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# Modified Oil Bitumens Obtaining

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**ABSTRACT**: The article presents the results of studies on the production of sulfur-containing bitumen. The possibility of increasing the resources of bitumen due to the involvement in the composition of oil bitumen as a modifier of elemental sulfur, as well as improving penetration, fragility temperature, structure coefficient of bitumen is shown.

**KEY WORDS**: Oil bitumen, sulfur, needle penetration, fragility temperature, softening point.

## I.INTRODUCTION

Oil bitumen is widely used in industrial and road construction. However, traditional technological methods for the production of bitumen do not always allow obtaining materials with quality that meets modern requirements. World practice of road construction shows that the low operational characteristics of materials used in road construction can lead to a relatively low turnaround period for the operation of asphalt roads [1]. Therefore, improving the quality of oil bitumen - increasing their durability, fracture toughness, tensile properties are urgent tasks.

One of the effective methods for improving the properties of petroleum bitumen is the modification method, which opens up new opportunities in the production of high-quality petroleum bitumen. The modification allows obtaining petroleum bitumen with the specified physicochemical properties, allowing the production of road surfaces which have increased durability, resistant to crack formation and low temperature effects. In the conditions of the republic, where bitumen obtained by the technology of liquid-phase oxidation of heavy oil residues is mainly used, the direction of obtaining modified bitumen is of undoubted interest.

One of the promising modifiers of road bitumen is technical sulfur, which is an inexpensive and high-tonnage by-product of the oil and gas refining industry. There is sufficient world experience in the use of sulfur in road construction, indicating a higher physicomechanical and rheological properties of sulfur-bitumen binders and mixtures based on them compared to conventional bitumen and asphalt concrete [2, 3].

Uzbekistan is a major producer of sulfur, which is obtained as a result of the purification of natural gas and oil products. Based on abovementioned, the task was set to study the possibility of obtaining sulfur-bitumen binders based on local raw materials.

## II. METHODOLOGY

As the objects of study, BND 40/60 oil road bitumen (Table 1) and granular sulfur of the Ferghana Refinery's diesel fuel hydrodesulfurization unit with a purity of 99.9% were selected.

In accordance with the selected method, sulfur-bitumen binders were obtained in a laboratory reactor equipped with a mixing device and electric heating. The preparation of sulfur-containing bitumen was carried out by stirring at a temperature of 135-140°C and a speed of rotation of the propeller stirrer 500 rpm, the duration of mixing was 30 minutes. The amount of sulfur in bitumen varied from 1 to 20% wt. After heat treatment of the mixtures, they were kept for 24 hours and the properties of the modified bitumen were determined.

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**Table 1**

**Basic physical and mechanical properties of oil road bitumen BND 40/60**

| № | Properties | Values |
|---|---|---|
| 1. | Needle penetration depth, 0.1mm:<br>at 25°C<br>at 0°C | <br>57<br>17 |
| 2. | <br>Elongation, cm:<br>at 25°C<br>at 0°C | <br>100<br>5,2 |
| 3. | Softening point, °C | 54 |
| 4. | Fragility temperature, °C | -17 |
| 5. | Ductility interval | 71 |
| 6. | Structure coefficient | 0,71 |
| 7. | Penetration index | - 0,2 |

The properties of the studied samples of sulfur-containing bitumen were determined by the methods adopted for testing viscous road bitumen. The main physical and mechanical properties of sulfur-containing bitumen are given in table 2.

**Table 2.**

**Basic physical and mechanical properties of sulfur-containing bitumen**

| Properties | The sulfur content in bitumen, wt. % | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 5 | 10 | 15 | 20 |
| Needle penetration depth, 0.1mm: at 25°C<br>at 0°C | 58<br>19 | 60<br>20 | 62<br>22 | 58<br>20 | 56<br>19 | 55<br>16 |
| Elongation, cm: at 25°C<br>at 0°C | 103<br>5,9 | 105<br>6,5 | 97<br>5,7 | 74<br>5,5 | 69<br>5,2 | 65<br>4,5 |
| Softening point, °C | 55 | 54 | 52 | 52 | 53 | 52 |
| Fragility temperature, °C | -19 | -21 | -20 | -19 | -17 | -16 |
| Ductility interval | 74 | 75 | 72 | 71 | 70 | 68 |
| Structure coefficient | 0,72 | 0,71 | 0,74 | 0,96 | 1,01 | 1,05 |
| Penetration index | -0,3 | -0,6 | -0,7 | -0,17 | 0,38 | 0,34 |
| Weight loss after warming | 2 | 2 | 2 | 3 | 3 | 3 |

