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Research Article

MODIFICATION OF ROAD BITUMENS POLYMER AND STRUCTURE FORMING ADDITIVES

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ABSTRACT

In the article, to increase the reliability and durability of road and roof coverings in construction, the use of bitumen modified with polymers and structure-forming additives, in order to expand the plasticity range and save materials and energy resources. For increase in reliability and durability of road adding coverings in building it is expedient to use bitumen's modified by polymers roofs and gel-forming additives, for the purpose of expansion of an interval of plasticity and economy.

KEYWORDS

Bitumen, asphalt concrete, cohesion and adhesion, structure-forming additive (SFA), polymer-bitumen binders of road and roofing, elasticity, SBS-styrene-butadiene-styrenes, SP-BOEPW - sulfonic product based on electrode production waste.

INTRODUCTION

In the conditions of Uzbekistan, the study and use of modified bitumen in the construction of asphalt concrete roads and roofing is actual and perspective. This is due to the fact that an increase in the number of cars and freight traffic, an increase in the load on the road surface requires an improvement in the quality and operational properties of roads. Due to the increase in axial loads and high traffic intensity, there

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are problems with the deformation of asphalt concrete pavements of roads, which are built using simple unmodified bitumen.

Perspective of use modified bitumen is also explained by their higher performance characteristics, which have a large operating temperature range. For example, the difference between the brittleness and softening temperatures of the modified bitumen we offer is about 100 0 C, while for ordinary bitumen it is only about 60 0 C [1].

Asphalt concrete and roofing materials, which are prepared using modified bitumen, are characterized by high resistance to deformation due to a higher degree of elasticity of such bitumen. Also, modified bitumen helps to slow down the aging process of asphalt concrete and insulating materials. Expert studies have shown the advantages of asphalt concrete based on polymer-modified ¬bitumens compared to conventional asphalt concrete in terms of: strength, shear resistance, brittleness temperature and crack resistance, stability in the aquatic environment and durability of asphalt polymer concrete coatings [2].

Modification of bitumen can be achieved not only with polymers, but also with the introduction of structure-forming additives and surfactants into them, which improve the quality of bitumen.

We have developed a rational innovative technology for producing viscous road, roofing and construction bitumen from oil tars and low-viscosity bitumen without the traditional energy-intensive oxidation process[3]. The essence of the method lies in the use of a structure-forming additive to tar or initial bitumen, which helps to reduce the binder preparation temperature by 100–150° C and reduce the duration of the technological process by 10–30 hours, depending on the nature of the raw material[4].

II. Methods of research. The technological process of preparing bitumen is carried out in bitumen boilers at a temperature of 140-160 ° C and within 45-60 minutes by mechanical mixing of the structure-forming additive with oil tar or low-viscosity bitumen. At the same time, the amount of additive required to obtain viscous bitumen that meets the requirements of GOST s is regulated depending on the nature of the oil feedstock[5].

Bitumen grade BND 200/300 from the Kirishi Oil Refinery factory, obtained on the basis of West Siberian oils, and an anionic surfactant structure-forming additive “СП-ОЭП-sulfonic product based on electrode production waste” based on industrial waste, which is salts of aromatic sulfonic acids, were used as raw materials for the production of road viscous bitumen using non-oxidizing technology. In this case, a promising type of polymer " СБС КРАТОН Д1101 styrene-butadiene-styrenes " was used as a polymer additive. The production of this polymer is currently established and the volume is increasing every year, which creates conditions for increasing the production of asphalt concrete and roofing materials based on polymer bitumen binders[6].

RESULTS

Tests of the modified bitumen were carried out in accordance with the requirements of GOSTR 52056-2003 "In polymer-bitumen road binders based on block copolymers of the styrene-butadiene-styrene type", also GOST 22245-90 "Viscous petroleum road bitumens. Specifications"[7].

With the introduction of the “СП-ОЭП” surfactant structure-forming additive into the BND 200/300 bitumen in the amount of 2% (Figure1), we obtained a

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viscous bitumen of the BND 60/90 grade that meets the requirements of GOST 22245-90 "Viscous petroleum road bitumens.

