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The study of physical and chemical properties of oil and its distillates of the Zhanazhol oil field

Abstract. This paper discusses the physico-chemical characteristics of a samples of crude oil, gasoline, kerosene and diesel from Zhanazhol oil fields (RK). Zhanazhol oil field is shown to be marked 2.0.1.0 in accordance with the requirements of ST RK 1347-2005 governmental standard. We have found out that the recovered fractions (gasoline, kerosene, diesel fuel) can be used as initial raw materials of motor fuels.

Key words: oil, mineral oil, gasoline, kerosene, diesel, physico-chemical properties.

Introduction

According to the Strategy of Industrial and Innovative Development of Kazakhstan all actions will be aimed for the formation of the government's economic policy of the Republic of Kazakhstan as well as aimed to achieve sustainable development through economic diversification and shifting from extraction to processing [1].

Today, Kazakhstan is in the group of the states which have huge reserves of hydrocarbons and produces a significant influence on the formation of the current situation at the global energy market. Kazakhstan has 208 exploited hydrocarbon fields and half of them are oil fields, the third part of them are oil and gas deposits, and the rest of them are gas and gas condensate. At the present, over 70 oil fields of them are being industrially developed. Zhanazhol oil field is among these oil fields, the composition of which is rich in mercaptans, sulfides, disulfides and other organic sulfur compounds. It refers to the carbonate rocks of the Carboniferous era. It is one of the most important promising oil fields in the production of oil and gas in our country [2-3].

Against the background of globalization of the world economy Kazakhstan faces a number of objective problems, among which is raw materials' orientation. In this regard, the possibility of obtaining valuable products from domestic oil fields is an urgent problem.

Today, «CNPC – Aktobe is dealing with oil production from Zhanazhol oil field and preparation of commercial oil.

Zhanazhol oil field produces about 6 million tons of oil per year. This oil is produced as a ready-to-primary processing commercial product that meets ST RK 1347-2005 state standard. The volume of gas separated from the oil, is about 3.5 billion m³ per year after purification from sulfur compounds in accordance with the requirements of ST RK 1666-2007 and GOST 5542-87, as well. It reaches consumers as domestic gas. It is widely used in everyday's life and as a fuel for road transport. Liquefied gas which is called propane-butane mixture of hydrocarbons is extracted in the amount of 140 thousand tons per year.

This paper describes the physico-chemical characteristics of oil and its products from Zhanazhol oil field from the wells №1-4.

Materials and methods

Crude oil, gasoline, kerosene and diesel distillate oil of Zhanazhol oil field were used as research objects.

Studies were conducted at the certified testing laboratory (Certificate No.03 / 14) of research and comprehensive analysis of fuels and refined products of BSE SRI NCTM.

The determination of distillation of oil, gasoline, kerosene and diesel were carried out on the experi-

mental unit (AVR-LAB-02), that is used to determine the composition of petroleum fractions, according to GOST 2177-99, ISO 3405, ASTM D 86.

The determination of the cetane index of diesel fuel was carried out by calculation regarding GOST 27768-88, based on the fluid density and boiling point of 50% fraction in accordance with GOST 2177-82.

The determination of cloud point, freezing point and limit point of diesel fuel was carried out on the unit (OPLCM «CRYSTAL») according to the ISO 9001.

Diesel fuel density determination was performed using a densitometer. Determination of sulfur in diesel fuel composition was carried out on the unit (Spectroscan S) by the GOST R 51947-2002, ASTM D 4294-98.

The determination of certain comparative deviations of analysis results was carried out in accor-

dance with GOST. The arithmetic mean was taken as a calibration certificate number for results. This arithmetic mean was calculated to the accuracy of the regulatory two parallel experiments with a proven level of probability between two parallel experiments conducted by 95%, which does not exceed the values specified in state standard.

Results and their discussion

In this study the main physical and chemical characteristics and hydrocarbon composition of crude oil and gasoline, kerosene and diesel derived from Zhanazhol oil field were identified.

Table 1 shows data to determine the physico-chemical characteristics of crude oil from Zhanazhol oil field.