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## III. EXPERIMENTAL RESULTS

As the table, the addition of sulfur leads to a change in the basic physical and mechanical properties of petroleum bitumen, which indicates a change in the structure of bitumen.

The nature of the change in the penetration rate of oil bitumen from the sulfur content is extreme. Within a concentration range of up to 5%, sulfur favorably improves penetration. Its value increases from 57 to 60 units. The increase in penetration values is apparently explained by the ability of sulfur at certain concentrations to plasticize the structure of bitumen, and the decrease in penetration values indicates its ability to structure the system. This is apparently due to the influence of the processes of interaction of sulfur with bitumen. Also, in this case, the softening temperature slightly decreases, the extensibility decreases at temperatures of 25°C and 0°C, the structural characteristic of bitumen - the structure coefficient increases.

The above-noted tendency to change the characteristics of sulfur-bitumen is due to a change in the structure of bitumen due to the interaction of sulfur with the components of bitumen

When bitumen interacts with sulfur, two main chemical reactions occur. The first reaction proceeds at a temperature below 140°C, at which the interaction of open sulfur chains (formed as a result of breaking ring bonds) with hydrocarbons occurs in the direction of creating sulfur-carbon bonds, i.e. polar aromatic bonds, with the formation of chemical bond bridges:

\ /
HC-S-CH
/ \

In this case, the probable structure of the organosulfur compound is polysulfide, which at higher temperatures transform into cyclic sulfides with a thiophene type structure including intermolecular cross-links. The processes of formation of carbon disulfide bonds (chemical interaction of sulfur and bitumen) are based on the interaction of a split sulfur ring or its fragments and unsaturated hydrocarbon components of resins, as well as alkenes present in small amounts in heavy aromatic hydrocarbons of oil components.

Due to the fact that the main structural elements of resins are systems consisting of aromatic, naphthenic and heterocyclic rings interconnected by short aliphatic bridges and containing one or several aliphatic substituents in the ring (in this case, aliphatic compounds are represented by both saturated and unsaturated linear hydrocarbon compounds), they are the most likely products of interaction with sulfur.

Another reaction proceeds at a temperature above 140 ° C, at which dehydrogenation of the components of the organic binder occurs, a sign of which is the release of hydrogen sulfide, which is formed due to the combination of sulfur dioxide with hydrogen. Dehydrogenated chains undergo cyclization, resulting in an increase in the number of structure-forming complexes such as asphaltenes and other high molecular weight compounds. At this stage, “crosslinking” of organic fragments with sulfur occurs. These temperature limits are arbitrary, since in reality both reactions proceed simultaneously.

The formation of organosulfur compounds as a result of chemical interaction contributes to an increase in viscosity and important physical and mechanical properties and is an important aspect in improving the quality of road petroleum bitumen used in regions with a prevalence of high positive temperatures.

A further increase in sulfur content reduces this indicator to a value less than for the original bitumen. This circumstance, apparently, is due to the fact that the addition of large amounts of sulfur (more than 5%) leads to the formation of sulfur crystals in a solution of bitumen, which adversely affects the main indicators of the quality of bitumen.

## IV.CONCLUSION AND FUTURE WORK

Thus, when using sulfur-bitumen compositions with an optimum sulfur content, such important indicators of bitumen quality as penetration, brittleness temperature, and structure coefficient are improved. This makes it possible to increase the production of bitumen by involving up to 3-5% of elemental sulfur in the composition of oil bitumen as a modifier of elemental sulfur, as well as the production of sulfur-containing oil road bitumen with improved physical

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and mechanical properties. In addition, the use of sulfur as an additive to road bitumen is one of the qualified options for the disposal of technical sulfur from refineries.

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