

Preparation and study of a composition based on butadiene nitrile polymer using Astragals

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ABSTRACT

This paper is devoted to the topic "Preparation and Study of a Butadiene Nitrile Polymer-Based Composition Using Astragals."

Binary blends of butadiene nitrile rubber and astragals in various mass ratios were prepared, and the flow index of the alloy system was studied at temperatures of 130°C, 160°C, and 170°C and under loads of 12.0-21.0 kg. Our studies showed that at a temperature of 160°C and with an astragals content of 5 parts by weight in the binary blend, it acts as a modifier. As a result of the modification, the technological properties of NBR, primarily compatibility with other components and chemical stability, are increased by 1.5 times compared to standard modifying agents. An optimal formulation for producing rubbers based on butadiene nitrile and astragals was developed. A rubber compound based on an optimal formulation was prepared, and the vulcanization mode and time were determined. The resulting vulcanization temperature was 157°C, with a vulcanization time of 26 minutes. This work was conducted with the goal of acquiring a BNR-based rubber for cables that is chemically resistant to aggressive environments, more advanced, and fully capable of meeting operational specifications, exhibiting chemical resistance in saline areas, and suitable for use as a coating. The key parameters of the resulting mixture were determined using physical and mechanical methods and compared with standard rubbers, confirming that the proposed rubber's key parameters fully meet the standard requirements.

Keywords: Astragals, nitrile butadiene rubber, modification, vulcanization, ecology

INTRODUCTION

Nitrile butadiene rubber is one of the main rubbers in the rubber industry. Important rubbers resistant to oils and gasoline are obtained based on NBR. However, some properties of NBR (mainly its low resistance to ozone and chemical resistance in aggressive environments) limit the areas of its application [1-8]. In order to reduce these disadvantages of NBR, many researchers first used state-of-the-art mixers to obtain the rubber composition [9-11]. Then, 5 parts by weight of antiparticles were added to the plasticized NBR and mixed in the same mixer for 5 minutes. ZnO as an activator and Altax as an activator were added to this mixture and mixed again for 5 minutes to obtain the modified composition [12-13]. Other authors, on the other hand, kept the NBR-based rubber composition in an oven with air circulation at 70 °C for 70 hours to study the effect of thermal aging [14-19]. These authors modified nitrile-butadiene rubber with functional groups [20-22]. The main research efforts of the scientists focused on improving the mechanical strength of NBR and, primarily, on modifying the rubber with chemically functional groups. As a result of this modification, it was possible to improve the strength and chemical resistance of NBR materials [23-24]. Furthermore, recent studies have shown that nitrile-butadiene rubber is more durable than PET-based fabrics and exhibits superior properties [25-29].

Method

The general appearance of the astragals for modifying nitrile-butadiene rubber is shown in Figure 1.

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Figure 1 The general appearance astragals

As a result of the research, we determined that the astragals we used contained - Selenium 1.5 mg%. Macro- and micro-elements (calcium, silicon, aluminum, iron, magnesium, cobalt, zinc, copper, manganese, molybdenum, chromium

Roller milling of the composition

The compositions based on nitrile butadiene rubber and astracous were prepared on a roller mill by mixing in a temperature range of 30-60°C for 12 minutes. (See Table 1)

Table 1. Formulation of the composition based on nitrile butadiene rubber and astracous

	Ingredients in the composite material	Mooney Viscosity ML4-100°C	Micro volume porosity MKM
1	NBR	90/53	7.2
2	PVC	50/53	0.75
3	Astragaus	53/50	4.6 0,12

As a result of experimental studies for the production of NBR-based rubber compounds, an optimal formulation was obtained, the data for which are presented in Table 2. (This formulation is provided and compared with the standard formulation.)

l: Table 2. Comparison of the standard and proposed formulations

Ingredient	Reference composition			Suggested composition	
NBR	100	100	100	93	84
Sulphur	3.5	2.5	2.5	2.5	2.5
Altax	1,5	1,5	0.9	0.9	0.9
Mercapto	0,5	0,5	1.2	1.2	1.2
ZnO	3.5	3.5	3.5	4	4

Neozon-D	2	2	1	1	1
Stearic acid	1.2	1.2	1.2	1	1
Rosin	2.5	2.5	2.5	1.5	1.5
Technical carbon (P-803)	25	25	25	18	18
Technical carbon (P-234)	45	45	45	55	55
Astragaus	-	-	-	10	15

RESULTS AND DISCUSSIONS

Geological Properties Study

The rheological properties of the composition were studied using a TIR-4 unit at various temperatures of 120°C, 170°C, and 190°C and various loads. The results are presented graphically in Figures 2-4.