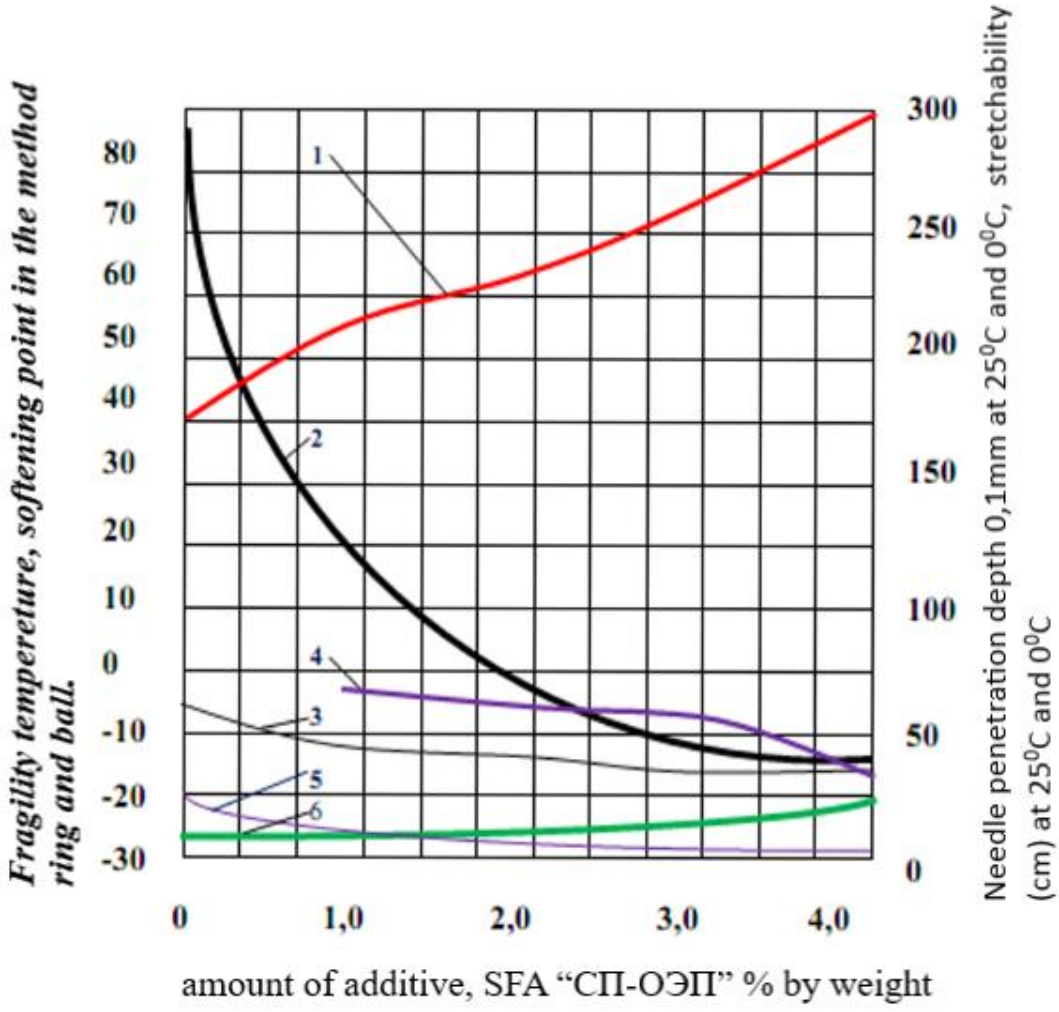

Figure 1. Changes in the physical and chemical properties of bitumen200/300, depending on the amount of the (SFA) "СП-ОЭП". 1-Softening point in the method ring and ball (0° C). 2-needle penetration depth at 25° C(0.1mm). 3-needle penetration depth at 0° C(0.1mm). 4-stretchability at 25° C (cm). 5-stretchability at (cm). 6-fragility temperature (0° C).

The results of experimental studies have shown that an increase in this additive to 3 and 4% leads to a significant increase in the softening temperature of bitumen and, at the same time, penetration decreases, and the brittleness temperature slightly increases.

Chemical analysis of the composition of the resulting bitumen showed a slight change in the amount of oil. But due to the association of additives with resins, a product is formed that is analytically defined as asphaltenes. It can be assumed that the interaction of the structure-forming additive with

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bitumen results in a restructuring of its structure, which is accompanied by a sharp change in the physicochemical properties of the resulting binders [8].

It has been established that bitumens with a softening point BND 60/90, obtained by oxidation and BND 200/300 prepared with the addition of the structure-forming surfactant "СП-ОЭП" 2% by weight, differ in penetration by 11x0.1 mm at 25 0 C and 12x0.1 mm at 0 0 C, by brittleness temperature by 20 C and by softening point by 70 C. The worse indicators of the properties of oxidized bitumen are explained by the lower content of plasticizing components in it – oils and the high content of asphaltenes and resins, which was confirmed by our earlier studies of the effect of the structure-forming surfactant "СП-ОЭП" on roofing bitumens [9]. A significant decrease in the penetration depth of the needle, especially at a temperature of 25 0 C, an increase in the softening temperature is facilitated by the addition of the "СП-ОЭП" surfactant, starting from 1% by weight of the bitumen, the brittleness temperature also slightly increases and the extensibility decreases. The temperature viscosity curve shows an increase in heat resistance and a shift in the plasticity interval towards higher temperatures [10].