Table 1 – Physical and chemical parameters of crude oil from Zhanazhol oil field

Parameters	Samples of oil from Zhanazhol oil field wells			
	1	2	3	4
Density at 20°C, kg / m ³	814.5	819.2	816.6	818.4
Kinematic viscosity at 20°C, cSt	17.9	6.4	4.9	5.7
Freezing point, °C	-38	-40	-42	-44
Mass fraction of water, % not more than	0.09	0.08	0.10	0.09
Content of mechanical impurities, % not more than	0.048	0.041	0.044	0.040
Volume, % mass.:				
Sulfur	2.65	2.63	2.63	2.67
Nitrogen	0.13	-	-	-
Silica resin	9.8	7,9	4,6	2,7
Asphaltenes	0.60	0,69	0.50	0.36
Paraffins	2.95	4,6	6.87	8.1
Freezing point of paraffin, °C	51	46	47	50
Coking ability, %	2.12	1.9	1.4	1.3
Ash, %	0.22	0.21	0,23	0.30
Acid number, mg KOH / g	0.13	0.11	0,12	0.15
Fractional yield,% mass.:				
Up to 200°C	25.8	32.6	29.4	31.4
Up to 350°C	47.7	54.9	54.3	58.1

Table 1 shows that the density of oil from wells No.1-4 ranges from 814,5-818,4kg / m³ and kinematic viscosity is within 17.9-5.7 cSt, the mass fraction of paraffin is 3.34% , the total sulfur is within 2,63-2,67 wt.%, mass fraction of water is 0.09%, mass

fraction of solids is within 0.040-0.048%. According to the research of physical and chemical parameters of oil from wells No.1, 2, 3 and 4, well №4 is selected as for further studies. Being naphtha-paraffinic base oil from Zhanazhol oil field is labeled as follows: ac-

cording to the requirements of the state standard ST RK 1347-2005 Symbol oil – 2.0.1.0. It is labeled in this way by group composition according to the values of hydrocarbon indicators as given above.

As the studied oil contains large amounts of gasoline fractions, kerosene (Table 1) it relates to a number of light oils characterized by low density and low viscosity and yield of resins and asphaltenes.

Fractional composition of oil is characterized by a wide temperature range and relatively high boiling total yield of oil products up to 84% (fraction 70-350°C, Table 1). Physico-chemical parameters of gasoline, kerosene, diesel and oil distillate fractions of oil from the well №4 were studied for more detailed analysis of individual distillates. The results obtained on the physico-chemical characteristics of gasoline are shown in Table 2.

Table 2 – Physical and chemical characteristics of the gasoline fraction of Zhanazhol oil field

Temperature of obtaining fractions, °C	Yield by oil, wt. %	Density at 20°C, kg/m ³	Fraction composition, °C				Amount of sulfur %mass.
			Initial boiling point	10%	50%	90%	
Initial boiling point -120	8.6	728.0	60	91	97	113	0.85
Initial boiling point -130	10.3	734.0	63	84	102	121	
Initial boiling point -140	11.9	741.0	67	87	107	129	
Initial boiling point -150	13.1	743.0	70	90	111	138	
Initial boiling point -160	14.7	750.0	71	92	116	148	
Initial boiling point -170	16.2	756.0	72	94	121	158	
Initial boiling point -180	17.9	761.0	73	96	126	168	
Initial boiling point -190	19.3	764.0	74	98	131	171	
Initial boiling point -200	20.8	766.0	75	100	138	186	

As Table 2 shows gasoline oil fraction of Zhanazhol oil field has a density in the range of 728-766 kg / m³, and the total amount of sulfur is 0.85 %mass.

According to the literature survey the combustion efficiency depends on the fractional composition of gasoline. To provide the necessary starting properties of commercial gasoline, up to 30% of lighter components of straight-run fractions are included in its composition. Table 2 shows that the gasoline fraction of Zhanazhol oil field meets these parameters (Initial boiling point -60°C and Initial boiling point -75°C) and fully can be used as raw materials for using in the summer commercial fuels.

