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MODELING PVT PROPERTIES OF RESERVOIR FLUIDS WITHIN THE KARATON-SARKAMYS BLOCK BY THE EXAMPLE OF THE PRORVA GROUP OF FIELDS

Abstract. To date, the urgent task is to create PVT models that adequately reproduce the properties of reservoir hydrocarbon mixtures, based on both Black oil-type models and composite PVTi, PVTsim.

Availability of reliable data on PVT properties of reservoir fluids plays a leading role in calculating oil and gas reservoir reserves, estimating oil recovery factors, well studies, numerical reservoir modeling and for making informed decisions when designing field development. In practice, the results of field, laboratory and theoretical studies are used simultaneously to justify the properties of natural hydrocarbon mixtures. At each of the noted stages, specialists strive to increase the reliability of the obtained data and to develop methods of their interpretation. Determination of the properties of reservoir fluids in the oil field is a prerequisite for the effective use of various methods of exposure to the bottomhole zone, the selection of equipment for well operation. Properties of formation fluids are determined by different thermobaric conditions and change depending on the current state of the reservoir and the characteristics of reservoir pressure changes. All known methods for determining the properties of reservoir fluids are divided into two groups: experimental and computational. Each group has both advantages and certain disadvantages.

Key words: reservoir, formation oil properties, PVT, experiment, density, viscosity, saturation pressure.

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МОДЕЛИРОВАНИЕ PVT СВОЙСТВ ПЛАСТОВЫХ ФЛЮИДОВ В ПРЕДЕЛАХ БЛОКА КАРАТОН-САРКАМЫС НА ПРИМЕРЕ ПРОРВИНСКОЙ ГРУППЫ МЕСТОРОЖДЕНИЙ

Аннотация. На сегодняшний день актуальной задачей является создание PVT-моделей, адекватно воспроизводящих свойства пластовых углеводородных смесей, основанных как на моделях нефти типа Black oil, так и композиционных PVTi, PVTsim.

Наличие достоверных данных о PVT свойствах пластовых флюидов играет ведущую роль при подсчете запасов нефтяных и газовых залежей, оценке коэффициента извлечения нефти, исследовании скважин, численном моделировании коллекторов и для принятия обоснованных решений при проектировании разработки месторождений. На практике результаты промысловых, лабораторных и теоретических исследований используются одновременно для обоснования свойств природных углеводородных смесей. На каждом из отмеченных этапов специалисты стремятся повысить достоверность получаемых данных и развить методы их интерпретации. Определение свойств пластовых флюидов нефтяного месторождения является обязательным условием эффективного применения различных методов воздействия на призабойную зону скважин, подбора оборудования для эксплуатации скважин. Свойства пластовых флюидов определяются различными термобарическими условиями и меняются в зависимости от текущего состояния пласта и характеристики изменения пластового давления.

Ключевые слова: залежь, свойства пластовой нефти, PVT, эксперимент, плотность, вязкость, давление насыщения.

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ПРОРВА КЕН ОРЫНДАРЫ ТОБЫНЫҢ МЫСАЛЫНДА ҚАРАТОН-САРҚАМЫС БЛОГЫНДАҒЫ РЕЗЕРВУАР СҰЙЫҚТЫҚТАРЫНЫҢ ҚАСИЕТТЕРІН PVT МОДЕЛЬДЕУ

Аннотация. Бүгінгі таңда Black oil типті мұнай модельдеріне де, pvti, pvtsim композициялық модельдеріне де негізделген көмірсутек қоспаларының қасиеттерін барабар көбейтетін PVT модельдерін құру өзекті міндет болып табылады.

Қабаттық сұйықтықтардың PVT қасиеттері туралы сенімді деректердің болуы Мұнай және газ кен орындарының қорларын есептеуде, мұнай алу коэффициентін бағалауда, Ұңғымаларды зерттеуде, коллекторларды сандық модельдеуде және кен орындарын игеруді жобалау кезінде негізделген шешімдер қабылдауда жетекші рөл атқарады. Іс жүзінде коммерциялық, зертханалық және теориялық зерттеулердің нәтижелері табиғи көмірсутек қоспаларының қасиеттерін негіздеу үшін бір уақытта қолданылады. Белгіленген кезеңдердің әрқайсысында мамандар алынған мәліметтердің дұрыстығын арттыруға және оларды түсіндіру әдістерін дамытуға тырысады. Мұнай кен орнының қабат сұйықтықтарының қасиеттерін анықтау ұңғымалардың ұңғыма маңы аймағына әсер етудің әртүрлі әдістерін тиімді қолданудың, ұңғымаларды пайдалану үшін жабдықты таңдаудың міндетті шарты болып табылады. Қабат сұйықтықтарының қасиеттері әртүрлі термобариялық жағдайлармен анықталады және қабаттың ағымдағы күйіне және қабат қысымының өзгеру сипаттамасына байланысты өзгереді. Қабаттық сұйықтықтардың қасиеттерін анықтаудың барлық белгілі әдістері екі топқа бөлінеді: эксперименттік және есептелген. Бүгінгі таңда өзекті міндет-қабаттағы көмірсутек қоспаларының қасиеттерін жеткілікті түрде көбейтетін PVT модельдерін құру.

