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Araştırma Makalesi

The Effect of Service Conditions on the Performance of Silicone and Neoprene Elastomer Materials

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Abstract: In this study, the behavior of VMQ and CR materials under harsh service conditions (compression and temperature) were investigated. For this purpose, a group of samples were compressed at a rate of 25%, and then they were subjected to a temperature treatment between 293 K and 373 K for 24 hours. After each heat treatment, the tensile strength at the breaking point of materials was determined and compared with the samples only subjected to heat treatment. The results have shown that the CR and WMQ elastomer materials maintain their mechanical properties under specified hard conditions.

Key words: Elastomer, Silicone, Neoprene, Tensile strength

Servis Koşullarının Silikon ve Neopren Elastomer Malzemelerin Performansına Etkisi

Öz: Bu çalışma da, lastik conta olarak yaygın olarak kullanılan VMQ ve CR malzemelerinin zor servis şartları (sıkıştırma ve sıcaklık) altındaki davranışları incelenmiştir. Bunun için bir grup numune %25 oranında sıkıştırıldıktan sonra, 24 saat süre ile 293-373 K arasında sıcaklık işlemine maruz tutulmuşlardır. Her bir sıcaklık işlemi sonrasında malzemelerin kopma noktasındaki çekme dayanımları belirlenmiştir ve sadece sıcaklık işlemine maruz bırakılan numuneler ile karşılaştırılmıştır. Elde edilen sonuçlar, CR ve WMQ elastomer malzemelerin belirlenen zor şartlar altında mekanik özelliklerini koruduğu göstermiştir.

***Anahtar kelimeler*:** Elastomer, Silikon, Neopren, Çekme kuvveti

1. Introduction

Elastomers, which are rubber-based materials, are currently used in many parts in many sectors such as automotive, textile, agriculture and livestock, food, construction, armature, and health [1, 2]. Silicone rubbers (VMQs) are a very important group of elastomers that can maintain their mechanical performance over a wide temperature range [3]. On the other hand, Chloroprene rubber (CR, is also known by the trade name Neoprene) is one of the best synthetic rubbers for general purpose. While the main advantage of CR is its excellent resistance to atmospheric aging and ozone [4], VMQ

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can maintain its flexibility even at low temperatures below -70 ° C [3]. Therefore, they appear as two important materials on which intensive work has been done. Corresponding to this, Leng et al. [5] found that after thermal oxidative aging, the physical properties retention rate of VMQ/BR (butadiene rubber) are higher than that of BR. In case of CR compound [6], the dependence of tensile strength on the crosslinking time and temperature shows that the influence of crosslinking time is such that in the range between 4.75 min and 5.5 min, the tensile strength value reaches the maximum and then declines dramatically. Meanwhile, VMQ/functionalized graphene (FG) foams also exhibited improvements in tensile strength (130%) and the corresponding elongation at break (140%) compared to VMQ/chemical reduction graphene (rGO) foams [7]. In addition, the results also showed that more addition of VMQ could improve crack propagation resistance of natural rubber (NR)/VMQ [8].

When specifying a material for an application, there is a lot to consider. Temperature, environment, compatibility, hardness, compression, and certifications have to be taken into account. In this study, it was investigated whether elastomer materials (VMQ and CR) maintain their mechanical and elastic properties under challenging conditions (by exposure to heat and load) with a new test method created from the combination of ASTM D395 and ASTM D412 standards.

2. Material and Method

In this study, the CR and WMQ materials, which are the most popular materials in the industry due to their high mechanical strength, with 70 Shore A hardness were used. Technical information of these materials were given in Table 1.

Table 1. Some properties of VMQ and CR samples

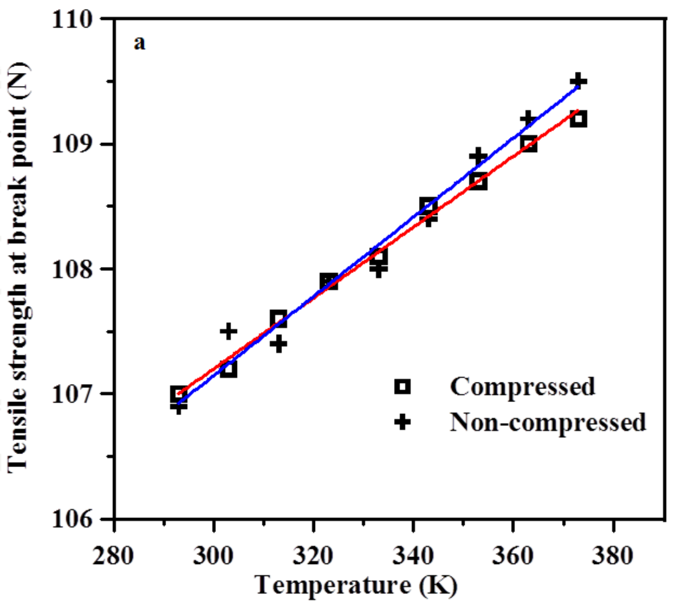
Properties	test standard	Neoprene (CR)	Silicone (VMQ)
Density (g/cm3)	ASTM D 297-13	1.39	1.21
Hardness (Shore A)	ASTM D 2240-05	70	70.7
Strenght at break point (N)	ASTM D 412-06 a DIE C	129.7	107.1
Elongation at break point (%)	ASTM D 412-06 a DIE C	378.3	361