One of the most important oil products is kerosene, which has a wide range of applications. Its most important application is as a jet fuel and as a combustible component of liquid rocket fuel. Data on specific physico-chemical characteristics of kerosene are shown in Table 3.

The density and the heat of combustion of jet fuel are characterized by its energy capabilities. The

higher density the greater of the amount of fuel can be loaded into the tanks of the aircraft increasing flying range without additional fuelling. Thus, the density of the kerosene fraction of Zhanazhol oil field varies from 797-813,5kg / m³ and possesses all the above -given properties. Kerosene oil fractions of Zhanazhol oil field corresponds to the components of RT and TS-1 jet fuels by the basic parameters (the amount of sulfur – 1.32%, the crystallization temperature – 60°C, calorific fractions with a boiling point of 120-260°C in is in the range 10295-10311 kcal / m³, smoke point within 21-24 mm) which are presented in Table 3. Faction 160-260°C complies with lamp oil KO-20. Today, the most common fuel is diesel, because diesel engines are more economical, they have lower fuel consumption and higher efficiency than that of gasoline. Fractional composition of diesel fuel affects the completeness of combustion, atomization conditions, exhaust smoke, the degree of carbonization. The data on the physical and chemical characteristics of diesel are given in Table 4.

Table 3 – Physical and chemical characteristics of the kerosene fraction of Zhanazhol oil field

Parameters	Temperature of obtaining fractions, °C		
	120-230	120-240	160-260
Oil output, % wt.	17.3	19.2	16.7
Density at 20°C, kg / m ³	797.0	798.0	813.5
Fractional composition, °C			
Initial boiling point	144.9	152	176
10%	152	156	193
50%	180	188	214
90%	214	222	242
The viscosity at 20°C, mm ² /s	1.49	1.53	1.76
Flash Point, °C	36	38	37
Crystallization temperature, °C	-60	-60	-59
The amount of sulfur, % mass	1,32	1.33	1.32
Heat of combustion, kcal / m ³	10311	10310	10295
The height of the smoke point of the flame, mm	24.0	23.0	21.0

Table 4 – Description of the diesel distillate of Zhanazhol oil field

Parameters	Temperature of obtaining fractions, °C				
	150-350	180-350	200-350	230-350	240-350
Oil yield, % mass.	34.4	28.2	26.4	21.5	19.8
Density at 20°C, kg/m ³	832.0	842.0	843.0	848.0	850.0
Fractional composition, °C					
10%	196	225	244	-	273
50%	260	271	280	-	288
90%	320	320	326	-	314
Viscosity, mm ² / s					
u	4.27	4.79	5.77	6.7	6,5
Y ₅₀ , mm ² / s	2,11	2.44	2.49	4.6	4,8
The cloud point, °C	-31	-18	-17	-13	-12
Freezing point, °C	-38.4	-22	-20	-18	-11
The amount of sulfur, % mass	0.88	0.76	0.83	-	0.9
Aniline point, °C	58.4	59.6	72.4	-	74.2
Diesel index	61.5	50.8	51.6	52.1	55.0
Cetane number	47.0	48.0	47.0	49.0	51.0

Diesel fractions of Zhanazhol oil field having a freezing point in the range of 11 and $-38,40^{\circ}\text{C}$ refer to summer diesel fuels used in the devices of auotractors. $240-350^{\circ}\text{C}$ dewaxed diesel fractions can be used as raw materials for secondary processes to produce high-octane gasolines. According to the standards of diesel fuel for boiling temperature limits of defined fractions, diesel fraction of Zhanazhol oil field can be used as raw material for commercial DTS and DTG diesel.

Conclusion

In conclusion, it should be noted that Zhanazhol oil field is one of the most promising and largest oil fields in the Caspian region of western Kazakhstan in terms of the processes of deep processing of hydrocarbons. Oil from Zhanazhol oil field is shown to have a high yield up to 84%. Based on the obtained physico-chemical characteristics of gasoline, kero-

sene and diesel distillates of the given oil fractions can be used as raw material for commercial fuels.

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