

ANNOTATION

of the dissertation for the degree of Doctor of Philosophy (PhD)
on the specialty 6D072100 - Chemical technology of organic substances
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“Development of obtaining technology of organic binders for the creation of pavements using plastic waste ”

The actuality of the work. The road development program of Kazakhstan provides a significant increase in the consumption of road bitumen with a simultaneous increase in their quality indicators.

Petroleum bitumen is the most common in road construction. The properties of bitumen depend on the properties of oil and the way they are produced. The best raw materials for road bitumen are high resin low paraffin oils containing a large amount of asphalt resin (more than 20%). It is known that the Republic of Kazakhstan has its own significant reserves of high sulfur, low paraffin, high quality road bitumen, suitable for the production. The yield of residues - raw materials for the production of road bitumen - exceeds 60%. The issue of providing Kazakhstan's road-building companies with their own high-quality road bitumen is highly relevant.

Bitumen is one of the main components of asphalt concrete mixtures, which significantly affects the quality of the road surface, and hence the duration of its maintenance-free operation. Due to the peculiarities of the physical and mechanical behavior of bitumen, as well as the relative cheapness and large volume of production, petroleum bitumen has been used for over a hundred years as the main binding material for the production of asphalt concrete. However, the ever-increasing loads on the roads require an ever-higher quality of the materials used and, last but not least, binder materials. It is possible to significantly improve the performance characteristics of the binder by combining bitumen with high-molecular compounds to obtain the so-called polymer-bitumen binders. Organic binder material is the main structure-forming component of asphalt concrete, largely predetermining its properties. Due to the organic binder material, individual mineral grains form a solid monolith, able to withstand mechanical forces and the effects of atmospheric factors.

The combination of bitumen and polymer increases its heat and frost resistance, improves adhesion properties. Analysis of the literary material revealed a high interest of researchers in the problem of obtaining new, valuable in practical terms polymer-bituminous composites. In accordance with the State Program for the Development of the Road Sector, the needs of Kazakhstan in road bitumen only for roads of republican significance will be about 350 thousand tons. In the future, the road construction of the republic as a whole plans to consume up to 700 thousand tons of bitumen annually. Then these needs will further increase.

The main supplier of bitumen to Kazakhstan is Russia, from where more than 300 thousand tons of road bitumen are imported annually. Kazakhstani own annual bitumen production does not exceed 350 thousand tons/year. It should also be taken into account that the quality of bitumen imported from outside does not always meet the requirements of the modern road construction of the republic, which is characterized by the diversity of five road-climatic zones. All this indicates the need to create a new modern large-tonnage bitumen production in the Republic of Kazakhstan, which will be directly related to the consumer, satisfying his ever-increasing needs not only in quantity, but also in the regulated quality of a valuable product. Therefore, the development of rational technologies for the processing of petroleum bitumen into high-quality road bitumen is an urgent task.

Linksto research and government programmes: The work was carried out within the framework of the basic research program: B-16-02-03 “Study of the composition and properties of oil from promising fields of the Republic of Kazakhstan, development of the optimal technology for their processing” (2015-2020) and on the budget program “Grant financing” of the Ministry of Education and Science of the Republic of Kazakhstan on topics: “Development of adhesive additives and polyfunctional modifiers to create polymer bitumen binder and asphalt concrete of the new generation” and “Development of technologies for producing new efficient materials for the oil and gas industry from oil and fat waste industry” 2015-2017.

Objects of study: road bitumen, polymer waste, plasticizers, vermiculite, organic binders.

The paper uses IR Fourier spectroscopy, methods for studying the physical and mechanical properties of bitumen and organic binders, etc. Methods for obtaining modified bitumen, and methods for preparing raw materials for bitumen production were selected and worked out based on theoretical and practical results approved in production and by modern scientists at the present stage of technology development for obtaining bitumen materials.

Subject of study.Development of polymer-bitumen organic binders by modifying domestic bitumen with polymer wastes.

The aim and objectives of the study.The aim of the work is to develop a technology for the production of polymer-bitumen organic binders for the creation of pavements using polymer waste.

To achieve this goal the following tasks were set:

- to consider the problems of creating road organic binders by modifying bitumen with polymeric materials.
- to study the state of bitumen production in the Republic of Kazakhstan and abroad;

- to analyze the basic principles of the raw materials selection for the production of modified polymer-bitumen organic binders with improved performance properties.

- to systematize the modern view of the petroleum bitumen structure;

- to investigate the relationship between the structure-properties of modifying organic binders and the regulation of the physical and mechanical properties of bitumen when modifying with polymer waste and expanded vermiculite;

- to develop technology for the production of organic binders to create pavements using polymer waste.

The scientific novelty of the research lies in the fact that

- the general laws of the structure formation process of organic binder on the basis of oil road bitumen and polymer modifier were established.

- it was proved that directional regulation of the properties of the binder is possible by introducing additives, which allows one to control the structure formation process and the formation of the required properties of organic binders;

- the mechanism of the physical and chemical interaction of the proposed modifying additives in the composition of the polymer-bitumen composition was established;

- the effectiveness of modifying additives: polymeric waste to regulate the operational and economic performance of the resulting organic binder was proved.

