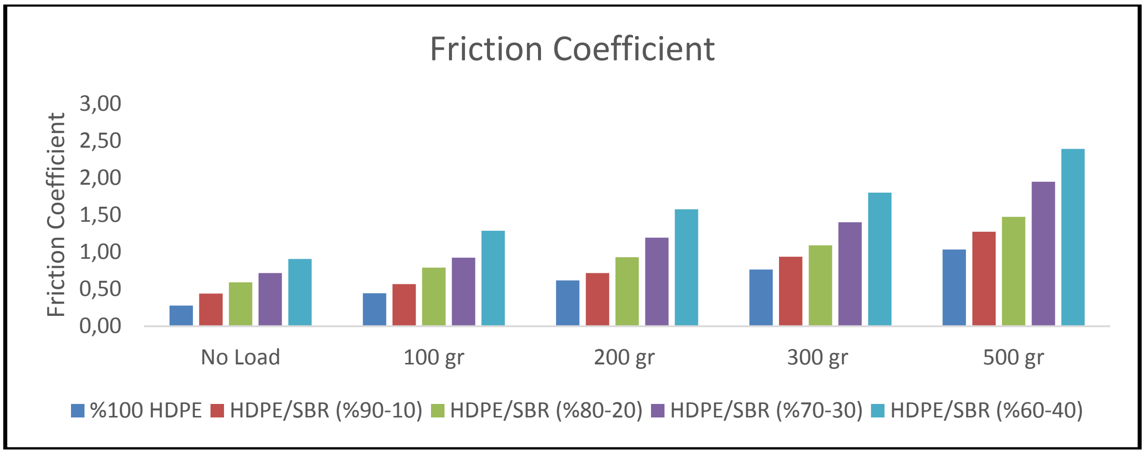

Figure 3. Friction coefficient for various specimens sliding under load.

Fig. 3 shows that the friction coefficient for various specimens sliding under load and in this step was applied to different speed. It is seen that the static friction coefficients of the HDPE/SBR polymer composites were upper than that of the pure HDPE generally. Firstly unload force was applied to composite and the friction coefficient is increase. These increase was up with SBR contribute. This situation has continued to increase with the increase of load similarly. Based on these result the loading had a great effect on the static and dynamic friction coefficient of the composite. As the load increases the friction coefficient of all kinds of composites increases. The bonding strengths between the HDPE matrix and SBR elastomers fillers changed with the content of the fillers which accounted for the differences in the tribological properties of the HDPE filled with the varied content fillers. The tribological properties of HDPE composites blend SBR and its variety was studied at different loads and distance under dry sliding.

Conclusion

The toughness of the composites resulted from the strong interfacial adhesion between elastomer contribute and high density polyethylene matrix. The wear loss of HDPE and its composites with decreasing load force and distance. With the addition of fillers to the composite the wear rate and friction coefficient significantly and clearly changed. The composites filled with a low level content of fillers showed augment to wear rate. While the composite with a high level content of fillers had lower wear rate.The sliding distance and applied load had a great effect on the wear rate of composites. The applied load is a more significant parameter than the sliding speed. The bonding strengths between the polymer matrix filler rate and hardness which accounted for the differences in the tribological properties of the composite filled with the varied content fillers. The results showed that the coefficients of friction reduce linearly with the load increase for HDPE and its composites.

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