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Thermal processing of Beke oil sands

In this work thermal method to processing organic part from oil sands were used. Content of organic part in oil sands was 9 wt. %. The composition of the oil sand was determined by elemental analysis and chemical composition of the organic part of oil sands was determined by infrared spectroscopy. The main properties of oil sands related to the structure and properties of the mineral, natural organic binder features of the interaction of mineral materials with organic binders, rock density, binder content and the degree of filling into the pores. The organic component of natural bitumen on the physical and chemical properties similar to high viscosity heavy crude oil.
Keywords: oil sands, organic binder, deposit Beke.

Introduction

Kazakhstan has significantly increased the flow of vehicles, changed the mass of vehicles, modern road design, construction technology and new road equipment. All this has led to increased consumer demands for quality of roads. The Republic of Kazakhstan has huge reserves of conventional crude oil and for the extraction of oil to become one of the largest producing countries in the world. Efficient processing of oil, petroleum products and their using is a major environmental problem. Conventional oil is reduced and high energy consumption necessitates the search for alternative sources of hydrocarbons. A huge source of energy stored in rocks and oil sands are an invaluable source. This direction is a huge attraction of chemical and environmental industries. Republic of Kazakhstan has a lot of oil sands deposit and a great source of energy [1-4].

Petroleum products play an important role in economic development of any nation. The growth in energy consumption is connected to the growth in the economy of any country; however, the energy demand of the world is increasing while conventional oil reserves are declining. The shortage of oil of known petroleum reserves will make less attended energy resources more attractive. The bitumen is much too viscous to be recovered by traditional petroleum recovery techniques. In the world oil sands have different term, as petroleum bitumen rocks, extra heavy oil and tar sands. Tar sands contain about 10-15 wt. % bitumen, the remainder being sand or other inorganic materials. The estimated world-wide resources of oil sands more than conventional oil reserves [5-9].

Mining and processing of heavy oils is associated with technical difficulties. The market for crude oil and the imbalance prevailing prices for oil and heavy oil products has to seek technologically and economically effective ways of mining, pipeline transportation and deep processing of heavy oils. Efficient processing of petroleum, petroleum products and their use is a major environmental problem. Organic part of oil sands can be serving as a promising source of various types of fuels, lubricants, bitumen and petroleum products. To extract bitumen from the oil sands is using a variety of methods: extraction by organic solvents, thermal, flotation with various additives. Modern petroleum refineries are not focused on the application of these technologies. Therefore, the actual problem is the

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development of bitumen processing complexes and advanced technologies of extraction of natural bitumen in view of their physical and chemical properties. Solving these problems will allow involving in the development of significant reserves of natural bitumen Republic of Kazakhstan [10-12].

Materials and Methods

The object of research in the article was oil sand of deposit Beke which located in western Kazakhstan (Mangistau region). For the separation of organic part from oil sands the thermal method was used. Isolation of the organic part oil sands performed thermally methods. Processing was carried out on periodic action installation, which is showing in Figure 1.

The plant consists of a cylindrical reactor of 20 cm length and an internal diameter of 8 cm in case of the necessity of purging the raw material gas in the reactor vessel at its lower part there is a valve for supplying gas sparging. Gas from the reservoir is fed into the reactor through the perforated diaphragm upward through the raw material. In the upper part of the reactor is a gas nozzle and for outputting products. The gases and vapors are coming through the tube in a refrigerator cooled by water. The reactor was heated with an electric furnace. Adjustment of the heating is carried out increasing the supply voltage through the furnace thermostat. The condensed liquid products flow from the refrigerator at the tank. A raw material with a specific weight is loaded into a reactor at room temperature and turns the heating furnace. In the process, the temperature measured raw materials and products, the amount of liquid in the vessel. The process ends with turning off the heating elements after the temperature of the residues in the reactor the process reaches the final temperature 560 °C.

The processing carried out monotonic heating from room temperature to 560 °C, heating rate of oil sands was varied from 6 to 16,7 °C per minute. The average duration of process was 45 minutes.

Figure 1 – Installation for thermal processing oil sands

After cooling the reactor, it is opened and poured it obtained from the solid residue. The mass of liquid products and solid residue was determined by weighing. Yield the organic part was 9 wt. %.

Results and Discussion

Physical-chemical characteristics and potential of the organic content in the oil sands were studied by standard methods of analysis. For the extraction process thermal method was used.

The elemental composition of the oil sands is shown in Table 1. As seen from the table that the composition contains the organic parts of the oil sands, as expected, the hydrocarbon has sulfur and

the presence of oxygenates. Mineral fraction mainly contains silicon, oxygen-containing compounds, a significant carbon content (30.22 %), sulfur and hydrogen – insignificant. This confirms the fact that after the thermal effect of the carbon remains in the mineral part of the oil sands.

