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PARTICULARITIES OF BITUMEN MODIFICATION BY OXIDATION OF PARAFFIN TARS

Ukraine possesses relatively small oil reserves, making it crucial to explore ways of maximizing its utilization. The production of petroleum bitumen with predetermined properties is of significant importance. The quality of oxidized bitumen heavily relies on the quality of tars used in its production.

Tar, a mixture of various high-molecular organic substances such as oils, resins, and asphaltenes, forms the basis of bitumen [1]. Different types of bitumen are characterized by quality indicators that depend on the composition of these components and the structure of molecules within the group. Therefore, not every bitumen can be obtained from any tar. Industrial tars, obtained during oil distillation, do not meet the requirements of specific bitumen grades due to their excessive oil component. Oxidation with air oxygen is one method employed to produce marketable bitumen. However, changes in the chemical composition of tar impact the quality characteristics of the resulting bitumen.

An increase in the content of heavy aromatic hydrocarbons and asphaltenes in the starting bitumen leads to a corresponding increase in the oxidized bitumen. Consequently, these results in a higher softening temperature, decreased ductility, and impaired plasticity and low-temperature properties [1, 2].

The production of oxidized road bitumen from residual paraffinic oils is a complex process. Paraffins present in the heavy residues of paraffinic oil distillation are practically non-oxidizable, hindering the production of oxidized bitumen that meets technical requirements. When the paraffin content exceeds 3%, bitumens become brittle. Solid paraffins lack plastic and adhesive properties, negatively affecting the elasticity of bitumen and reducing its temperature range of plasticity, strength, and adhesion to mineral materials. Attempts have been made to develop technologies to mitigate the negative impact of excess paraffinic hydrocarbons on bitumen quality. Consequently, high-paraffin and low-resin oils are deemed unsuitable for bitumen production [3-4].

Several known technologies focus on reducing the content of paraffin-naphthenic hydrocarbons in tar and increasing the content of aromatic hydrocarbons and resins. One such technology involves increasing the depth of selection of distillate fractions during residual bitumen production, resulting in slight improvement in properties due to simultaneous reduction of paraffinic-naphthenic and aromatic hydrocarbon content. Consequently, a lower content of paraffinic-naphthenic hydrocarbons in the raw material enhances bitumen's ductility and brittleness temperature [5-6]. Another method involves paraffin modification, wherein paraffins in highly paraffinic oil residues (boiling point > 450°C) are partially destroyed, driven off, or isomerized into more reactive compounds using potassium persulfate, manganese acetate, or ozone.

However, traditional oxidation methods used to produce petroleum bitumen do not comply with existing standards, necessitating the improvement of bitumen properties. One approach to address this issue is obtaining bitumen through the oxidation of compound raw materials, allowing deliberate manipulation of performance characteristics. In this study, the method involved mixing paraffin tar with residue from the distillation of Orkhovitsk oil, followed by oxidation. The Orkhovitsk oil residue was introduced into the raw material at mass proportions of 10%, 30% and 50%.

Comparing the results presented in Table 1, it is evident that adding residue from the distillation of Orkhovitsk oil to paraffin tar yields bitumen with improved quality indicators. Specifically, elasticity increases from 35 (at 25°C) to 37 (at 25°C), while bitumen penetration decreases from 260x0.1 mm (at 25°C) to 165x0.1 mm (at 25°C). Thus, by altering the oxidation conditions of paraffin tar, petroleum bitumens with diverse properties can be obtained.

Table 1 – Properties of oxidized petroleum bitumen obtained on the basis of a mixture of paraffinic tar and residue from the distillation of Orkhovitsk oil

Parameter	The content of the residue from the distillation of Orkhovitsk oil , % мас.			
	0	10	30	50
Softening point,(ring-and-ball method), ºC	35	35	36	37
Ductility at 25 ºC, cm	40	50	63	87
Penetration at 25 ºC, 0.1	260	230	195	165
Penetration index	-1,3	-1,9	-2,1	-2,2
Brittleness temperature, ºC	-44	-45	-45	-45

Notes: raw material – tar-0 (without modifier); process conditions: temperature – 250ºC; volumetric air supply rate – 2.5 min^{-1}, duration of oxidation – 3 h.

The influence of technological factors (temperature, duration of oxidation and air consumption) on the operational properties of oxidized petroleum bitumens was studied.

It has been established that bitumen with improved operational properties obtained from the residue of paraffinic oils can be used by adding to the raw materials the residue from the distillation of Orkhovitsk oil.

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