

# Study of Binary Systems Based on Butadiene-Terephthalate Rubber and Astragals and Its Rheological Properties

Shixaliyev Kerem<sup>1,\*</sup>

## Abstract

*Study of binary systems based on butadiene-terephthalate rubber and Astragals and it In this work, Nano sized astragals was used for the first time to modify butadiene terephthalate rubber. For this purpose, compositions were prepared to study the properties of butadiene terephthalate rubber with different astragals contents of 1, 3 and 5 mass parts. Their results were compared with the control composition without nanoparticles. The presence of astragals and its distribution in the matrix of butadiene terephthalate rubber was confirmed by determining the melt flow indices of the binary system and IR analysis. The effect of Nano sized astragals modification on the main rheological properties of polybutylene terephthalate was studied. The effect of Nano sized astragals on the kinetics of vulcanization was studied To select the vulcanization mode of the rubber compound, the optimum and plateau of the vulcanization process were determined, and it was established that the onset of vulcanization begins at 127 °C and ends at 155–157 °C. The vulcanization process was carried out at a temperature of 175<sup>0</sup>C and The main indicators of the obtained vulcanizate were determined by the physical and mechanical properties of the vulcanizates by known methods. The obtained data were compared with reference rubbers. In terms of strength, the proposed rubber exceeds the standard by 1.2 times. The ultimate strength of the vulcanizate sample is achieved up to 26 MPa.*

**Keywords:** Astragals, butadiene terephthalate rubber, modification, vulcanization, rheology

## INTRODUCTION

At present, on an industrial scale, the problem of obtaining ozone-resistant rubber under modern conditions is solved mainly by synthesizing new types of polymers and creating polymer compositions, where the properties of individual components additively complement each other [1-5]. However, these methods of obtaining polymeric materials are associated with very complex technological processes. Therefore, many authors are developing new methods for obtaining various polymer compositions in existing technological conditions and technological equipment, significantly simplifying the

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technological cycle of processing, radically reducing the weight and dimensions of products, and, of course, their cost [6-9]. Today, an important task for researchers is the main problems of processing polymer composite systems with polyfunctional properties based on polyolefin and heterochain polymers, providing high physical and mechanical properties of products operating in extreme conditions. Therefore, we believe that the task of researchers is to create polymer systems with the required set of operationally important properties. To achieve this, it is necessary to modify the polymer and determine the parameters of compatibility and interaction of polymer mixtures.

Thus, it is possible to determine in what proportions polymer systems can be combined, and having determined this, it is possible to say with confidence in what proportions these polymer and modifier systems can be combined [10-15].

Astragals is used in various fields due to its unique properties [16-20]. Yellow-red astragals is found only in the Nakhichevan Autonomous Republic of Azerbaijan [21-23]. It is most often found on dry rocky slopes. Many scientists have determined its composition and found mainly [24-26]. In this study, astragals growing in the mountainous areas of the village of Kutak in Nakhichevan was used. Except for the inner side, all parts of the plant are covered with whitish or yellowish hairs. The color of the stems is brownish-gray, the leaves are gray-green, and the flowers are yellow. These astragals are 21-33 cm tall, have red hairs up to 20 cm long and are mostly erect. A number of authors have found that the astragals used in this study contains flavonoids, emperor, quercetin, isorhamnetin, astragal side, antioxidants, amino acids, vitamins,  $\alpha$ -tocopherol (vitamin E), triterpene glucosides, a number of dacyantogenides (and selenium 1.5 mg% [27-28]. Macro- and microelements are present (calcium, silicon, aluminum, iron, magnesium, cobalt, zinc, copper, manganese, molybdenum, chromium). When we received the astragals we used in this study, their leafy stem was 21 cm long and in bloom. All parts of the plant, especially the calyx, were covered with long, soft, whitish hairs. The stem was ribbed, up to 2.9 mm thick. The leaves were compound pinnate, long-petiolate, 17-21 cm long, and consisted of 11-115 pairs of leaflets. The leaflets were sub sessile, oblong-lanceolate, 18-23 mm long and 5 mm wide. [29-32]

Butadiene terephthalate is widely used in various fields of industry, but in rubber production its use for some shortcomings does not find application in this field. To eliminate these shortcomings, we used astrax as a modifier. Studies of the work of researchers have shown that today the modification of polymers is relevant. I want to note that my articles are mainly hung on the process of modification of industrial polymers to obtain polymeric materials with high physical and mechanical properties [33-36]

## Method

For the modification of butadiene terephthalate rubber, we used astragals for the first time. mainly around the villages of Kalakh and Dermis. Astragals (called Gavan in Azerbaijan) is a perennial herbaceous plant 15-35 cm high, stem 4-20 cm long, elongated-erect or erect, reddish. Except for the inner side of the crown, all parts of the plant are covered with whitish or yellowish hairs. The color of the stems is brown-gray, the leaves are gray-green, the flowers are yellow. It is a deciduous shrub 20 cm high, with dense branches forming a cushion, the leaves are prickly, all parts are covered with thin, weak hairs. Leaves 8-12 mm long, pinnate, adjoining half of the stem, linear-lanceolate. Leaves 6-9 pairs, elliptic or oblong-ovate, 10 mm long, with acute tips. Glabrous above, sparsely or densely hairy below. Flowers form 2-3 short inflorescences in the leaf axils. Inflorescences are flat, sepal-shaped, up to 13 mm long. Calyx 10-16 mm long, tubular, thick, short, white-haired. Teeth serrate, greenish. Its crown is up to 13 mm long. Sail 7-8 mm wide, oblong-elliptic. Keel shorter than wing. Females elongated, fluffy-hairy, up to 16 mm long, stem naked, columnar. Pods sessile, oblong, acute, silky-white-hairy, unilocular, polyspermous. Blooms in June-July.