Түйін сөздер: кен орны, қабат майының қасиеттері, PVT, тәжірибе, тығыздық, тұтқырлық, қанықтыру қысымы.

Intoduction. The initial information for building thermodynamic models of reservoir hydrocarbon mixtures are the results of studies of formation and surface samples, as well as field data. The main criterion for reliability of the obtained data on samples is representativeness of the selected samples (Yushchenko et al., 2015:56). Accordingly, the samples of the reservoir fluid, which were taken in accordance with the regulations of representative sampling provide an opportunity to use these data to create a fluid model of the field (Odegov et al., 2015).

However, the complexity and specificity of geological structure, insufficient study of the basic laws of change in filtration-volume properties, ambiguity of assessments of the phase state of natural hydrocarbon systems, anomalously high reservoir pressure create significant difficulties in creating geological and hydrodynamic models of deposits.

Information about the composition, physical, chemical and thermodynamic properties of the reservoir fluid is an important link in the structure of the initial information required for the creation and further use of geological and technological documentation of various levels (calculation of reserves, technological schemes of field development, etc.) (Pedersen at al., 2010:407).

To create a PVT model of a field based on the equation of state (Nugaeva et al., 2012) and fundamental principles of the thermodynamics of multicomponent systems when calculating phase equilibrium, first of all it is required to determine the component composition of the reservoir mixture (Wilson et al., 2011:15).

In practice, we are often faced with the lack of data on the component composition of reservoir oil, and in the case of gas-condensate-oil deposits - with the lack of information about the composition and properties of the gas cap gas, as well as free gas, including the potential content of stable condensate (C5+) (Rodriguez et al., 2006).

By the example of Prorva group of fields (Kisimbay, Aktobe, Dosmukhambetovskoye, Zapadnaya Prorva, S. Nurzhanov (all deposits) and S. Nurzhanov North-West wing) (Fig.1), the PVT characteristics of oil composition and properties of Karaton-Sarkamys block are presented.

Fig.1 - Overview map

The Aktobe field is geographically located in the south-eastern part of the Pre-Caspian depression The S. Nurzhanov oil field is located 15 km south-west of it. The field reveals a complex of Meso-Cenozoic deposits, represented by Triassic, Jurassic, Cretaceous, Paleogene and Quaternary systems, as well as saline deposits of the Kungurian stage of the Permian system.

The Dosmukhambetovskoye field is located on the southern edge of the Pre-Caspian Basin, 6 km north of the Aktobe field. The Dosmukhambetovskoye field contains deposits from the Kungurian age to the Quaternary system.

The Kisimbay field is located in the south-eastern part of the Caspian depression. In the field, deposits from Quaternary to Lower Permian inclusive are uncovered, but the upper part of the section is well studied by wells, the lower part of the section is uncovered by isolated wells. The sections uncovered in all of the drilled wells are identical.

The West Prorva field is geographically located in the southeastern part of the Pre-Caspian Basin on the eastern shore of the Caspian Sea. The field has exposed sediments from the Paleogene to the Kungurian stage of the Lower Permian. From the surface, these sediments are overlain by sediments of Quaternary age.

The S. Nurzhanov gas and oil field (all reservoirs) is characterized by a complex geological structure expressed in the presence of tectonic faults that divide the field into numerous blocks. The reservoir strata are characterized by significant heterogeneity both in the area of the deposits and in the section. The commercial oil and gas content of the field is associated with terrigenous-carbonate sediments of the Valanginian stage (Lower Cretaceous) and sediments of the Upper, Middle Jurassic and Triassic deposits.

At the S. Nurzhanov field (all deposits), the strata of Paleozoic and Meso-Cenozoic deposits are uncovered. In the section of deposits rocks of Permian, Triassic, Jurassic, Cretaceous, Paleogene and Quaternary systems are distinguished. S.Nurzhanov deposit (North-West wing) territorially belongs to Karaton-Sarkamys block. Lithological characteristics of the section are given on the basis of the nearby main S.Nurzhanov deposit (all deposits).

