SSRG International Journal of Chemical Engineering Research
ISSN: 2394 – 5370 / https://doi.org/10.14445/23945370/IJCER-V9I2P103

Volume 9 Issue 2, 13-16, May-Aug 2022

Orignal Article

Modification of Bitumen with Polyethylene and Rubber Wastes

Aliyeva Aida[1], Shixaliyev Karam[2], Aliyeva Zahida[3]

[1,2]*Department of "Organic substances and technology of macromolecular compounds," chemical-technological faculty.*
[3]*Azerbaijan State Oil and Industry University Baku, Azerbaijan,*

Received: 07 May 2022 Revised: 09 July 2022 Accepted: 30 July 2022 Published: 06 August 2022

Abstract - *In the present work, modifications of road oil bitumen based on rubber and polymer waste were studied. Using crumb rubber with a particle size of 0.4–0.8 mm made it possible to obtain asphalt concrete with high physical and mechanical properties. This work confirmed that, in terms of complex parameters, only crumb rubber has the potential to improve the properties of the bituminous binder. It is shown that in the construction and maintenance of roads, high efficiency can be achieved by using a rubber-bitumen composition. As a result of bituminous modification of rubber crumb, the elasticity of the composition increased by 3 times, and the softening point by 2 times. The conducted studies also made it possible to establish that adding crumb rubber and polyethylene waste to bituminous binders increases their adhesion to stone materials.*

However, this increase is insignificant, from 2 (original bitumen) to 3 points with adding polymer waste (on a five-point scale). To improve this indicator, it is desirable to use additives, mineral powders, and high molecular weight petroleum acid. Our studies show that combining polymer waste with HFNC in a modified binder provides high shear, crack, and water resistance to asphalt concrete.

Keywords - *Bitumen, Crumb rubber, Ecology, Modification, Recycling, Softening point.*

1. Incidents

Most polymers are highly durable, mechanically strong,[1-3],[4-7],[811],[12-14],[15-18],[19-22] they have hardness, are sensitive to temperature changes, and sometimes resist aging and disintegration. Various amounts of additional components are added to polymers to increase their mechanical properties. It can be said that 50 wt. h of other components can be added to the polymer per 100 parts of its mass. Polymers are used not only to buy various products but also as modifiers. Recently, petroleum road bitumen has been modified with polymers in order to number of proper several lost commonly used polymer modifies that modify the modifying:[23-25],[26-27],[28-30] thermoplastics, thermoplastic elastomers, rubbers, and rubber scrubbers.

Styrene block copolymers are used as elastomeric materials Sterol-Butadiene-styrene (SBS). Bitumen modified with is characterized by good elasticity, high softening temperature, and resistance to cold and heat. Taking these into account motor this motor modified TB 25/4,,0, TB 70/30 and Vamotor5/25 oil-roamotorumen, polyethylene, rubber, and we used high molecular weight oil tour.

2. Methods and dissertation

The study was carried out only according to the current standards. The standard method for determining the extensibility does not reflect the actual working conditions of bitumen in the road structure. The duration of a single impact of a dynamic load during the passage of a car is about 0.1–0.01 s.

In this case, the deflection of the coating does not exceed 1–1.5 mm, and the deformation rate corresponds to approximately 600–1000 cm/min. Relative temperature deformations in the asphalt concrete pavement also do not exceed 0.001. In this regard, I.M. Rudenskaya and A.V. Rudensky emphasize that the extensibility index turns out to be of little use for assessing the quality of bitumen and does not allow one to judge the behavior of the binder on the road surface under dynamic influences.

For the modification of bitumen grades, TB 25/40, TB 70/30, and Vaki 85/25, polyethylene and rubber waste were used. The physical and mechanical properties of the bitumen used are shown in Table 1, and the formulation based on polyethylene and rubber dust is shown in Table 2.

Subsequently, based on the obtained mineral powders and active bitumen (B75), an asphalt concrete mixture was prepared with the following composition: (wt. h. -46); mineral powder -26; bitumen -10; high molecular weight petroleum acid (HMPA)

Table 1. Composition of bitumen-polymer compositions

Composition Components	Content of components, wt. Parts. By examples								
	1	2	3	4	5	6	7	8	9
Rubber crumb-polyethylene waste	-	5	10	15	20	25	30	35	40
Bitumen	200	200	200	200	200	200	200	200	200
Filler	200	200	200	200	200	200	200	200	200
mineral powder	150	-	-	-	25	40	50	60	80
high molecular weight petroleum acid	-	-	-	-	10	10	10	20	20
The mixing temperature of components in the mixer, °C	100	70	90	100	160-180	70	90	70	100
Mixing time, min	15	10	12	15	65-120	10	12	10	15

As laboratory studies have shown, this technology of introducing active rubber powder is not accompanied by the destruction of macromolecules, which provides quite satisfactory elastic properties for the road surface.