The *Astragalus* species used in this study are distributed from the foothills of Kolwezi village in Baber district, Bata Yorta, Gheil Gish Lag, Antara village in Shabazz district, Givenchy, Tea in Cordova district etc. to the high mountain areas, on dry rocky, grassy slopes, shrubs and valleys. (Figures 1 and 2)

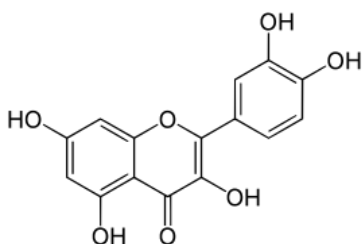
When we examined the chemical composition of *Astragalus* used in the study, we determined that its main composition contains 1.5 mg% selenium and various microelements such as calcium, silicon, aluminum, iron, magnesium, cobalt, zinc, copper, manganese, molybdenum, and chlorine. The presence of such components in *Astragalus* makes it the best modifier.



**Figure 1.** Astragals fugacious



**Figure 2.** Astragals phantom



Chemical composition of astragals

### Preparation of BTFR-Based Nanocomposites

Several authors have used laboratory rubber mixers as a research technique to prepare Nano composites. First, BTFR BSK was plasticized in Bunbury for 2 minutes to obtain rubber Nano composites. In this work, a mill was used which is used to obtain nanoparticles. Then, the plasticized BTFR was added with Nano filler selected at 1, 3 or 5 parts per hour and mixed in the same mixer for 1 minute. This compound was mixed with ZnO as an activator and SC as a lubricant for 0.5 minute. Then, stabilizers (TMQ, IPPD and ozone wax) were mixed for another 0.5 minute. The rubber Nano composites were cured in an oven with air circulation for 70

**Table 1.** The main indicators of the astragals that we used in this work

Vital forms		Number of species	Total country %
According to the Safebreaker system			
1	Shrubs	13	14,94
2	Armrests	7	8,04
3	Herbs (plurals)	55	63,21
4	Herbs (unions)	12	13,79
Total:		87	100
According to the Raunchier system			
1	Phanerophytes (Ph)	13	14,94
2	Memphites (Ch)	7	8,04
3	Hemicryptophytes (Hk)	55	63,21
4	Therophytes (Th)	12	13,79
Total:		87	100

All these elements and vitamins show that this astragal can be used in the pharmaceutical industry and in medicine. The main properties of the yellow-red astragals that we use were studied by Dashing Gambaro during their formation, and the results obtained are given in Table 1 hours at a temperature of 70 ° C to study the effect of thermal aging [14-18].

The chemical composition of Astragals was studied and it was determined that it contains organic acids, tannins, essential oils, triterpene compounds - glycyrrhizin, dacyantobioside, coumarins, vitamins C, E, a large amount of iron, calcium, phosphorus, magnesium, sodium, as well as silicon, manganese, manganese, silicon, isorhamnetin, astragalin, narcissus and other microelements. The rubber mixture was made on a laboratory mixer for 12 minutes at a temperature of 1300C at the first stage without the introduction of sulfur, after cooling the mixture to 90 0C, sulfur was added to the composition in order to avoid "scorch vulcanization" IR spectra of films up to 100 μm thick were recorded on a VR spectrometer with a NaCl and LiF prism in the region of 700 cm<sup>-1</sup> . X-ray structural analysis (1.5x2.5 mm plate) was carried out on the URS-50 IM installation with ionization registration.

## RESULTS OF EXPERIMENTAL RESEARCH

### Results and Discussions

#### *Study of rheological properties*

The volume consumption of the mixture and the dependences of the displacement rates of the binary mixtures on the stress (logo) was carried out in the ITER-4 device at temperatures of 100°C, 130°C, 150°C, and 170°C

100°C, 130°C, 150°C and 170°C studies were conducted to determine the flow index of the alloy of the obtained composition, and the results were calculated as follows

#### Cargo

$$P1 = \frac{11.75}{0.7144} = 16.44 \text{ kg sec}^2$$

$$P2 = \frac{20.85}{0.7144} = 29.18$$

$$P3 = \frac{27.75}{0.7144} = 38.84$$

$$P4 = \frac{35.75}{0.7144} = 49.34$$

$$\tau = \frac{P \delta}{\pi} = \frac{P 0.05}{2.08} = \frac{P 0.05}{1.6}$$

$$\tau_1 = \frac{16.44 \cdot 0.05}{1.6} = 0.5137 * 9.806 * 10^4 = 5.037342 \cdot 10^4 \log 4.70 \text{ Pa}$$

$$\tau_2 = \frac{29.18 \cdot 0.05}{1.6} = 0.9118 * 9.806 * 10^4 = 8.9411108 \cdot 10^4 \log 4.95 \text{ Pa}$$

$$\tau_3 = \frac{38.84 \cdot 0.005}{1.6} = 1.2137 * 9.806 * 10^4 = 11.901542 * 10^4 \log 5.08 \text{ Pa}$$

$$\tau_4 = \frac{49.34 \cdot 0.05}{1.6} = 1.5418 * 9.806 * 10^4 = 15.11889 * 10^4 \log 5.18 \text{ Pa}$$

$$Q = \frac{s}{t} \frac{\pi p^3}{4} = \frac{0.02}{t} \frac{3.14(0.954)^2}{4} = \frac{0.014288}{t}$$

