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Book of Abstracts contains the materials presented and discussed at the International Symposium, which aimed to provide a platform for scientists and research engineers to present their research and development results in the fields of combustion, self-propagating high-temperature synthesis, oil and condensed systems, energy, materials science, and nanotechnology.
The materials in this book may be useful for researchers, university professors, and PhD and MSc students interested in the study and application of composite, nanocomposite, and advanced functional materials.

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NEW METHODS OF OIL AND NATURAL BITUMENS OBTAINING AND EXTRACTION

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Growing demand for bitumen requires finding and developing new sources of its production. This problem can be solved by using non-traditional sources of hydrocarbon raw materials, the reserves of which in Kazakhstan are significant. Oil sands as a source of bitumen production are attractive due to large reserves, efficient distribution of components and production volumes. In Kazakhstan, there are more than 60 oil sand deposits that are not developed and not used. At depths of up to 120 m, there are 15-20 billion tons of oil sands. The problems of their production and processing are associated with the low content and high viscosity of bitumen and insufficiently developed methods of their extraction.

The introduction of new technologies in the production of bitumen, based on the activation of raw materials due to physical and chemical effects, using an ozone-air mixture, ultrasound exposure, modifiers based on man-made waste, makes it possible to obtain high-quality bitumen from other types of raw materials previously considered unsuitable for the production of bitumen. New methods for obtaining and extracting petroleum and natural bitumen have been developed, which serve as an alternative to traditional bitumen production technology. The implementation of the developed methods eliminates the problem of bitumen deficiency and improves the quality of road surfaces.

A promising direction for improving the production of oxidized bitumen is the activation of bitumen raw material – vacuum residue by increasing the interphase surface and dispersion, which reduces the duration of the oxidation process and reduces air consumption. Acceleration of the vacuum residue oxidation process is solved by using an ozone-air mixture as an oxidizer.

Ultrasonic technologies are used to enhance oil recovery. In the USA, China, Russia, Canada, they are aimed at improving oil recovery with a decrease in water content and removing pollutants from organic impurities. The studies provide for the development of a method for using ultrasound to increase the degree of bitumen extraction.

To obtain polymer and rubber-bitumen binders, finished bitumen is modified with polymers or rubber crumb, but they are not mixed with bitumen to a homogeneous state, since it does not dissolve in the mixture and does not form a continuous network. To effectively combine bitumen with rubber crumb, it is necessary to improve the oxidation process of oil residues. The introduction of modifiers into vacuum residue before oxidation leads to a change in the ratio of the components of the dispersed phase and the environment, which affects the rate of the oxidation process. Therefore, the studies propose modifying not the finished bitumen, but the raw material - vacuum residue. It is also proposed to modify it simultaneously with two modifiers, which enhances their effect.

The optimal conditions for the process of accelerated oxidation of heavy oil residues with an ozone-air mixture have been established: for vacuum residue from the Pavlodar Petrochemical Plant

the optimal conditions are a temperature of 250°C and a time of 4 hours, an oxidizer consumption of 7 l/min per 1 kg of raw material and an ozone content in the mixture with air of 75%; for vacuum residue from "Asphaltbeton 1" LLC - a temperature of 240 and 250°C depending on the grade of bitumen and an oxidation time of 3 hours; for Karazhanbas oil vacuum residue with an ozone-air mixture: a temperature of 260°C and a time of 3 hours, an oxidizer consumption of 10 l/min, and an ozone content in the mixture with air of 50%. The physico-mechanical properties of the products of accelerated oxidation of vacuum residues with an ozone-air mixture and their compliance with the requirements of the standard were determined: the oxidation product of Karazhanbas oil vacuum residue with an ozone-air mixture at 260°C for 3 hours corresponded to the BND 35/50 brand, the oxidation products of vacuum residue from Pavlodar Petrochemical Plant at 250°C for 4 hours with an ozone-air mixture with an ozone content of 90% and a flow rate of 5 l/min, vacuum residue from "Asphaltbeton 1" LLC at 240°C for 3 hours, at 250°C for 2 hours with an ozone-air mixture with an ozone content of 90% and a flow rate of 10 l/min corresponded to the BND 70/100 brand. The composition of bitumens obtained by accelerated oxidation of heavy oil residues with an ozone-air mixture has been determined: the concentration of heavy polycyclic aromatic hydrocarbons decreases and the content of lighter and more stable compounds, such as acenaphthenes and naphthalenes, partially increases.

The optimal conditions for the oxidation process of heavy oil residues - vacuum residues of the Pavlodar Petrochemical Plant and "Asphaltbeton 1" LLC with the addition of polymer waste have been established: the amount of polymer waste is 2-3 wt. %, the temperature is 250-270°C, the oxidation time is 3-4 hours. The optimal conditions for the oxidation process of heavy oil residues with the addition of rubber crumb have been established: for vacuum residue of the Pavlodar Petrochemical Plant, the process temperature is 260 °C, the oxidation time is 3 hours, the amount of added rubber crumb is 10 wt. %; for vacuum residue of "Asphaltbeton 1" LLC, the process temperature is 260 °C, the oxidation time is 3 hours, the amount of added rubber crumb with a particle size of up to 0.6 mm is 15 wt. %. Optimal conditions for the oxidation process of vacuum residues from the Pavlodar Petrochemical Plant and "Asphaltbeton 1" LLC with the simultaneous addition of polymer waste and rubber crumb have been established: the amount of polymer waste and rubber crumb is 1.5 wt. % each and their ratio is 1:1. The oxidation products of vacuum residues from the Pavlodar Petrochemical Plant and "Asphaltbeton 1" LLC with the addition of polyethylene waste and rubber crumb meet the requirements of ST RK 1373-2013 for petroleum road bitumens of the BND 100/130, BND 35/50, BND 130/200 and BND 70/100 grades in terms of physico-mechanical properties. The bitumen obtained by oxidation of vacuum residue from "Asphaltbeton 1" LLC has a lower carbon content and a higher oxygen content than the bitumen from the Pavlodar Petrochemical Plant vacuum residue. A pilot plant for obtaining bitumen by oxidizing heavy oil residues with the addition of modifiers - polymer waste and rubber crumb - was manufactured with a reactor volume of 125 l, an operating temperature of up to 300 °C, a heating power of 4-8 kW, an air flow rate of 5-45 l/min, and a stirrer rotation speed of 30-100 rpm.

The optimal ultrasound parameters for extracting natural bitumen from oil sands of the Beke and Munaily Mola fields were determined: frequency 22 kHz, ultrasound power 1500 W, optimal solution concentrations: 1 wt. % or 0.25 mol/l NaOH and 0.18 mol/l KOH, pH of the medium 12 or more, the ratio of oil sand of the Munaily Mola deposit to the solution is 1:2, the optimum temperature of the solution is 75 °C, the time of ultrasonic treatment with water is 20 minutes or more, with KOH and NaOH solutions - 8 min. Natural bitumens extracted from oil sands under the influence of ultrasound are characterized by a high content of mechanical impurities and

penetration, low values of density, softening point and extensibility, for their compliance with the requirements of the standard for road bitumen additional oxidation is necessary. Natural bitumen is rich in aromatic compounds, a high coefficient of aliphaticity indicates a low content of branched isoalkanes. A high degree of aromaticity and concentration of sulfur-containing heterocomponents are observed in asphaltenes and resins. A pilot plant for extraction natural bitumen from oil sands using ultrasound was manufactured for processing 10-15 kg of oil sand using an ultrasonic cavitation reactor with a frequency of 20 kHz and a power of 3 kW for 20-30 minutes.

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