Table 1 – Elemental composition of oil sands

Sample	Elemental composition, wt. %					
	C	Si	S	O	H	N
Oil sands	78.77	7.16	1.36	10.69	2.02	-
Mineral part	30.22	45.49	0.12	21.12	0.77	-
Organic part	84.69	-	1.29	2.12	11.39	0.51

The research aimed to define and study the physical and chemical, mineralogical composition, as well as qualitative indicators of the organic part of oil sands, which extracted by thermal methods. The purpose of this study is to use the oil sands as alternative hydrocarbon materials. Some characteristics of liquid distillate and yield of individual products were determined (Table 2).

Table 2 – Products characteristics of thermal processing the oil sand

Parameters	Contents
Yield of products, wt. %	
Gaseous	2.4
Liquid	9.6
Solid residue	88.0
Characteristics of the liquid fraction:	
Density, g/cm^3	0.850
Molecular weight	261
Total sulfur content, %	0.77
Ash, %	0.38
Coking ability, %	15
Flash point, °C	42
Pour point, °C	-38.0
Iodine value, 12g per 100 g oil sands	84

Natural bitumen has a low yield of light fractions, fractions boiling up to 180 °C is low (7.9 wt. %). Content of fraction boiled from 180 to 250 °C are also low (12.2 wt. %). Due to the low content of gasoline and kerosene fractions, organic part should be used for bitumen (Table 3).

Table 3 – Fractional composition of thermal processing products

Parameters	Organic part of oil sands
Fraction part, wt. %:	
IBP – 180 °C	7.9
180 – 250 °C	12.2
250 – 300 °C	12.6
300 – 350 °C	52.6
350 °C – end of the boiling	14.8

Elemental and phase composition of organic and mineral part of oil sands was designated in Belgorod State University, Russia. Mineral content of oil sands after extraction were studied at apparatus X-ray phase analysis. This results as following in Table 4.

Table 4 – Mineral content of oil sands

Phases	Formula	Quality index
Quartz	SiO_2	0.675
Calcite	$CaCO_3$	1.129
Calcium sulfide	CaS	0.803
Lime	CaO	1.022
Portlandite	$Ca(OH)_2$	1.155
Graphite	C	1.453

The composition of organic part has also been studied by infrared (IR) spectroscopy. In the spectrum of the organic part shows absorption bands with low intensity at 1640.91, 965.54 and 909 cm^{-1}, which belong to the benzene derivatives. The band intensity at 1707 cm^{-1} indicates the presence of carbonyl groups, oxygen-containing organic compounds and the absorption band at 1031.84 cm^{-1} is due to stretching vibrations of C–O–C groups, oxygen-containing compounds. The characteristic absorption band for the aromatic structures (1604 cm^{-1}) and the presence of absorption bands in structures saturated groups as –CH–CH_2–CH_3 in an area 1376, 1462, 2853 cm^{-1}. During thermal method for extracting natural bitumen intensity of deformation vibrations of benzene derivatives (815, 875, 760 cm^{-1}) are increases.

The next table was conducted to determine knock characteristics of fractions received from synthetic oil of oil sands from Beke deposit to their suitability as a motor fuel. The characteristics are shown in Table 5.

Table 5 – Knock characteristics of motor fuel

Parameters	The initial sample	Gasoline fraction 80-180 °C	Diesel fraction 180-250 °C	Gasoil fraction 250-320 °C
Octane number	-	80	Not defined	Not defined
Cetane number	-	-	above 45	Not defined
Flash, °C	-	-	35-40	-
Density at 20 °C, kg/m^3	0,870	0,754	0,817	0,864
Pour point, °C	-40	Not defined	-50-55	-45
Filterability temperature limit, °C	above -35-40	Not defined	above -40	above -25
Benzene volume %	-	1	Not defined	Not defined

At table 5 shows that the gasoline fraction is equivalent to gasoline AI-80, diesel fraction has a low pour point and a good indicator of the limiting filterability temperature that is favorable for diesel in the winter time. Gasoil fraction can be used as a heating fuel. It follows that the synthetic oil derived from oil sands, is also of interest for further research in this direction.

Conclusion

The organic part of oil sands from Beke deposit, what extracted by the extraction method, the physical and chemical characteristics are suitable for the preparation of synthetic oil products. The fractions, received from synthetic oil of oil sands are suitable as a motor fuel. Qualitative characteristics of fraction products after thermal heating processing the oil sands can see the many physical and chemical properties similar to the petroleum fractions. The elemental characteristics of oil sands found that the property of natural bitumen is close to the parameters of synthetic oil. The analysis results showed that natural bitumen is heavy factions that can later be used to obtain different types of oil bitumen.

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