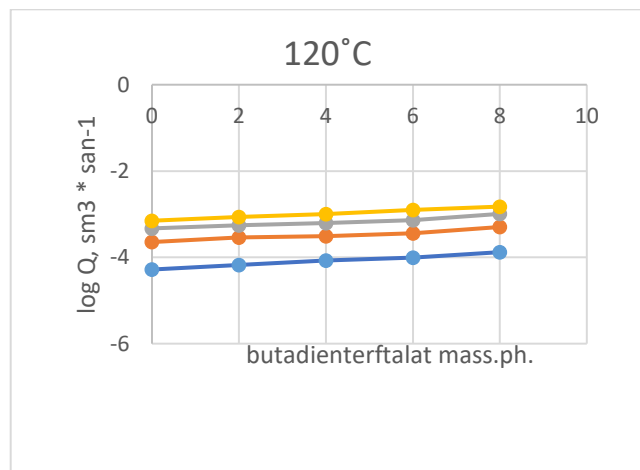


Figure 2. Flow ability index of the composition at 120°C.

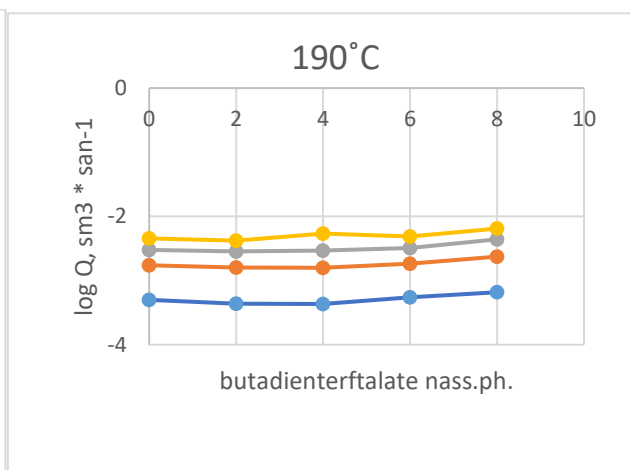


Figure 3. Flow ability index of the composition at 190°C.

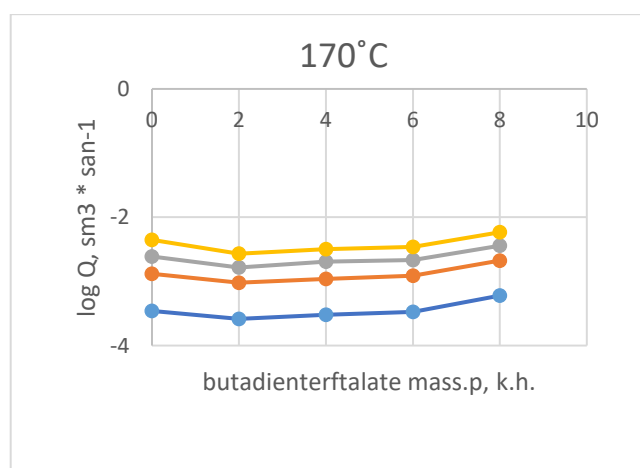


Figure 4. Flow ability index of the composition at 170°C.

The study found that astragalus is compatible with nitrile butadiene rubber at 5-7 parts by weight and can be combined with it in various proportions. However, the best results were achieved with astragalus content of 6 parts by weight.