Table 2. Physical and mechanical properties of the composition based on rubber dust

№	Indicators	Samples				
		1	2	3	4	5
1.	Needle penetration at 25 °C	38	72	100	71	96
The softening	The softening point, °C	49	68	82	56	75
3.	Brittleness temperature, °C	-10	-10	-26	-8	-20
4.	Extensibility at 25, °C	40	60	70	55	60
5.	Density, g / sm 3	2,34	2,36	2,38	2,2	2,4
6.	Temperature changes at T=65 °C for 5 hours	7	6	6	6	6
7.	Tensile strength at 20 °C at 50 °C	2,4 0,9	3,0 1,0	3,5 1,2	3,1 1,1	3,4 1,3

The obtained granular bitumen-polymer compositions were tested according to standard methods. The data are presented in tables 3 and 4.

Table3. Indicators of physical and mechanical properties of asphalt concrete mixtures

Names of indicators	Samples			
	1	2	3	4
Compressive strength, MPa, At 20 °C 50°C	 2,2 0,9	 - -	 - -	 - -
Water-resistance coefficient, %	0,90	-	0,95	0,89
The water-resistance coefficient for long-term water saturation, % by volume	0,86	0,90	0,94	0,90
Swelling, % by volume	0.6	0,9	0,5	1,0
Residual porosity, % by volume	2,1	2,4	2,0	2,3

As can be seen from Table 2, the optimal amount of polymer waste addition to bitumen is 4–5%. In this case, the decrease in the depth of penetration of the needle (penetration) at 25 ° C does not exceed 19% for BND 60/90 bitumen and 28% for BND 90/130 bitumen. In contrast, the extensibility decreases from 98 to 17 0, 1 mm and 100 to 26 0.1 mm.

The remains of the Guzdek stone quarry {11} were used as a mineral powder. The data obtained are shown in Table 4.

Table 4. Asphalt Mix Test Results

Names of indicators		asphalt concrete		
		Initial bitumen	Activated Mineral Powder	indicators according to the standard
Average density, g/sm3		2,25	2,36	-
Residual porosity, %		2,6	1,98	2.5-5.0
Water saturation, % by volume		2,0	1,4	1,5-4,0
: Compressive strength, MPa, at a temperature				
	20 ºC	3,0	3,8	2.0
	50 ºC	1,0	1,9	0.9
	0 ºC	6,0	7,6	12
Water resistance coefficient		0.86	0,98	0,75

Results

As a result, a polymer-bitumen binder was obtained that meets the operational requirements for asphalt concrete pavements. It is shown that, as a result of the research, a polymer-bitumen binder composition was obtained, which, in terms of its physical and mechanical properties, surpasses unmodified road oil bitumen.

References

[1] Shikhaliev K.S, “Modification of Petroleum Bitumen with Polymer Waste,” *Exact Science Technical and Scientific Journal Kemerovo* , 2017.

[2] V.N. Shestakov, V.B. Permyakov, V.M. Vorozheykin, G.B. Starkov , “Technological Assurance of the Quality of Construction of Asphalt Concrete Coatings, “ Methodical Recommendations / Compiled By. - Omsk: OJSC "Omsk Printing House", pp. 256 , 2004.

[3] Babak O.G, “ The Use of Modified Binders in Road.” Construction ,” O.G. Babak, G.B. Starkov // Road Equipment and Technologies, no.5, pp. 72 – 75, 2001.

[4] Gokhman L.M, “The Use of Polymer-Bitumen Binders in Road Construction L.M. Gokhman Road Equipment and Technologies,” no. 5, pp.. 65 – 70, 2001

[5] Zolotarev V.A, “ Bitumens Modified with SBS Type Polymer: Features of Composition, Structure, Properties ,” *V.A. Zolotarev. - Kharkiv: Publishing House* ,KHNADU, pp. 17, 2003.

[6] Shikhaliyev K.S. Alieva Z.N, “Modification of Petroleum Bitumen with Polyethylene Waste,” *The Problem of Modern Science and Education* , 2017.

[7] Shixaliyev K.S, “Exelolted Thermoplastics-Based Compositions,” *European Science Review. Scientific Journal,* no. 5-6, pp. 89-94, 2017.

[8] Shikhaliyev Karam Sefi, “Compositions and Products Based on Polyvinyl Chloride,” *Collection of Articles of the X International Scientific and Practical Competition*. Penza. 25.07.2017. Articles 19-25.

[9] Shikhaliyev Karam Sefi , Amirov Fariz Ali, “Research on the Process of Obtaining Coated for Various Purposes Based on Petroleum Bitumen*,” Innovative Development of Science and Education. (Monograph). ICNS, Science and Education, Penza*, pp. 318 , 2017.

[10] Amirov Fariz Ali , Shixaliyev Kerem Sefi, “ Obtaining and Application of Rubber Mixtures Based on Isoprene(SRI-3) and Functional Group Polymers,” *Austrian Journal of Technical and Natural Sciences* , no.3-4 , pp. 27-31, 2017.

[11] Shixaliyev Kerem Sefi, “Exploited Thermoplastics-Based Compositions,” *European Science Review.Scientific Journal,* no. 5-6, pp. 89-96, 2017.

[12] Shixaliyev Kerem Sefi ., Salimova Nigar A, “Thermodynamics and Mutual Distribution of Macromolecules in the Systems-Shrine-Shloro Containing Polimeriseuropean Science Review: Scientific Journal,” no. 3-4, pp. 118-120, 2017.