100° C

**Cargo**

$$Q_1 = \frac{0.014288}{118.67} = 0.000120 \cdot 0.1210$$

$$Q_2 = \frac{0.014288}{71.55} = 0.000019969 \cdot 0.19$$

**Cargo**

$$Q_1 = \frac{0.014288}{36.85} = 0.00038773 \cdot 0.387$$

$$Q_2 = \frac{0.014288}{19.67} = 0.00072638 \cdot 0.7263$$

**Cargo**

$$Q_1 = \frac{0.014288}{18.26} = 0.00078247 \cdot 0.7824$$

$$Q_2 = \frac{0.014288}{11.34} = 0.0001259964 \cdot 1.259$$

**Cargo**

$$Q_1 = \frac{0.014288}{12.45} = 0.00114763 \cdot 1.1476$$

$$Q_2 = \frac{0.014288}{8.04} = 0.00177711 \cdot 1.772$$

130°C

**Cargo**

$$Q_1 = \frac{0.014288}{60.27} = 0.0000237066 \cdot 0.237$$

$$Q_2 = \frac{0.014288}{26.2} = 0.000545345 \cdot 0.545$$

**Cargo**

$$Q_1 = \frac{0.014288}{18.34} = 0.000077906 \cdot 0.779$$

$$Q_2 = \frac{0.014288}{8.19} = 0.00174456 \cdot 1.744$$

**Cargo**

$$Q_1 = \frac{0.014288}{10.29} = 0.00138853 \cdot 1.3885$$

$$Q_2 = \frac{0.14288}{4.73} = 0.003020718 \cdot 3.0207$$

**Cargo**

$$Q1 = \frac{0.014288}{6.31} = 0.00226434 \quad 2.264$$

$$Q2 = \frac{0.014288}{3.15} = 0.00453587 \quad 4.5358$$

150°C

**Cargo**

$$Q1 = \frac{0.014288}{26.48} = 0.00053957 \quad 0.5395$$

$$Q2 = \frac{0.014288}{14.83} = 0.00096345 \quad 0.9634$$

**Cargo**

$$Q1 = \frac{0.014288}{7.27} = 0.00196534 \quad 1.965$$

$$Q2 = \frac{0.014288}{4.89} = 0.00292188 \quad 2.9218$$

**Cargo**

$$Q1 = \frac{0.014288}{3.99} = 0.00358095 \quad 3.5809$$

$$Q2 = \frac{0.014288}{2.43} = 0.00587983 \quad 5.8798$$

**Cargo**

$$Q1 = \frac{0.014288}{2.92} = 0.00509589 \quad 5.095$$

$$Q2 = \frac{0.014288}{156} = 0.00915897 \quad 9.158$$

170°C

**Cargo**

$$Q1 = \frac{0.014288}{15.46} = 0.00092419 \quad 0.924$$

$$Q2 = \frac{0.014288}{8.48} = 0.00168491 \quad 1.6849$$

**Cargo**

$$Q1 = \frac{0.014288}{4.71} = 0.00303354 \quad 3.0335$$

$$Q2 = \frac{0.014288}{2.33} = 0.00613218 \quad 6.1321$$

**Cargo**

$$Q1 = \frac{0.014288}{2.79} = 0.00512115 \quad 5.12115$$

$$Q2 = \frac{0.014288}{1.42} = 0.0100619 \quad 10.0619$$

**Cargo**

$$Q1 = \frac{0.014288}{2.0} = 0.007144 \quad 7.114$$

$$Q2 = \frac{0.014288}{0.79} = 0.0180861 \quad 18.0861$$

The dependences of displacement rates of binary mixtures on stress (logo) were performed at temperatures of 100°C, 130°C, 150°C and 170°C:

100° C

$$\gamma = \frac{Q}{\pi \delta^3} = \frac{Q}{0.0003925}$$

**Cargo**

$$\gamma_1 = \frac{0.000120}{0.0003925} = 0.30573248^{\log-0.5146}$$

$$\gamma_2 = \frac{0.00019969}{0.0003925} = 0.5087643^{-0.2935}$$

**Cargo**

$$\gamma_1 = \frac{0.00038773}{0.0003925} = 0.98784713^{-0.00531}$$

$$\gamma_2 = \frac{0.00072638}{0.0003925} = 1.85064968^{0.2673}$$

**Cargo**

$$\gamma_1 = \frac{0.00078247}{0.0003925} = 1.9935541^{0.2996}$$

$$\gamma_2 = \frac{0.001259964}{0.0003925} = 3.21009936^{0.5065}$$

**Cargo**

$$\gamma_1 = \frac{0.00114763}{0.0003925} = 2.9238981^{0.4659}$$

$$\gamma_2 = \frac{0.00177711}{0.0003925} = 4.52766^{0.6559}$$

130°C

**Cargo**

$$\gamma_1 = \frac{0.000237066}{0.0003925} = 0.6039898^{0.2189}$$

$$\gamma_2 = \frac{0.000545345}{0.0003925} = 1.389414^{0.1428}$$

**Cargo**

$$\gamma_1 = \frac{0.00077906}{0.0003925} = 1.9848662^{0.2977}$$

$$\gamma_2 = \frac{0.00174456}{0.0003925} = 4.444738^{0.6478}$$

**Cargo**

$$\gamma_1 = \frac{0.00138853}{0.0003925} = 3.537656^{0.54878}$$

$$\gamma_2 = \frac{0.003020718}{0.0003925} = 7.690968^{0.8863}$$

**Cargo**

$$\gamma_1 = \frac{0.00226434}{0.0003925} = 5.7690191^{0.7611}$$

$$\gamma_2 = \frac{0.00453587}{0.0003925} = 11.55356^{1.0628}$$

150°C

**Cargo**

$$\gamma_1 = \frac{0.00053957}{0.000325} = 1.3747006^{0.1382}$$

$$\gamma_2 = \frac{0.00096345}{0.0003925} = 2.454649^{0.3899}$$

**Cargo**

$$\gamma_1 = \frac{0.00196534}{0.0003925} = 5.007236^{0.6996}$$

$$\gamma_2 = \frac{0.00292188}{0.0003925} = 7.4364^{0.8714}$$

**Cargo**

$$\gamma_1 = \frac{0.000358095}{0.0003925} = 9.123439^{0.9602}$$

$$\gamma_2 = \frac{0.000587983}{0.0003925} = 14.980458^{1.1755}$$

**Cargo**

$$\gamma_1 = \frac{0.00509589}{0.0003925} = 12.983159^{1.1134}$$

$$\gamma_2 = \frac{0.009155897}{0.0003925} = 23.334955^{1.3680}$$

170°C

**Cargo**

$$\gamma_1 = \frac{0.00092419}{0.0003925} = 2.3546242^{0.3719}$$

$$\gamma_2 = \frac{0.00168491}{0.0003925} = 4.29276433^{0.6327}$$

**Cargo 2**

$$\gamma_1 = \frac{0.00303354}{0.0003925} = 7.72876433^{0.8881}$$

$$\gamma_2 = \frac{0.00613218}{0.0003925} = 15.623388^{1.193}$$

**Cargo 3**

$$\gamma_1 = \frac{0.00512115}{0.0003925} = 13.047515^{1.1155}$$

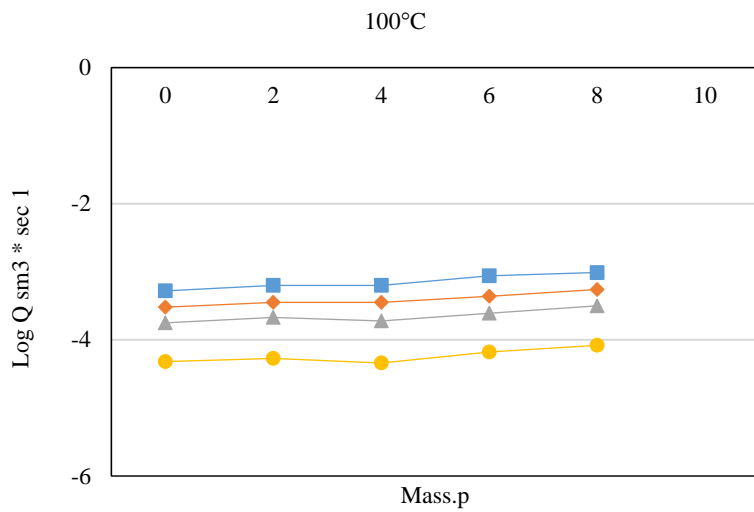
$$\gamma_2 = \frac{0.0100619}{0.0003925} = 25.635414^{1.4088}$$

**Cargo 4**

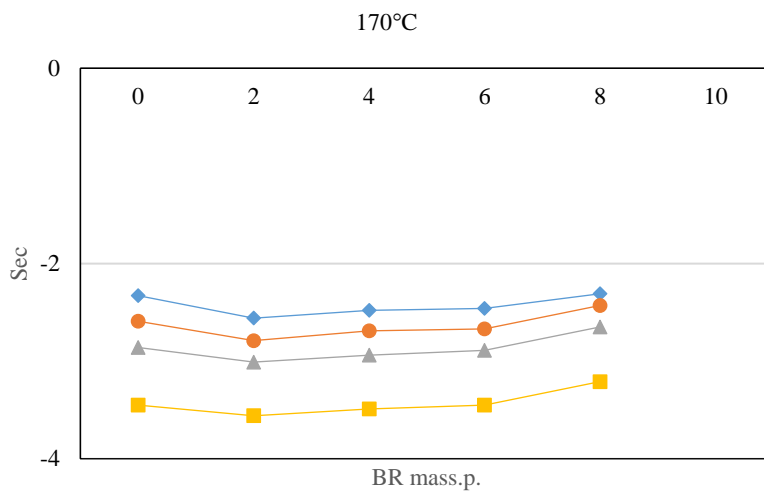
$$\gamma_1 = \frac{0.007144}{0.0003925} = 18.201273^{1.2601}$$

$$\gamma_2 = \frac{0.0180861}{0.0003925} = 46.079235^{1.6635}$$

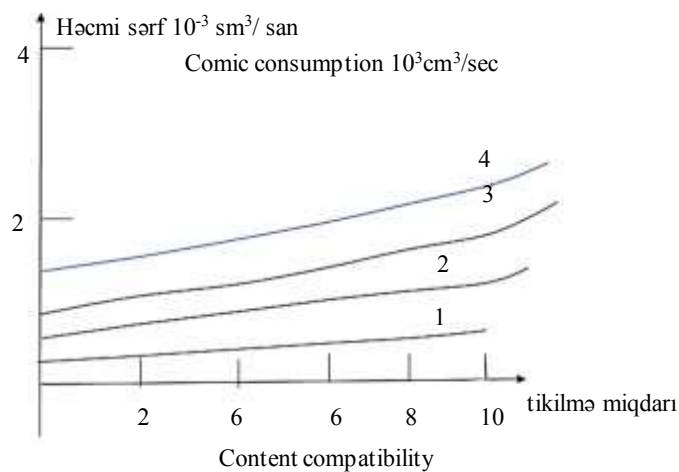
As a result of the analysis, it was determined that astragalus is compatible with butadiene terephthalate and can form a composition with it in different proportions. However, it was determined that the best result is obtained when the astragalus component in the composition is 10 parts by mass. Considering all this, we aim to improve the physical and mechanical properties of polybutadiene terephthalate. We took the amount of astragalus as 10 parts by mass. The indicators obtained as a result of the report are shown in Figures 3-10.



