IMPACT OF HARDNESS OF RUBBER COMPOUNDS ON TIRE WEAR

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Abstract
This article deals with the effect of mechanical properties of a compound on tire wear. For detection purposes the samples of 13 kinds of rubber compounds were made, used and processed in practice. The hardness was measured with durometer of IRHD (International Rubber Hardness Degrees) type; Rapid wear test was conducted on a roller abrasive machine. All measurements were assessed and compared. The selected original results are listed in this article.

Keywords: tire, wear, hardness, effect, testing samples

1 Introduction

The tires play a non-substitutable role in an automotive industry and therefore their quality is very important. The level of a production technology and quality of a tire-casing used to be dependent on testing methods, used to test particular indicators. The testing methods should take into consideration above all the ultimate objective, which is the product and the purpose to which it is to be used. For these reasons, there is a requirement to choose new testing methods operating in a different way of wear for heavy loaded special vehicle tire crown compounds working in extreme terrain surface conditions than conventional road and laboratory testing on elastomeric abrasion.

2 Production of samples

Testing samples for all kinds of tests were prepared by mould-pressing on a hydraulic vulcanizing two-storey 400x400 type press. The shape and dimensions of the testing samples meet applicable standards [1 - 5]. The curing time and temperature were determined by rheology. After pressing the elements were cast off for more than 16 hours, as stated by the standard. There are pressed and vulcanized bodies in the picture see Fig. 1 and Fig. 2 for the preparation of samples for quick wear testing and some plates to take measures of hardness [2].

2.1 Taking measures of IRHD hardness

A characteristic being measured is the depth of the impression of a specified indenter by a set force into a material under defined conditions. A IRHD digital durometer (ASTM D2240 and DIN ISO 7619 standards) was used during measurements. The thickness of a testing body had to be minimum 6 mm aiming to define hardness with the IRHD digital durometer. The testing procedure was performed as follows. The testing body was placed on a flat, hard surface. The durometer was placed on the testing sample so that the centre of the durometer testing point was at least 12 mm from the edges of the testing body. Support part was applied on a testing body as quickly as possible so it was parallel to the surface of the testing body, and in order to ensure that the indentor heads for the perpendicular to the surface of the elastomer. There were 5 measurements carried out on each kind of compound, in which a mean hardness was defined for each compound. The result of the test has been expressed as an integral number. All results are ploted in the Fig. 3 and shown in the Tab. 1.

Fig. 1 *The plates for cutting the blades*

Fig. 2 *The bodies for the preparation of samples fora quick wear testing*

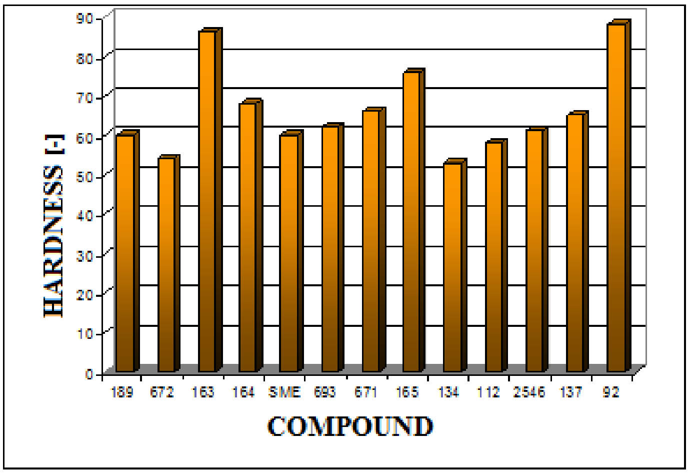

***Fig. 3** IRHD hardness*

***Table 1** The measured values of the hardness of particular compounds*

COMPOUND	1. VALUE	2. VALUE	3. VALUE	4. VALUE	5. VALUE	Median
189	59	61	60	60	60	**60**
672	54	55	54	53	54	**54**
163	87	87	86	85	85	**86**
164	67	70	68	68	67	**68**
SME	60	59	62	60	60	**60**
693	61	63	62	63	62	**62**
671	66	66	66	67	66	**66**
165	75	77	77	74	76	**76**
134	54	53	52	54	53	**53**
112	58	59	59	56	58	**58**
2546	61	60	62	61	62	**61**
137	64	65	66	66	64	**65**
092	88	86	89	89	88	**88**

2.2 Accelerated test for tire wear

The testing bodies are cylindrical shapes with a diameter of 16 mm and length 15mm. They were prepared from the mould bodies with dimension 150x30mm with a hollow drill. The test was performed at standard laboratory temperature. Abrasion of the surface temperature during the test increased, but for the purposes of determining the weight loss composition considers the temperature rise negligible. The temperature of a surface being worn has increased during the test, but for the purposes of determining the weight loss of the compound, these temperature increases are negligible. Before each test, it was necessary to remove the rubber powder from the abrasive cloth after the previous test. The test was conducted with a rotating testing body. The testing body was weighed with 1 mg accuracy. Subsequently it was mounted in the holder so as to protrude 2 mm, this length was checked.

A holder of a testing body and the slide were placed in the starting position and a controlled test was launched [3], [5]. Vibrations of the testing body holder were monitored. If excessive vibration had been present, reliable results would have not been achieved. The test run stopped automatically after reaching the abrasive distance of 40 m. Three tests were made for each compound [6], [7]. The testing bodies and testing device are shown in the picture see Fig. 4 and Fig. 5. After each test cycle the testing body was weighed with 1 mg accuracy. Sometimes small shreds hanging from the testing bodies had to be removed before weighing. All courses followed one after the other. The measured values were compiled and assessed. The measured values of weights of particular samples are recorded in Tab. 2 and they are plotted in Fig. 6.