Dependences of reservoir oil parameters on gas content were plotted according to the results of experimental measurements (Fig. 4-19). For rejection of low-quality values of parameters, the control of material balance data was used. In addition, all data were evaluated using the equation of state to eliminate gross errors of laboratory studies (Brusilovsky et al., 2013).

Research Material and methods. To assess the properties of the initial reservoir oil, a mathematical recombination of the composition was carried out using the obtained average value of gas content. Gas and oil compositions were used according to the results of KMG Engineering LLP laboratory as the most qualitative and detailed ones. For other laboratories the composition of degassed oil is either missing, or determination of the composition was carried out with violations of the methods of conducting, which led to poor-quality results (e.g., lack of “plus” residue in the composition). Properties of oil fractions were obtained by exponential prediction from the hydrocarbon number, taking into account compliance with the material balance with the adopted density and molecular weight of oil (Tulsa, 2015). The obtained composition of reservoir oil was used to roughly assess the quality of laboratory results, which resulted in the rejection of clearly substandard values of parameters (saturation pressure, volume factor, density of reservoir oil).

On the whole, the Prorva group of fields was analyzed:

- Kisimbay - 14 deep and 25 surface samples;
- Aktobe - 22 deep, 7 recombined and 29 surface samples;
- Dosmukhambetovsky - 22 deep, 11 recombined and 34 surface samples;
- West Prorva - 54 deep and 64 surface samples;
- S. Nurzhanov (all deposits) - 162 deep, 7 recombined and 174 surface samples;
- S. Nurzhanov Northwest Wing - 22 deep and 19 surface samples (Table 1).

Table 1 - Number of analyzed samples of Prorva group of deposits of Karaton-Sarkamys block

The field	Number of samples analyzed		
	depth samples	recombined samples	surface samples
Kisimbay	14	-	25
Aktobe	22	7	29
Dosmukhambetovsky	22	11	34
West Prorva	54	-	64
S. Nurzhanov (all deposits)	162	7	174
S. Nurzhanov Northwest wing	22	-	19

In the area of Kisimbay and S. Nurzhanov fields (all deposits), Valanginian productive horizon at depths of -1585.0m and -1900.9m (South wing, South field) and -1893.4m (N-E field), respectively, is identified. The density of formation oil of m.y. Kisimbay of Valanginian horizon varies from 0.603 g/cm^3 to 0.805 g/cm^3, at the average for the horizon it is 0.757 g/cm^3 (Fig. 6). Saturation pressure at T_{pl} = 61°C and P_{pl} = 15.4 MPa is 10.4 MPa. (Fig.2-3) Average gas content is 74.6 m^3/t. Volume coefficient is 1.180 Oil in formation conditions is characterized by viscosity - 3.1 mPa*s on average. Density of degassed oil averages 0.873 g/cm^3, which characterizes oil as heavy.

Valanginian productive horizon of S. Nurzhanov deposit (all deposits) covers South wing, South field (abd. height -1900.9m) and North-East field (abd. height

-1893.4m). The density values of formation oil of the Southern Wing, Southern field and Northeastern field are 0.767 g/cm^3 and 0.789 g/cm^3 at an average temperature of 64-66°C, respectively. The gas content of the South Wing, South Field and Northeast Field averages 124.1 and 62.8 m^3/t, at saturation pressures of 7.3 and 10.4 MPa, respectively. The density of degassed oil of South Wing, South field is characterized as particularly light (0.830 g/cm^3), oil of North-Eastern field as light (0.843 g/cm^3). Jurassic productive horizons of the field (Yu-I, Yu-II, Yu-III, Yu-IV, Yu-V) are characterized by gas content from 95 m^3/t (Yu-I) to 153.6 m^3/t (Yu-V), density of degassed oil from 0.848 to 0.878 g/cm^3 and are classified as medium and heavy.

The Triassic productive horizons (T-I, T-II-A, T-III, T-IV, T-V) are characterized by gas content from 146.2 m^3/t (T-V) to 202.2 m^3/t (T-I), density from 0.891 to 0.897 g/cm^3 and are classified as heavy and bituminous.

The Jurassic productive horizons of Yu-II (abs. elevation -2283.0) and (abs. elevation -2436.8) Yu-IV of the North-Western flank of the S. Nurzhanov field are characterized by gas content from 147.3 m^3/t (Yu-II) and 95.8 m^3/t (Yu-IV), degassed oil density from 0.865 to 0.873 g/cm^3 and are classified as medium and heavy.