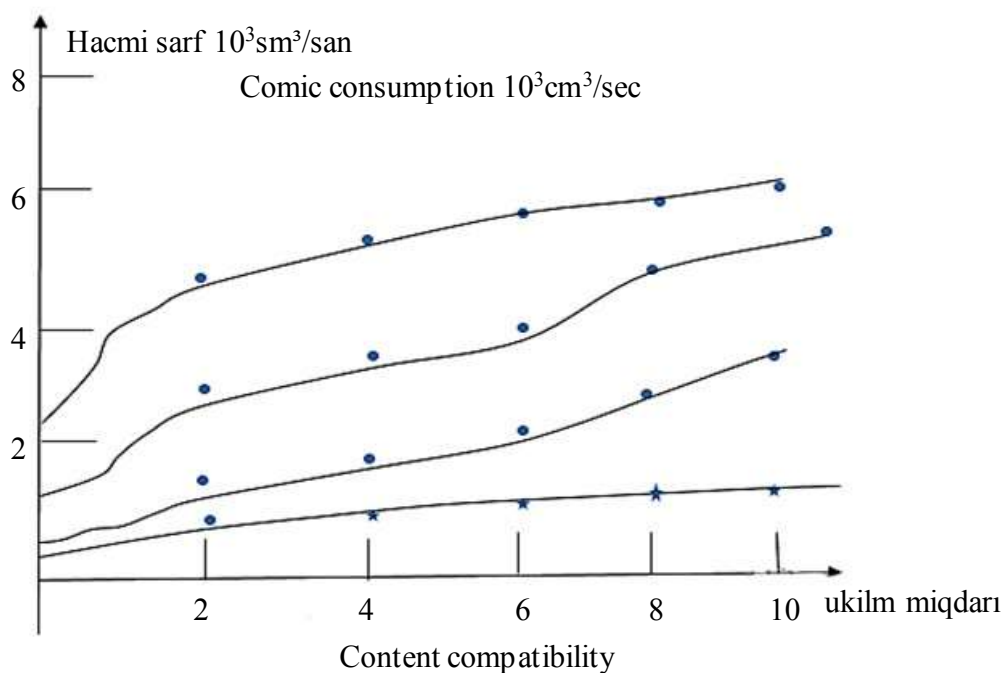
**Figure 3.** Flowability indices of compositions at 100C temperature.



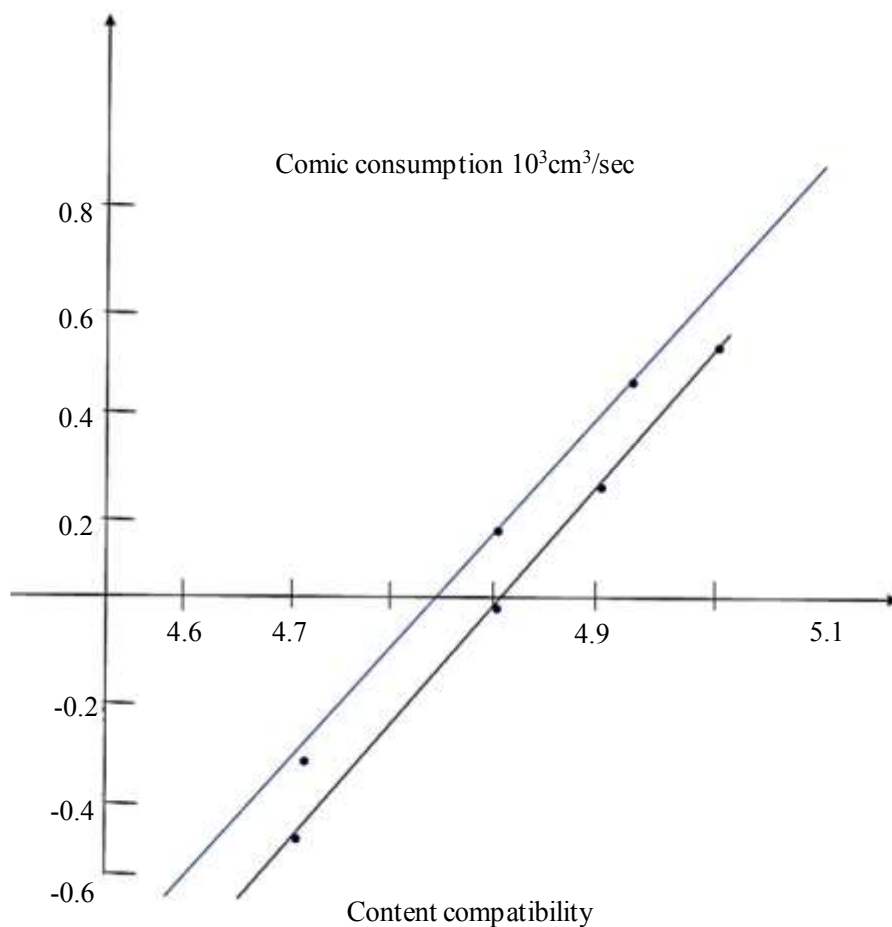
**Figure 4.** Flowability indices of compositions at 100 and 170C temperature.