Table 2 *Calculated values of weight reduction*

COMPOUND	Differences in weight [g]			Median
	Sample Nr. 1	**Sample Nr. 2**	**Sample Nr. 3**	
189	0,289	0,325	0,319	0,319
672	0,178	0,206	0,171	0,178
163	0,449	0,467	0,452	0,452
164	0,370	0,375	0,399	0,375
SME	0,180	0,161	0,181	0,180
693	0,328	0,320	0,322	0,322
671	0,192	0,205	0,160	0,192
165	0,350	0,380	0,392	0,380
134	0,125	0,152	0,144	0,144
112	0,326	0,429	0,378	0,378
2546	0,246	0,211	0,227	0,227
137	0,276	0,339	0,353	0,339
092	0,815	0,654	0,658	0,658

Fig. 4 *The samples for a rapid wear test*


Fig. 5 *Device for a rapid wear testing*

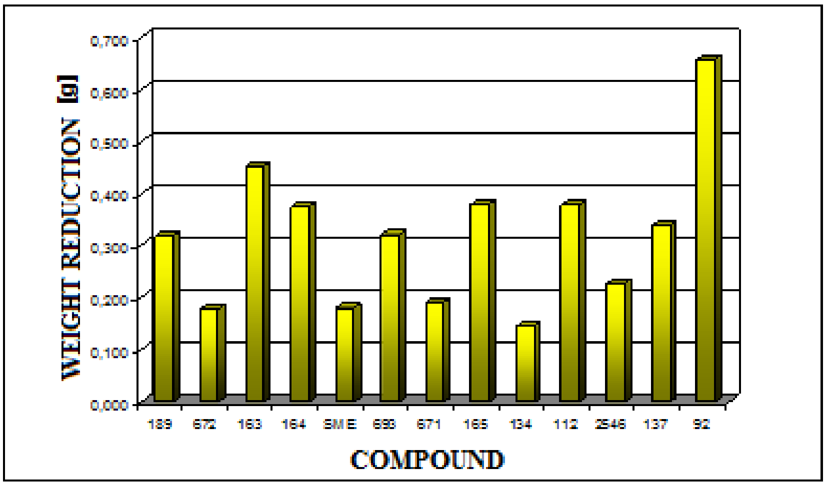

Fig. 6 Weight reduction of particular compounds

3 Interpretation

The most suitable method to define the quality and lifetime of the tire is testing in terms of future application of the product in practice [16]. However, the time interval of practical testing is long, as tires have a significantly longer lifetime than other industrial products [7], [8]. Therefore it is necessary to verify the quality parameters of tires at more frequent intervals in order to make technical and technological adjustments and to avoid the risk that a large number of products would be produced with an error.

3.1 Hardness

High hardness values were found for the 092, 163, 165 mixtures, which are at the same time the mixtures with the lowest wear resistance. Very low hardness was observed for mixtures 134 and 672, which also shows the least wear. This fits very well with the notion of material behavior. Greater hardness makes it easier to "crumble" the mixture, while a tougher material will withstand wear.

High hardness values were determined for compounds Nr. 092, 163, 165 which are also compounds of the lowest wear resistance. Very low hardness was measured in the compounds Nr. 134 and 672, which also showed the lowest wear [9], [17]. It meets also the expectations of the material behaviour.

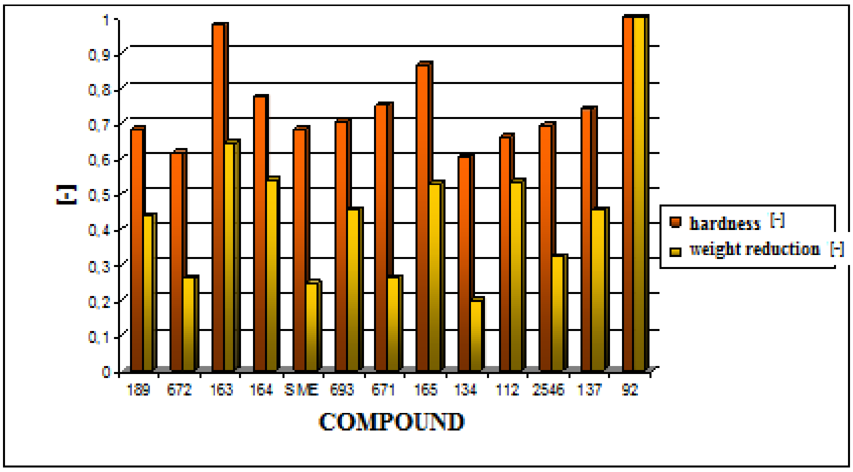

Fig. 7 Hardness and wear comparison

4 Conclusion

This article discusses the issue of wear of highly stressed parts from elastomer, especially tire treads. This article discusses an issue of the wear of highly stressed parts from an elastomer, particularly tire treads. The set of measurements was conducted testing and hardness tests. A test of rapid wear on a rotating cylindrical device forms a significant part of this work. On this device there was made a set of measurements on testing bodies made of thirteen kinds of different types of tread compounds assigned for the production of highly stressed tire treads for vehicles of special equipment and various technical vehicles. The results of all measurements were recorded and evaluated. Then they were compared with the wear of a tread compound. The analysis has led to an interesting relationship between the degree of wear observed on the testing device and hardness. The relationship between hardness and wear can be considered as relevant – the harder the sample, the higher the wear.

Rapid tests for wear of tread compounds can be carried out on the rotary device at very low operating costs and test duration. After the test, we obtain a good idea about the behaviour of a given compound.

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