To confirm the modification of NBR with astragalus, infrared analysis of this system was conducted, the results of which are presented in Figures 5-7.

a of pure NBR sample

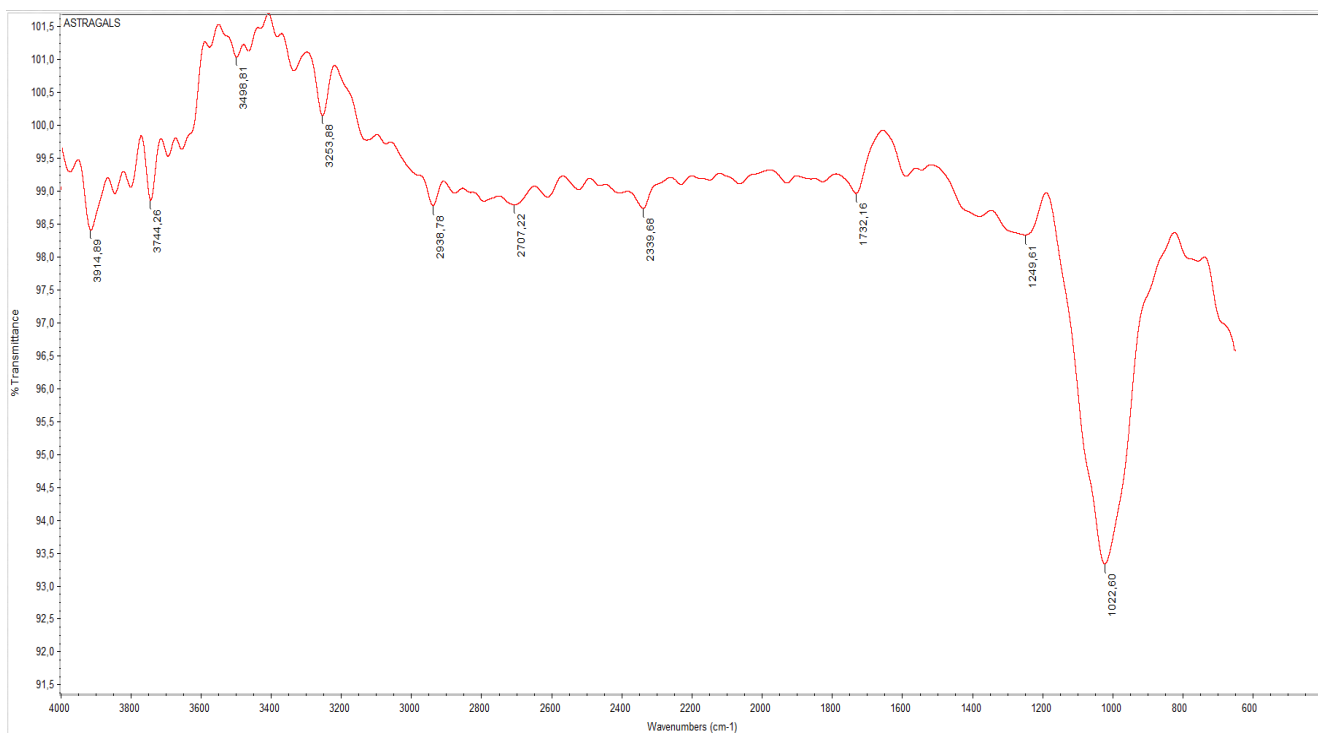


Figure 5. IR Spectra of pure astragals

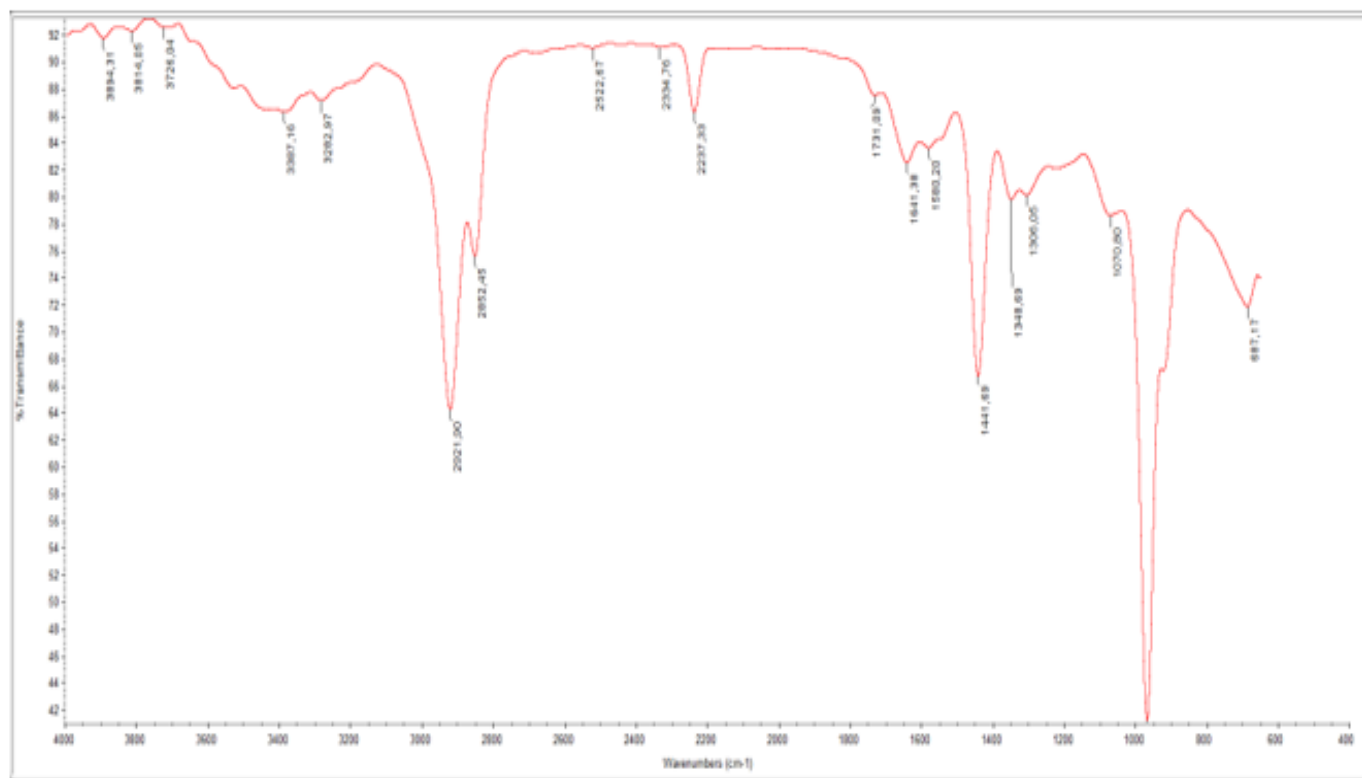


Figure 6. Infrared spectra of NBR composite sample with the addition of 6 parts by mass of astragals.

The resulting composition based on astragals biopolymer with the addition of nitrile butadiene rubber was vulcanized, and the physical and mechanical properties of the vulcanizate were determined after the vulcanization process (Table 3):

Table 3. Physical and mechanical properties of a vulcanizate based on NBR + astragals and their comparison with standard rubbers

Investigated properties		Sample of reference vulcanizate			Sample of obtained vulcanizate		
1.	Ultimate tensile strength, MPa	19	18,7	18,6	20,3	24,9	22,8
2	Relative elongation, %	325	337	315	390	420	445
3	Relative residual deformation, %	14	16	13	15	15,6	16,7
4	Tear resistance, kN/m	67	65	70	72,4	73,6	74,1
5	Friction resistance, cm ³ /Wh	61	64	59	66	63	62,7
6	Adhesion to the metal surface, MPa:	7.4	7,1				
	Steel - 3	-	-	7,7	10.1	11,5	12,1
	Brass			5,4	7,2	8,6	9,3
7	Brittleness Temperature, ⁰ C	14	-	34	31	31	29.5
8	Strength (Measured in TM-2 apparatus), MPa	96	92	88	86	87,2	85,5
11	Reversible deformation, %	14	13	16	16,7	16	15.7

RESULTS

1. Analysis of the Key Performance Indicators of the NBR + Astragals-Based Vulcanizate Revealed That the Resulting Rubbers Exhibit Ozone Resistance and High Chemical Stability. These Characteristics Can Be Used in the Production of Products Resistant to Ozone, Oil, and Gasoline, and Capable of Operating in Aggressive Environments.
2. The Proposed NBR-Based Material Can Be Used for General-Purpose Optical Cables.
3. The Proposed Composition (NBR + Astragals) Significantly Increases the Bond Strength of Rubber with Metals (Steel-3, Brass), Increases Gasoline Resistance, and Improves the Material's Mechanical Strength.

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