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Studies of Grape Leaves for Modification of Ethylene-Propylene Rubber Elastomer Ter Polymer

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ABSTRACT

This study investigates the modification process of SREPT-60 with grape leaves. It is shown that modification requires obtaining grape leaf nanoparticles and then performing the modification. The study found that the optimal amount of grape leaf particles for modification is 8-10% by weight. The wear resistance and electrical resistance of rubber obtained from SREPT-60 rubber compounds and grape leaves were studied. The results show that increasing the grape leaf mass to 8 parts by weight improves the overall rubber performance. At a frequency of 50 Hz, the permittivity decreases from 2.3 to 2.9, and the dielectric loss tangent tan decreases from 10^{-2} to 10^{-3}, while the breakdown strength increases.

In this study, grape leaves were used for the first time to modify rubber. The modification process of a composite based on Skep-60 and grape leaves was studied in detail using modern research methods. The melt flow rate of the composite was also studied to determine the processing parameters of the resulting composite.

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Introduction

In industry, SREP-60 is a basic polymer widely used in various industries [1-5]. In addition to excellent heat resistance, low-temperature elasticity and flexibility, weather resistance, oxidation resistance, ozone resistance, and aging resistance, SREP-60 also offers potential applications in automobiles, roofing membranes, sealants, pipes, belts, radiators, thermal insulation, and electrical insulation [6-11]. However, this valuable rubber has several drawbacks, primarily its low mechanical strength and ozone and electrical resistance. To improve these shortcomings, SREP-60 has been modified with various modifiers and methods [12-15]. Many authors have shown that the properties of SREP-60 rubber are improved by vulcanization, creating a cross-linked structure using sulfur as a vulcanizing agent. A second study [of modified SREP-60-based composites] concluded that it is necessary to investigate the rheological properties and behavior of polymer systems under deformation [16-21]. These properties determine the relationships linking stress, strain, and strain rate [22-24]. These relationships, obtained at various temperatures and deformation regimes for polymers with different molecular weights and polymer systems of varying compositions, provide valuable information about their properties, structure, and structural transformations and are of fundamental importance when considering problems associated with the processing of such systems [25-29].

Method

In this research, electron microscopy and other structural analysis methods were used to analyze parameters such as tensile strength, elasticity, wear resistance, as well as the morphology and phase structure of the material. The aim was to evaluate the potential of using grape leaves as a biocompatible and environmentally friendly component for rubber modification, potentially improving its performance or reducing its cost. For the first time, we have approved the use of SREPT-60 with grape leaves as a protective coating for railway cables.

Grape Leave

As grape leaves, a grape variety called Shani, which is found in the Novkhane vineyards, was used in this study, which is explained by the presence of carbohydrates and functional groups in such leaves compared to other grape varieties. As a result of the analysis conducted by the Microbiology Research Institute, the main composition of grape leaves (it was not possible to determine all ele The chemical composition of grape leaves includes proteins, fats, carbohydrates, ash, fiber, iron, potassium, calcium, magnesium, manganese, copper, phosphorus) and phytonutrients (beta-carotene).

Mixing and Vulcanization

Grape leaves are ground into powder and mixed with SREPT-60 rubber using special equipment, after which the mixture is vulcanized.

Results of Experımental Research
As a result of the research we conducted to prepare the composition for the dissertation work, when we adopt the recipe shown in Table 1 as optimal:

Table 1: Composition of Rubber Mixtures Based on SREPT-60 and Grape Leaves

Indications	What is known Example Names			Suggested Example Names		
Components	Q1	Q2	Q3	Q4	Q5	Q6
SREP-60	100	100	100	100	100	100
Grape Leave	-	-	10	6	10	12
Biopolymer(tree resin)	10	10	10	-	-	-
Fuel oil	4	-	-	-	-	-
DUEK-4(bis-dihidrotsiklopentadienil kapromate)	-	6	6	6	6	6
Sulphur	2	-	2	2	2	2
Captax	0,5	0,5	1	1	1	1
Altax	0,5	0,5	1	1	1	1
ZnO- zinc oxide	4	4	4	4	4	4
Antioxidant	2	2	2	2	2	2
Technical stearin	1	1	1	1	1	1
petroleum resin	2	2	2	2	2	2
Technical carbon P-803	20	20	20	20	20	20

Selecting the Optimal Recipe and Preparing the Composition Based on it
We adopted the formula given in Table 2 to prepare a binary system based on SREP-60 and Grape Leaf in different proportions.