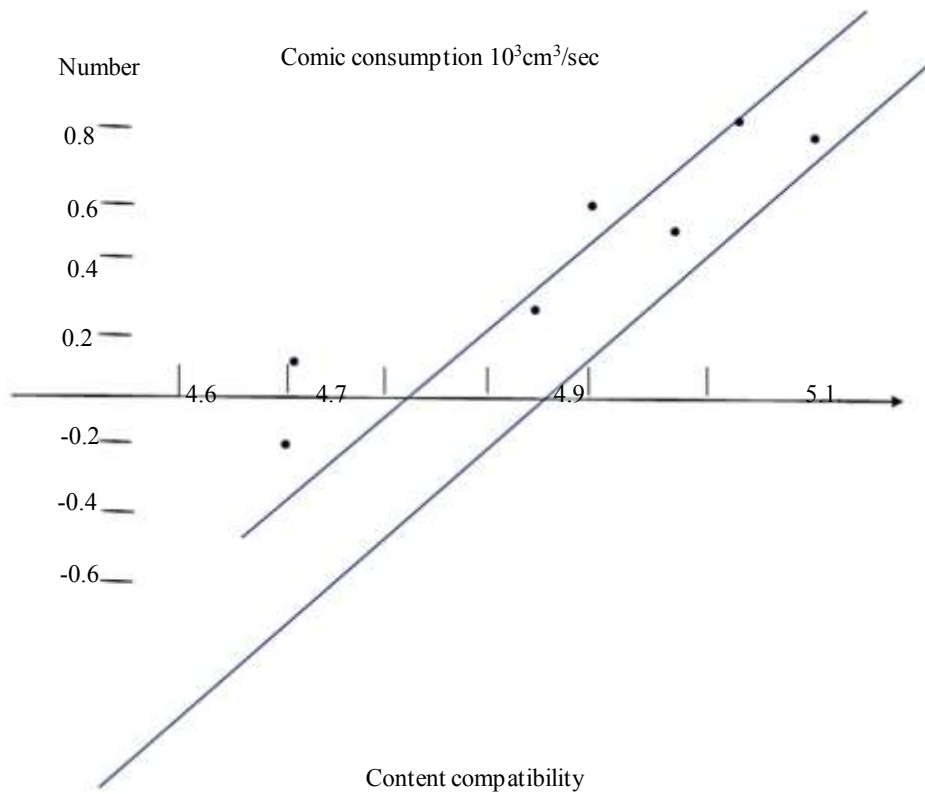
**Figure 5.** Dependence of volume consumption of BTFR and BTFR + astragalus binary mixtures at 100° C on the amount of astragalus in the mixture



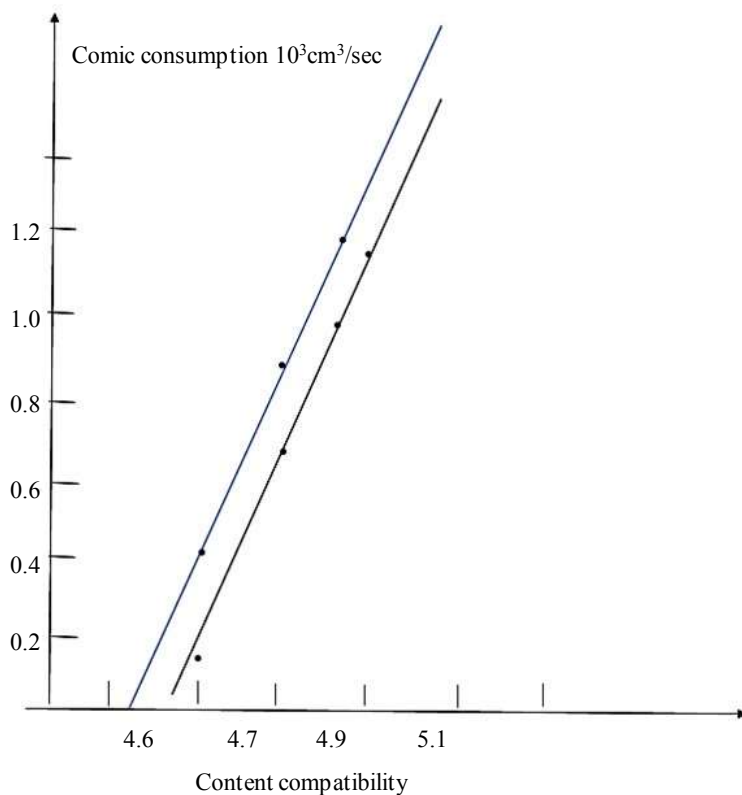
**Figure 6.** Dependence of the volume consumption of BTFR and BTFR + astragalus binary mixtures at a temperature of  $130^\circ \text{C}$  on the amount of astragalus in the mixture



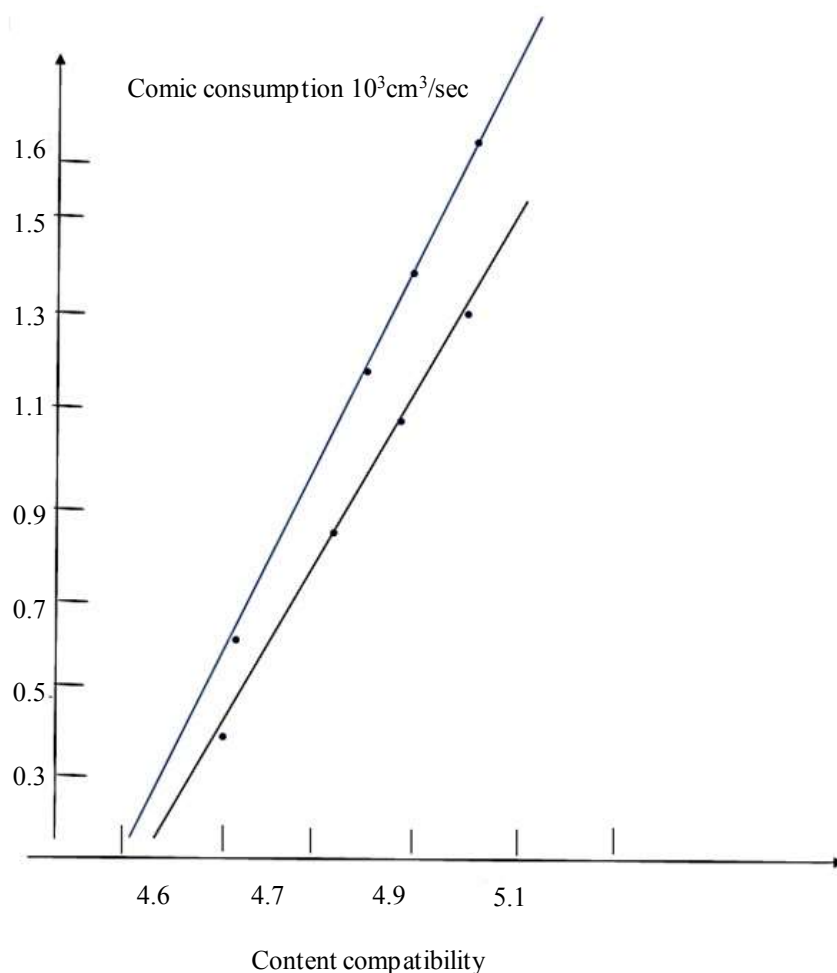
**Figure 7.** Stress (logo) dependences of displacement rates of BTFR and BTFR +astragals binary mixtures at  $100^\circ \text{C}$  temperature