The softening temperature rises much more intensively than the brittleness temperature, which has a positive effect on the plasticity interval, which, together with the penetration index, increases with an increase in the content of the "СП-ОЭП" surfactant additive. This phenomenon is apparently associated with the formation of additional supramolecular structures, analytically defined as asphaltenes, the structure-forming components of bitumen, which contribute to an increase in cohesive strength [11].

When using "СП-ОЭП" surfactant, one should choose the grade of bitumen in such a way that its main properties with the additive meet the requirements of GOST 22245-90 for road bitumen, taking into account climatic conditions [12]. Therefore, further studies were carried out using the "СП-ОЭП" surfactant additive to low-viscosity bitumen and oil tars, which makes it possible to convert liquid and low-viscosity bitumen into viscous, oil tars into low-viscosity bitumen without energy-intensive and long-term oxidation processes.16 tons of road bitumen grade BND 200/300 from oil tar with a viscosity of C 560 =312 sec. An experimental industrial batch of hot fine-grained asphalt concrete grade type "B" 300 tons was produced [13]. The proposed technology for producing BND 200/300 bitumen from oil tar and BND60/90 from BND 200/300 by the non-oxidizing method provides the material with good quality with a significant reduction in the duration of the technological process, saving energy and labor costs while excluding air supply [14].

The effect of the amount of polymer introduced into bitumen on its physical and chemical properties is shown in Figure 2.

From which it can be seen that the properties of the polymer-bitumen binder (PBB) comply with the requirements of GOSTR 52056-2003 in all respects when using the "СБС КРАТОН Д1101" polymer within concentrations of 6-8 % by weight. Only at these concentrations does the continuous phase of the polymer in the polymer-bitumen binder have an optimal degree of swelling in order to provide the required heat resistance of the composition.

At lower polymer concentrations, the compositions have a lower softening point and viscosity than is required for PBB 90 and PBB 60[15].

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An increase in the viscosity of the softening point in ¬the temperature range of 50-57°C can be achieved by oxidizing the original bitumen or the non-oxidizing technology proposed by us using the structure-forming additive surfactant "СП-ОЭП" within the limits not exceeding 1.0-2.0% of the mass (Figure.1).

The most scientific and practical interest is the complex application of polymers and structure-forming additives.

The results of the complex use of the polymer "СБС КРАТОН Д1101" and the structure-forming additive surfactant "СП-ОЭП" are shown in Figure 3.

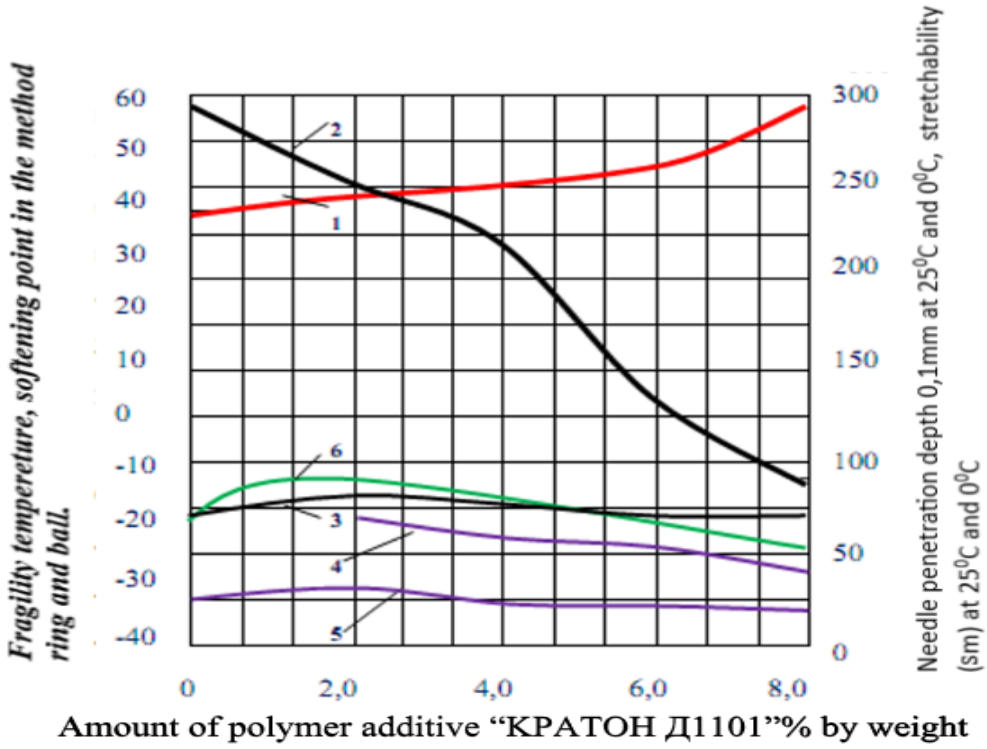

Figure 2. Changes in the physical and chemical properties of modification bitumen200/300, with polymer additive "КРАТОН Д 1101". 1-Softening point in the method ring and ball (0° C). 2-needle penetration depth at 25° C(0.1mm). 3-needle penetration depth at 0° C(0.1mm). 4-stretchability at 25° C (cm). 5-stretchability at (cm). 6-fragility temperature (0° C).