Table 2: Binary system based on SREP-60 and Grape Leaf

Example / Components	Q1	Q2	Q3	Q4	Q5
SREP-60	100	100	100	100	100
Grape Leave	-----------	4	6	10	12
Total	100	104	106	110	112

Results of Basic Analyses of Compositions Prepared Based on SREPT-60 Modified with Grape Leaves
We developed a composition using an optimal formulation and studied its physical, mechanical, and physical, chemical properties using state-of-the-art scientific research methods. The results are presented in Figures 1–9. The results of infrared spectroscopy studies are presented in Figures 1 and 2.

Within the framework of the study, the IR spectra of the obtained composition were comparatively analyzed and as a result of the modification according to the obtained wavelengths, broad and intense signals were observed in the spectrum in the region of 3545.52 cm^{-1} and 3492.58 cm^{-1} wave numbers, which means that the functional groups in the grape leaf found their place in the main chain of the polymer and sat on the main chain.

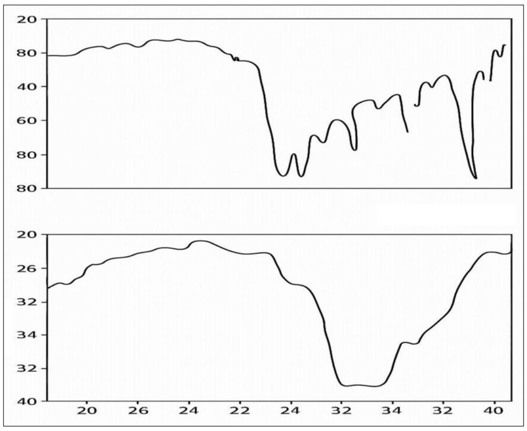
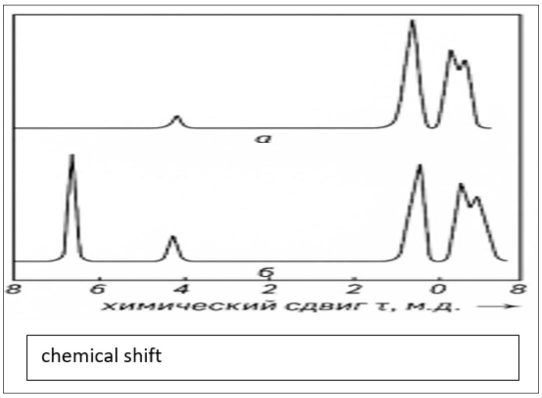


Figure 1: IR Spectra of Pure Elastomer SREPT-60

Binary mixtures based on SREP-60 and grape leaf were prepared. Their rheological properties (primarily the alloy flow index) were studied. Melt flow indices were studied at various loads of 11.75, 20.85, 26.10, and 32.60 kg and temperatures of 130°C -175°C. Experiments were conducted on an IIRT-5 instrument. Based on the obtained data, a report was compiled, graphs were plotted, and process parameters were determined.



IR Spectra Grape Leave Composition – 8% (mass).

Figure 2: NMR Spectra of SREP (a) and SREP-60 (in C6D6 Solution) Modified with Grape Leaves (b).

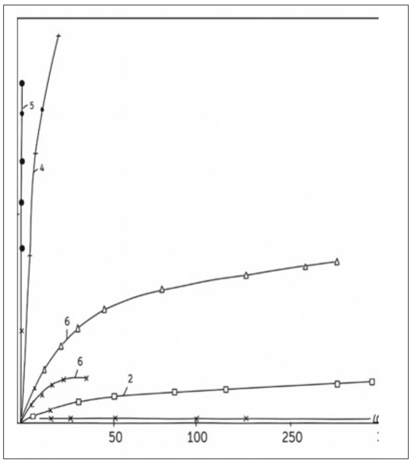


Figure 3: Stress-Strain Curves of SREP.T-60 Modified with Grape Leaves

Component content (% by weight): 1 - pure SREP.T-60; 2. SREP.T-60 + grape leaves - 4; 3. SREP.T-60 + grape leaves - 6; 4. SREP.T-60 + grape leaves - 8; 5. SREP.T-60 + grape leaves - 10- In this work, we also determined the extent to which the SREP elastomer, SREPT-60, would be modified by UF, and the results obtained are presented in Figure 4.

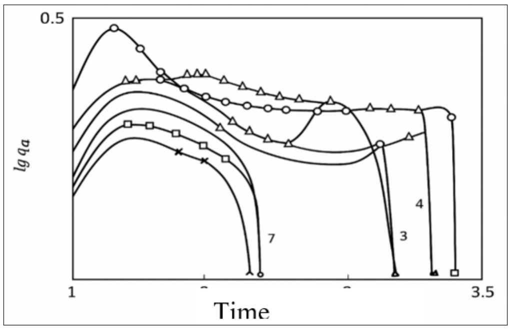


Figure 4: Relaxation Time Spectra of SREP-60 (1) Modified with Grape Leaves.