**Figure 8.** Stress (logo) dependences of displacement rates of BTFR and BTFR +astragals binary mixtures at  $130^\circ\text{C}$  temperature.



**Figure 9.** Dependences of strain (logo) displacement rates of binary mixtures of BTFR and BTFR + astragalus at a temperature of  $150^\circ\text{C}$ .



**Figure 10.** Dependences of the rates of displacement of deformations (logos) of binary mixtures of BTFR and BTFR + astragals at a temperature of 170° C.

#### Rubber Mixture Based on BTFR and Astragals

Based on BTFR and astragalus, using the flow index of mixtures, we adopt the optimal recipe shown in Table2

**Table 2.** A rubber mixture made based on polybutylene terephthalate.

Main components	Standard resin mixture prepared based on polybutylene terephthalate (100 parts by mass, part by mass according to rubber)	The rubber mixture prepared based on polybutylene terephthalate modified with nanomaterials (100 parts by mass, part by mass by rubber)
Polietilen tereftalat	100	90
tree resin	-	2.5
Astragalus	-	10
Petroleum bitumen	5.0	5.0
Zinc oxide	3.0	3.0
Stearic acid	2.0	2.0
Sulphur	2.0	2.0
Tiuram	1.5	1.5
Sulfenamide	1.0	1.0
Neazon-D Technical carbon H330	3.030	3.030

## RECIPE

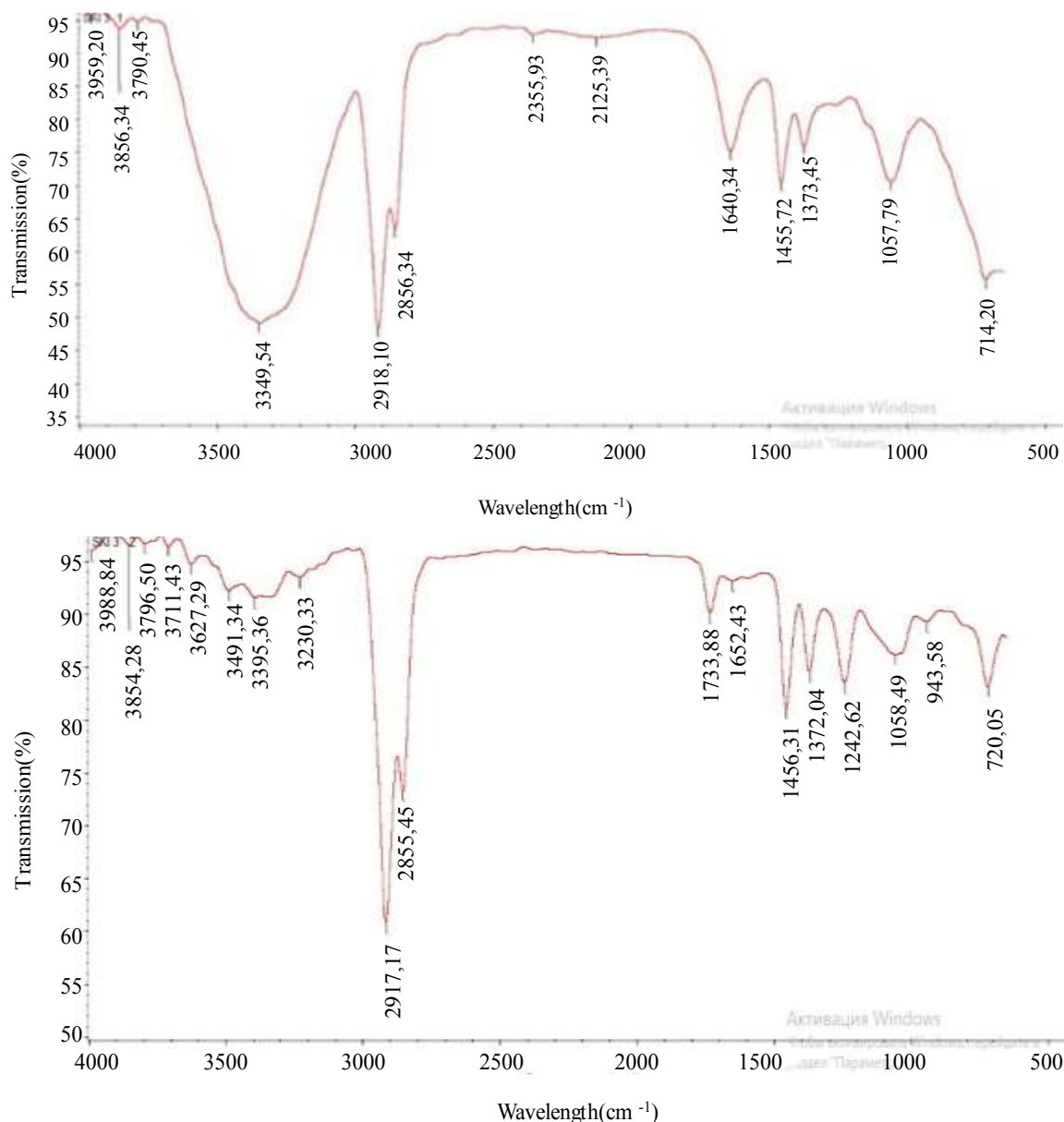
The mixture of the optimal receptor composition was prepared in laboratory conditions at a temperature of 90°C for 12 minutes until a dispersed system was obtained and vulcanized with a constant vulcanization mode. The main indicators of the obtained vulcanizate are shown in Table 3 according to the results determined in accordance with the standard.