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surfactant "СП-ОЭП" are shown in Figure 3. The test results show that BND 60/90 and PBB 90 bitumen can be obtained by combining BND 200/300 bitumen with 2% of the polymer mass "СБС КРАТОН Д1101" and 1.0% of the mass from the structure-forming additive surfactant "СП-ОЭП". Thus, the use of the structure-forming additive "СП-ОЭП" makes it possible to reduce the consumption of polymers by 50-60% to obtain high-quality road viscous polymer-bitumen binders.

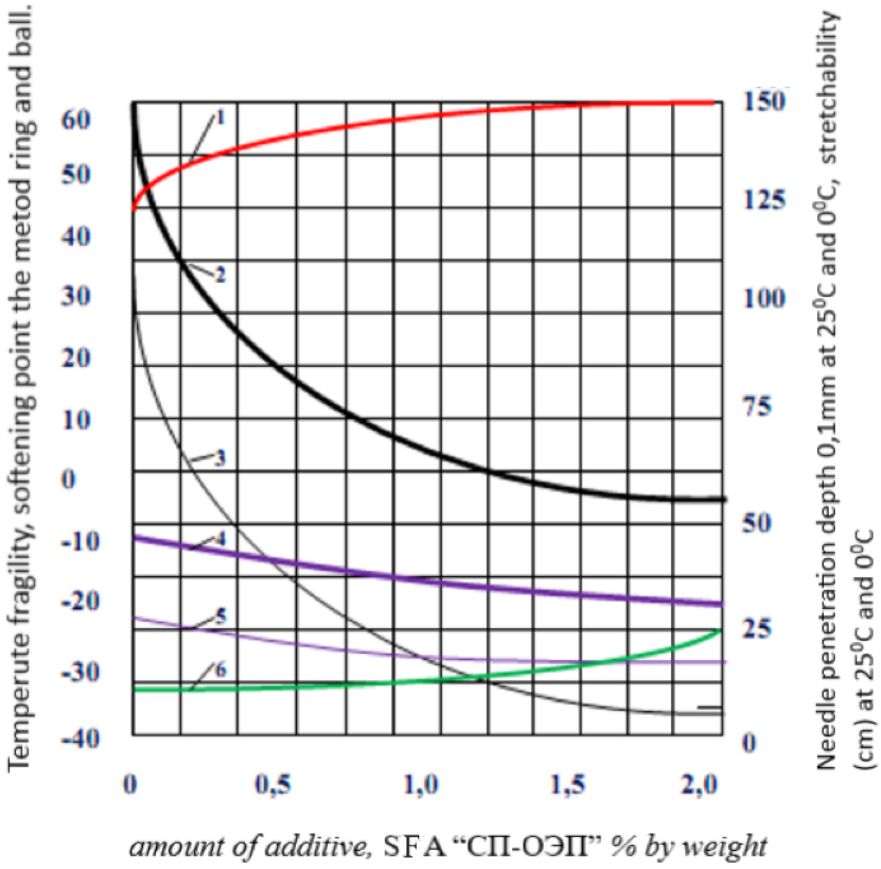

Figure3. Changes in the physical and chemical properties of modification bitumen200/300, with 2% polymer additive "КРАТОН Д 1101" and also, with additive (SFA) "СП-ОЭП. 1-Softening point in the method ring and ball (0° C). 2-needle penetration depth at 25° C(0.1mm). 3-needle penetration depth at 0° C(0.1mm). 4-stretchability at 25° C (cm). 5-stretchability at (cm). 6-fragility temperature (0° C).

CONCLUSION

Analyzing the test results, we can say that road bitumen obtained using the "СБС КРАТОН Д1101" polymer and the "СП-ОЭП" surfactant structure-forming additive from ternary compositions have a wider range of plasticity ¬, mainly due to an increase in viscosity, softening temperature and lower brittleness temperature.

All of the above allows us to recommend triple compositions as a basis for obtaining viscous heat-

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resistant road bitumen, which will retain its properties both during the preparation of the asphalt concrete mixture and during its further service in the road surface in the dry hot climate of Uzbekistan.

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