A large number of materials (VMQ and CR) that are considered to be used as rubber gaskets were cut in suitable sizes for ASTM D 412 tests. The cut materials of CR and VMQ are divided into two groups. While only conditioning was applied to one group of the materials, the other group was subjected to heat treatment after being compressed at a rate of 25% (ASTM D395). Heat treatment was applied to both groups of samples by keeping the samples in the Espec Corp air conditioning device for 24 hours at 293, 303, 313 ...373 K temperatures. Then, tensile tests with Zwick Roell Z010 machine were applied to these two groups of materials to determine the tensile strength at breaking point.

3. Results

The mechanical properties of VMQ and CR materials maintain their service conditions. Corresponding to this, Cheng showed that the tensile strength of natural rubber materials decreases with the increment of temperature, while the elongation at break increases. This result was explained by the fact that the increase in the ambient temperature intensifies the thermal action, which alters the molecular chain order of the rubber [9]. In contrast to this, when strain crystallization occurs, the stress-strain curve rises considerably, thus ultimate strength at breakpoint increases as well [10]. In addition, Gong et al. [11] showed that with an increase in the filler concentration, the tensile strength and elongation of both VMQ composites decreased because more defects were generated in the matrix and weakened the tensile strength and elongation of the composites. The present study aimed to determine the tensile strength at the breakpoint of VMQ and CR rubber gaskets that have very intensive use under harsh conditions (temperature and pressure). The obtained experimental results were given in Figure 1.

From Figure 1, it is seen that the maximum strength value at break point was recorded as an increase of 2.2N (% 2.05) for a temperature change of 100 degrees in unprocessed gasket samples, while this value was recorded as 2.60 (% 2.42) N in the compressed gasket sample. On the other hand, in the CR samples, these values were recorded as 0.6(% 0.46) and 1.4(%1.08) N, respectively.



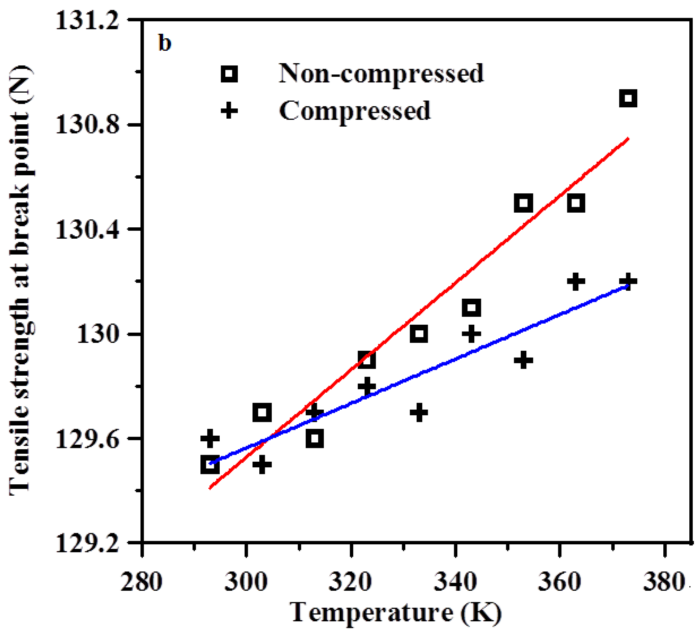


Figure 1. Tensile strength at break point vs temperature of VMQ (a) and CR (b) materials

4. Conclusions and Comment

Results showed that the compression force applied to CR and WMQ elastomer materials, as a result of exposure to high temperatures, these elastomer materials preserve their elasticity and mechanical properties. Thus, these materials will be able to work under long and hard working conditions without deformation and it will be possible to earn an income in terms of cost.

It is known that CR and WMQ elastomer materials, which have high commercial importance, find wide application in industry. In this study, it was concluded that the use of ASTM D395 standard and ASTM D412 two standards together for CR and VMQ materials does not pose any drawbacks in terms of tests. Thus, it has been shown that the number of test samples can be reduced and the material cost can be reduced. In addition, it is one of the other expected results to have a return in the long term as cost improvement (reduction) in the industry.

Author Statement

Adnan Çalık: Conceptualization, Methodology, Resource, Material, Instrument Supply.
Nazim Uçar: Writing, Reviewing and Editing
Yalçın Can: Investigation

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Conflict of Interest

As the authors of this study, we declare that we do not have any conflict of interest statement.

Ethics Committee Approval and Informed Consent

As the authors of this study, we declare that we do not have any ethics committee approval and/or informed consent statement.

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