The presence of functional groups formed by using astragals in the polymer can be clearly seen in Figure 11, which is confirmed by IKS-analysis. so it can be safely said that some of the properties of this polymer can be eliminated by modifying it with astragals.

In order to satisfy the chemical stability of the obtained polymer astragals composition vulcanizate in aggressive environments, we determined the physical and mechanical properties of the vulcanizates by vulcanizing the rubber mixture we prepared in the laboratory at a temperature of 155°C for 15 minutes in accordance with the recipes we accepted (Table4)

**Table 3.** Physico-mechanical parameters of vulcanizate based on PBT

The main indicators of vulcanization	Death limit	Requirements of the standard	The result obtained in practice
Relative elongation	%	300	500
Relative residual deformation	%	3,9	2,9
Elasticity (Bending Modulus)	GPa	3	4
Hardness Rockwell M	GPa	70	90
Hardness Area D	GPa	90	95
Stiffness (bending modulus)	GPa	3	4
Ultimate breaking strength	MPa	40	50
Durability (At Room Temp Notched Izod Effect)	J/m	29	45
Low Temperature Hardness	J/m	45	87
Yung's Modulus	GPa	2	3
Electrical property	Electrical property of vulcanizate	Electrical property of vulcanizate	Electrical property of vulcanizate
Arc Resistance	sec	123	180
Dielectric constant		2.9	4
Dielectric Strength	kV/mm	23	31
Dissipation factor	10-200 x 10 <sup>-4</sup>	10-200 x 10 <sup>-4</sup>	10-200 x 10 <sup>-4</sup>
Volume resistance	Ohm.sm	15 x 10 <sup>15</sup>	18 x 10 <sup>15</sup>
Shrinkage	%	0,6	2,1
Water absorption 24 hours	%	0,11	0,24
Density	q/cm <sup>3</sup>	1,3	1,39
Glass transition temperature	°C	55	64
Coefficient of linear thermal expansion	°C	6 x 10 <sup>-5</sup>	10 x 10 <sup>-5</sup>
Thermal conductivity	Vt/mK	0,21	0,27
Resistance to fire (LOI)	%	20	23
Learning class		HB	
Brittle transition temperature	°C	-32	-39
HDT @0.46 MPa (67 psi)	°C	123	148
HDT @1.8 MPa (264 psi)	°C	50	85
Maximum Continuous Service	°C	90	141
Minimum Operating Temperature	°C	-34	-40



**Figure 11.** The results of x-ray analysis of polymer with astragls

## RESULTS

1. By modifying polybutadiene terephthalate with astragals, it was determined how the modification process affects its mechanical properties.
2. . The physical and mechanical properties of the vulcanizate showed that this rubber is of great importance in the preparation of ozone-resistant rubbers and can be used on an industrial scale.
3. The physical and mechanical properties of the vulcanizate showed that this rubber is of great importance in the preparation of ozone-resistant rubbers and can be used on an industrial scale.
4. As a result of these studies, it was determined that rubber products based on polybutadiene terephthalate and astragalus nanomaterial are suitable for use for special purposes, since these rubber products are chemically resistant in aggressive environments and can operate in a wide temperature range.
5. The proposed composition allows to significantly increase the strength of the connection of rubber with metals (steel-3, brass), to increase the resistance to gasoline and to improve the tensile strength index.

**Table 4.** Physico-mechanical indicators of vulcanizates of rubber mixtures.

No	Name of key indicators	Key indicators					
		Requirements of the standard			Results from the experiment		
		1	2	3	4	5	6
1	Tensile strength, MPa	17	16,7	16,6	18.1	18,9	17,9
2	Relative elongation, %	320	330	300	360	380	395
3	Relative residual deformation,%	12	14	12	12	12,2	12,5
4	Tensile strength, kN/m	65	64	68	68,3	69,6	69,2
5	Friction, cm <sup>3</sup> /Wh	59	60	56	60	59	58,5
6	Metal bond strength, MPa: steel-3 brass	5,8-	5,4-	5,53,6	85,1	9,26,2	9,86,9
7	Brittleness temperature, °C	-11	-	28	26	25	24
8	Strength on TM-2, conventional unit	82	80	78	82	81,6	82,1
9	25°C for 24 hours degree of swelling at temperature, %:in an isooctane-toluene mixture (70:30) in gasoline-benzene mixture (3:1)	12-	14-	14,523,5	10,114,7	10,213,9	10,914,1
10	25°C for 48 hours heat aging at temp coefficients	0,850,64	0,870,62	1,030,88	0,920,83	0,940,86	0,950,90
11	Elasticity on jump, %	10	11	14	13,7	14	13.8
12	25°C for 27 hours ozone resistance at temp(deformation 20%, ozone hardness 0.015 %)	is falling apart	is falling apart	is falling apart	is falling apart	is falling apart	is falling apart

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