The main provisions for the defense:

- the systematization of organic binders for paving;

- the study of the bitumen production state in the Republic of Kazakhstan and abroad;

- the consideration of the basic principles of raw materials selection for the production of bitumen materials;

- the study of modern ideas about the structure of petroleum bitumen;

- the research of technological methods of bitumen production of road grades of increased durability;

- the study of the relationship between the structure-properties of modifying organic binders and the regulation of the physical and mechanical properties of bitumen by modifying polymer additives;

- the development of innovative road organic binders by modifying bitumen with polymeric wastes.

Theoretical significance

- the analysis of modern scientific and technological achievements of increasing the stability of polymer-bitumen organic binders in the formation of their structure;

- the principles of the effective quality modification of organic binders using industrial wastes were formulated on the basis of the main provisions of the oil dispersed systems theory;
- the development of technology for producing organic binders using polymer waste and vermiculite to create pavements of the required quality.
- the study of the expanded Kulantau vermiculite effect on the properties of polymer-bitumen compositions for road use.

The practical significance of the work:

- the parameters and technology for producing organic binders based on established patterns of formation of the PBB structure were developed;
- the expediency of the use of multi-tonnage waste-low-density polyethylene as an additive in an organic binder was proved, which, in combination with other modifying additives, improves the characteristics of the polymer-bitumen organic binder and reduces the cost of polymer-bitumen binders and environmental stress in the region.
- the optimal amount of exfoliated Kulantau vermiculite in the composition of the bitumen composition was established. An increase in elasticity and improvement of adhesion with vermiculite is shown, which ensures the strength and water resistance of the road surface using the developed organic binders.

At the DUOS BITUM GROUR enterprise, production tests of the obtained modified bitumens with the addition of industrial waste low-density polyethylene and Kulantau vermiculite were performed. It was established that the developed composition of the polymer-bitumen organic binder using polymer waste and vermiculite makes it possible to create pavements of the required quality to reduce the cost of the PBOB and environmental stress in the region.

As a result of the calculations, the main technical and economic indicators for the production of polymer-bitumen binders were determined. With a capacity of 52,800 t / year of PBOB, economic efficiency is 1580.662 thousandtenge per year.

The degree of reliability and approbation of the results.The reliability of the results obtained is ensured by the use of modern tools and research methods and is confirmed by the analysis of scientific and technical literature, previously conducted experimental studies based on the fundamental principles of the oil dispersed systems theory.

Approbation of work.Materials of the thesis were reported and discussed at various international, republican conferences and symposia: International symposium “Environmental and engineering aspects for sustainable living” Germany., Hannover, International conference of industrial technology and engineering (ICITE 2015), international scientific and practical conference “Auezov readings-14”: “Innovative potential of science and education of Kazakhstan in the new global reality”, Shymkent, SKSU, 2016, III International conference “Industrial technologies and engineering”

ICITE-2016, International Scientific and Practical Conference “Auezov Readings-15: Third Modernization of Kazakhstan - new concepts and modern solutions” dedicated to the 120th anniversary of Mukhtar Omarkhanovich Auezov, republican scientific and practical conference “Actual problems of educating young people based on national spiritual culture”, Shymkent. SKSPI, 2017, international scientific-practical conference “Auezov readings - 16: “The fourth industrial revolution: new opportunities for the modernization of Kazakhstan in the field of science, education and culture”, 2018, XIV international scientific-practical conference «Perspektywiczze opracowania sa nauka i technikami-2018», Przemysl, Poland, 2018, II international scientific-practical conference “Butlerov readings”, Krasnodar, 2018.

The personal contribution of the doctoral student consists:

- in the analysis and synthesis of the analytical studies results of scientific and patent literature on the topic of the thesis;
- in the selection of research and test methods;
- in conducting laboratory research and participation in pilot testing of organic binders to create pavements with high performance properties, considering the creation of innovative road organic binders by modifying bitumen with polymer materials, examining the state of bitumen production abroad and in the Republic of Kazakhstan, studying the effect of modifying additives on properties organic binders;
- in the development of processes for optimizing the control parameters of the physical and mechanical properties of polymer-bitumen organic binders using LDPE polymer waste, studying the effect of expanded vermiculite on the properties of polymer-bitumen compositions for road use;
- in conducting pilot trials for producing organic binders using polymeric waste to create pavements of the required quality.

Publication of research results. The main results of the dissertation research were published in 21 printed publications, of which 2 articles in the “Oriental journal of Chemistry” (India) 2017, 1 article in the Scopus journal “News of the Academy of Sciences of the RK”, 2017, 3 publications were published in the editions recommended by the Committee for Control of Education and Science of the Republic of Kazakhstan, 1 article in the journal “Scientific Works of M. Auezov South Kazakhstan State University”, 1 article in the journal “Bulletin of Science of South Kazakhstan”, 1 collective monograph in the publishing house “Internauka”, Moscow, 10 printed publications were published 3 in the collections of international scientific conferences, 2 patents of RK.

The structure and scope of the thesis. The thesis work is presented on the 123 pages of type written text and includes 33 figures and 28 tables. The work consists of introduction, review of literature, description of objects and methods of research, results and their discussion, conclusion and list of references of 160 titles.