Content of grape leaves, % (mass): 2 – 5; 3 – 6; 4 – 8; 5 – 10; ; T = 100^{0}C

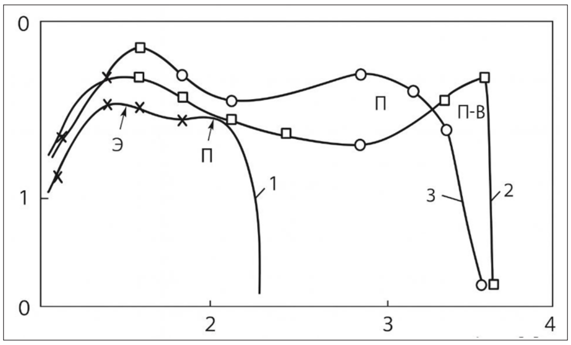


Figure 5: Relaxation Time Spectra of SREP and SKEPT-60 Modified with Grape Leaves.

- Original
- Modified SREP-60 (Grape Leave – 5% (Mass))
- Mechanical Mixture of SREP-60 with Grape Leave – 10% (Mass)

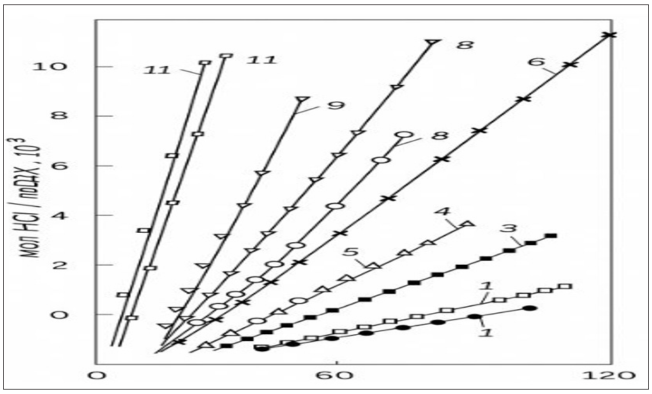


Figure 7: Thermal Decomposition of SREP-60 Modified with Grape leaf as a Function of Time at Different Temperatures and Grape Leaf Composition. Grape Leaf Content, % (Mass)

1-6; 2-10 ; 3- SREP-60 (T = 160 ^{0}C, in Nitrogen Atmosphere); 4-63; 5 -13; 6- Grape leaf (T = 170^{0}C, in nitrogen atmosphere); 7-6 ; 8-10; 9- Grape leaf (T = 180^{0}C, in nitrogen atmosphere); 4-10; 11-63 (T = 185^{0}C, in oxygen atmosphere

The rubber compound was prepared using the optimal formula and vulcanized at 158^{0}C, after which the key vulcanizate parameters were determined. The results are presented in Table 3.

Table 3: Physical and Mechanical Properties of Vulcanizates Based on SREP-60 + Grape Leaves

Name of Key Indicators	Requirements of the Standard			Results from the Experiment		
Tensile strength, MPa	17	16,6	16,7	16,5	19,7	18,5
Relative elongation, %	320	330	300	350	370	385
Relative residual deformation, %	12	14	12	12	12,3	12,6
Tensile strength, kN/m	65	64	68	66,9	68,7	68,9
Friction, cm^3/Wh	58	61	55	60	57	51
Brittleness temperature, ^oC	-	-	27	25	23	23
Strength on TM-2,	81	79	75	81	80	83
25°C for 24 hours, swelling degree at temperature, %: in a mixture of isooctane with gasoline (70:30)	11	13	13,9	10,4	11,1	10,7

Results

In this study, grape leaf modification was used to improve the key performance characteristics of SREPT-60. This is the first time we have used grape leaf as a modifier for SREPT-60. An optimal formulation based on SREPT-60 and grape leaf was developed. The optimal grape leaf content for modifying SREPT-60 was determined, showing that the optimal amount of grape leaf for modifying SREPT-60 is 6-8 parts by weight. A composite based on SREPT-60 and grape leaf was prepared, and the physical and mechanical properties of the vulcanizates were determined after vulcanization. It was shown that modifying SREPT-60 with grape leaf increases the mechanical strength and wear resistance of the rubber base. These data allow its use on an industrial scale.

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