[13] Bundjali B., Yudistira I., Jariah B, Sukria L , “Study on Properties of Polymer Blends From Polypropylene with Polycaprolactone and Their Biodegradability,” *Polymer Journal,* vol.39, no.12, pp.1337 -1344, 2007.

[14] Rijhikova I.G., Volkov A.M., Et All, "Modification Feature of Binary Mixtures P.P. -SKEP By the System of Organic Peroxidepolyfunctional Vinyl Monomer in the Reaction Extrusion Process," *Plastic Masses*, vol., pp. 40–45, 2013.
[15] Murtazina L.I., Garifullin A.R., Nikultsev I.A., Et All, "Influence of Plastification on the Property of Unhardened Hermetic Based on Ethylene-Propylene-Diene Rubber, " *Engineer-Chemist's Encyclopedia*, vol.8 , pp.31–35, 2014.
[16] Kirsh I.A., Pomogova D.A, "Study of the Properties of Secondary Polymer Materials Based on Polypropylene and Polyethyleneterephtalat, Obtained in the Influence of Ultrasonic Vibrations on the Polymer Melts," Moscow, *Plastic Masses*, vol.1 , pp. 48-51, 2021.
[17] Kurbanova N.I, "Heatelastolasticsare Based on Polypropylene and Tri-Ethylene-Propylene Copolymer," *Azerbaijan Chemistry*, vol.1, pp. 57–59, 2013.
[18] Turaev ER, Beknazarov Kh.S., Akhmedov UK, Jalilov AT, "Interphase Interactions of Three-Phase Polypropylene Composite Materials," *Universum. Technical Sciences*, vol.12, pp. 57-61, 2018.
[19] Shatin D.A., Wolfson S.I., Makarov T.V, "Influence of Modification of Triple Ethylene-Propylene Rubber on the Physicomechanical Properties of Rubbers," *Gazette of Kazan Technological Journal University*, vol. 4, pp. 5-7, 2010.
[20] Ryzhikova I.G., Volkov A.M., Bauman N.A., Kazakov Yu.M., Wolfson S.I, " Influence of the Concentration of Components of the Modifying System Peroxide TMPTA and the Mooney Viscosity of Rubber SKEPT on the Balance of Yield and Impact Resistance SKEPT Master-Batches in a Polypropylene Matrix," *Bulletin of the Technological University,* vol.4 , pp. 148-150, 2015.
[21] Ryzhikova I.G., Volkov A.M., Bauman N.A., Kazakov Yu.M., Wolfson C. B, vol. 4, pp. 134-13, 2015.
[22] Nueva E.K, "Production and Scope of Ethylene-Propylene Rubbers SKEPT," *Bulletin of Kazan Technological University*, pp. 129-131, 2012.
[23] "Prospects for the Development of Production of Ethylene-Propylene Rubber Production and Use of Elastomers," vol.1, pp. 53-54, 1998.
[24] Amirov Fariz. Shixaliyev Kerem, " Properties of Linear Low-Density Polyethylene," *International Journal of Innovative Technology and Exploring Engineering (IJITEE),*vol. 9, no.9, pp. 348-352, 2020.
[25] Alizade Aydan , "Skin-40 Rubber with the Participation of Simple and Complex Eternals Purchase of Chemically Resistant Rubbers," *International Journal of Engineering Technology Research & Management*, vol.6, no.1, pp. 54-63, 2022.
[26] Ryzhikova, IG, Volkov, A.M., Bauman, NA, Kazakov, Yu.M., Wolfson, SI, "Influence of the Concentration of Ponents of the Peroxide TUMP System Modifier and Mooney Viscosity of the SKEDT Rubber on the Yield Balance and Impact Resistance of Masterbatches of EPDM in A Polypropylene Matrix," *Bulletin of the Technological University*, no.4, pp.148-150, 2015.
[27] Shatin D.A., Wolfson S.I., Makarov TV.V, "the Effect of the Modification of Ethylene-Propylene Triple Rubber on the Physicomechanical Properties of Rubber," *Newspaper Kazan Technologitsal*, no.4, pp.5- 7, 2010.
[28] Sitnikova D.V., Bukanov A.M., Kovaleva A.N, "Influence of Technological Additions on the Properties of Rubbers Based on A Mortar and Emulsion Styrene-Butadiene Kauchkov in Blends with Highly Dispersed Silicic Acid Filler," *Kaushik I Retina*, no. 2, pp. 14, 2013.
[29] Turaev ER, Beknazarov Kh.S., Akhmedov UK, Dzhalilov AT, " Interphase Interactions of Three-Phase Polypropylene Composite Materials," *Universum.Technical Sciences* , no.12, pp.57, 2018.
[30] Ermilova EA, Sizova AA, Ilyicheva NN, Pleshakov DV, "Investigation of the Thermodynamic Compatibility of a Threecomponent Mixture of Nitramines with a Copolymer of Methyl Methacrylate and Methacrylic Acid, "*Advances in Chemistry and Chemical Technology*, vol. 2 ,pp. 65-67, 2014.