Modified Oil Bitumen

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Abstract. The article describes the modification of petroleum bitumen with elastomers of different chemical nature and molecular weight. The effectiveness and expediency of such a modification is shown. The objects of research in the work were the following brands of oil bitumen: BN-70/30 and BND-90/130. The following modifiers were used: butyl rubber (BK-1675), liquid thiocol a condensation product of aliphatic dihalo derivatives with sodium polysulfide, rubber crumb. Shown undoubted efficiency and the prospect of improving the technological and operational properties of bitumen systems by modifying the latter with selected polymers. In addition, this modification is economically feasible due to the low cost of the selected modifiers and their presence in the range of enterprises of the domestic chemical industry.

Key words: bitumen, modification, elastomers, binder, devulcanizate.

1. Introduction

Oil bitumen, thanks to a valuable set of technical properties, have long been widely used as a plastic binder in building materials. As natural asphalt, bitumen has been exploited since antiquity as a source of road paving, caulk, and mortar and is still used for these purposes in some parts of the world [1]. The large scale of industrial production of bitumen and the relatively low cost make them indispensable for the construction of highways, the production of soft roofs, the manufacture of waterproofing mastics, etc. The global production of bitumen is estimated at hundreds of millions of tons. However, the quality of many bituminous materials does not meet the modern requirements of the construction industry. The indicators of temperature stability are low and have low working capacity under alternating deformation conditions [2]. And there is a real technological problem of introducing modifying additives to overcome the forces of surface tension and the distribution of quantitatively small and relatively light additives in comparison to the base material [3]. These disadvantages lead to a decrease in the durability of materials in which bitumen serve as a binder and impregnating component.

The steadily growing demands on the quality and performance of materials based on bitumen cannot be satisfied only by choosing raw materials and improving bitumen production technology. In this case, resort to their modification. The most common techniques are the modification of fillers, surfactants, and polymeric additives.

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The objects of research in the work were the following brands of oil bitumen: BN-70/30 and BND-90/130. The following modifiers were used: butyl rubber (BK-1675), liquid thiocol - a condensation product of aliphatic dihalo derivatives with sodium polysulfide, rubber crumb (TU 38-10436).

We used standard methods for assessing the properties of bitumen compositions.

It is known that high-molecular industrial rubbers such as butyl rubber (BC) are poorly compatible with bitumen. One of the ways to increase their compatibility is to reduce the molecular weight, which in this work was achieved with the help of radiation destruction of BC. The absorbed dose of γ-irradiation of rubber samples was 125 Mrad. The modifying effect of the use of BC is manifested in the improvement of the performance characteristics of the compositions (Table 1). So, at 5% concentration of BD destructive agent, softening temperature (Tp) of bitumen increases from 690°C to 91 0°C, frost resistance from -80°C to -280°C, water absorption index decreases by more than 2 times.

The technological difficulties of combining bitumen with rubber (the need for destruction of the latter) caused the need to turn to liquid oligomeric rubbers, which are usually reactive [4]. The use of the latter allows to simplify the technology of modifying bitumen with elastomers. At the same time, it is necessary to consider that the curing of oligomers is carried out in a bitumen environment, which affects the speed of curing and the formation of polymeric structures. Therefore, the modification of bitumen BN-70/30 with thiokols (liquid polysulfide rubbers) was investigated. The dissolution of thiokol in bitumen occurs quickly, and the viscosity of the composition after cooling is lower than that of the original bitumen. The positive effect of this modification is obvious (Table 1).

Another modifier was a rubber destructive agent [5]. According to statistics, the mechanical loss of rubber in the operation of automobile tires constitute 10% of their initial mass. At the same time, rubber as a structural material, undergoes slight structural changes by the time the products are out of service, which is facilitated by the presence of an inhibitor that inhibits the development of the oxidation process, which underlies the aging of rubber. Consequently, worn tires are a source of valuable polymeric materials. Along with this, they are a source of long-term and persistent environmental pollution, due to the high resistance to natural factors. Thus, recycling used tires is of great economic and environmental importance. The most profitable of the implemented directions for the processing of used tires is to obtain a regenerate. To use regenerates as modifying additives in bitumen is a very tempting way to recycle tires, since huge amounts of bitumen in construction can "absorb" all this waste.

A modification of the road bitumen of the BND-90/130 brand with a vulcanised rubber crumb was carried out, the test results of which are presented in Table 1.

Table 1. The test results of bitumen-polymer compositions

| Composition          | Softening temperature, °C | Penetration, x0,1 мм | Ductility at 25°C, cm | Flexibility on a bar Ø50мм, 0°C | Water absorption after 42 days, % |
|----------------------|---------------------------|----------------------|-----------------------|---------------------------------|----------------------------------|
| BN-70/30             | 69                        | 13                   | 12                    | 3                              | -8                               | 0,67                             |
| BN-70/30 + BK 125MRad| 91                        | 6,0                  | 5,0                   | 1,1                            | -22                              | 0,32                             |
| BN-70/30 + 5% Thiocol| 94                        | 2,5                  | 1,5                   | 3,8                            | -28                              | 0,3                              |
| BND-90/130           | 42                        | 126                  | 25                    | 7                              | -10                              | 0,823                            |
| BND-90/130 +5% destructive rubber crumbs | 68 | 45 | 20 | 140 | -38,5 | 0,007 |
Thus, it has been established that to achieve the required physical and mechanical parameters, it is advisable to introduce rubber destructive agents up to 5% into bitumen. The higher content of this elastomer in bitumen does not give a significant effect.

With unlimited compatibility of thiokol with bitumen, showing a plasticizer function for the period of mixing, its vulcanization in a bitumen matrix leads to an increase in viscosity and an increase in all the basic operational and technical indicators of the resulting composition, which should be recommended as a roofing material.

The use of rubber crumb devulcanizate to modify the bitumen binder also showed the promise of its use in the form of improving the technical performance of the compositions.

Shown undoubted efficiency and the prospect of improving the technological and operational properties of bitumen systems by modifying the latter with selected polymers. In addition, this modification is economically feasible due to the low cost of the selected modifiers and their presence in the range of enterprises of the domestic chemical industry.

On average, additives of polymers allow to improve the main indicators of bitumen 1.4-1.8 times. The use of polymers as modifiers of road bitumen will significantly improve the quality of road asphalt concrete in coatings, increase their shear stability, water resistance, frost and crack resistance. Polymer modifiers can increase the service life of road and waterproofing coatings by a factor of 5–10, bringing the turnaround time between 15–25 years instead of 2–5 years for coatings of traditional bituminous materials. Thereby, material, labor and energy resources are significantly saved, material consumption of coatings decreases.

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