The Triassic productive horizons (T-II-A, T-IV-A, T-V) are characterized by gas content from 106.5 m^3/t (T-V) to 286.0 m^3/t (T-IV-A), density from 0.856 (T-IV-A), to 0.933 g/cm^3 (T-V), and are classified as heavy and bituminous (Pitkevich et al., 2010).

Analyzing the results of studies of formation oil productive horizons Dosmukhambetovskoye field should be noted that the study of fluid system of Middle Jurassic horizons satisfactory, the parameters on the horizons sustained, except for two samples, for which the gas content is 26 m^3/t (horizon VIII-2) and 25.2 m^3/t (XIV horizon). Basically, according to the results of formation oil studies, it is clear that there is some tendency for gas content to increase along the depth, density of formation oil and viscosity of formation oil are decreasing. Saturation pressure changes from 4.0 to 12.4 MPa (Fig.12). The density of formation oil of Jurassic horizons varies from 0.750 g/cm^3 to 0.850 g/cm^3 (Fig. 14). The value of gas content varies from 32.0-85.0 m^3/t. Volume coefficient varies from 1.102-1.266. Oil in formation conditions is characterized by viscosity of 2.5 mPa*s on average. The density of degassed oil varies from 0.836-884 g/cm3 and is characterized as light (VIII-1+2 horizon), medium (VIII-2 horizon) and heavy (VIII-4-B, IX-1, IX-2, X-2, XIV).

Physico-chemical properties of formation oil of Aktobe field were studied from productive horizons: VIII1, VIII2, VIII3, VIII4, VIII5, IX1, VIII1-IX1. Analysis of the results of PVT studies of reservoir oils, showed that the saturation pressure varies from 7.1 to 18.8 MPa (Fig. 12). The density of formation oil of

Jurassic horizons varies from 0.672 g/cm^3 to 0.755 g/cm^3 (Fig. 14). The value of gas content varies from 102.4-214.5 m^3/t. Volume coefficient varies from 1.217-1.538. Oil in formation conditions is characterized by viscosity of 0.9 mPa*s on average. The value of density of degassed oil varies from 0.811-842 g/cm^3 and is characterized as Oil of all horizons belongs to type “0” and “1” and is classified as especially light and light.

The main volume of downhole samples of the West Prorva field is characterized by the T-III productive horizon. The distribution of sampled formation oil over the area of the field is shown in Fig. 5 и 16-19. In terms of area, samples of the Jurassic horizon were taken from the pure oil zone from the peripheral part of the production facility, for the productive T-II horizon, samples were mostly taken from the central (wedge-shaped) part, for the productive T-III horizon covering almost the entire area.

Result and discussion. Laboratory PVT studies of reservoir oil samples from the field were conducted only as part of a reduced complex (standard separation, PV ratios), so only these basic experiments were used when building the model (Lasater et al., 2013).

The equilibrium gas composition was used when it was necessary to resaturate the reservoir oil samples to a saturation pressure corresponding to the reservoir pressure at the depth of the GOC. Modeling was performed in Schlumberger PVTi software. After adjusting the equation of state, fluid models corresponding to degassing conditions at the separator were unloaded. Separation conditions are assumed to be typical for the oil field system according to the RD (Standing, 2017).

As a whole, the dynamics of changes in gas content of formation oil based on deep samples of Yu-II horizon agrees with the behavior of saturated reservoir systems. Given the presence of a gas cap in the horizon, the saturated state of the fluid in the initial period of exploration is beyond doubt. Since the height of the deposit is not high and the error of laboratory data exceeds the probable changes in depth, the parameters of formation oil can be assumed unified by the height of the deposit (Petrosky, 2013).

The revealed dependence of formation oil properties allows to reconstruct the properties of the initial fluid in the saturated state (Guzhov et al., 2015). The saturation pressure of formation oil corresponds to the formation pressure at the GOC. Oil density in formation conditions is 0.688 g/cm^3. Viscosity of formation oil is 1.1 mPa*s. Oil-gas saturation pressure - 24.9 MPa. Gas content - 194.2 m^3/t, at a volume factor of 1.460.

All samples of T-II horizon are well approximated by a single correlation on the graphs of the dependence of the saturation pressure and volume coefficient on gas content. This is a criterion of belonging of all samples to a single reservoir system (Abbaszadeh et al., 2010). Decrease of gas content by samples is caused by sampling conditions (low permeability of reservoir and high underbalance, lack of preparation time for sampling, etc.), as well as decrease of reservoir pressure in the deposit (Khatib et al., 2012). Oil density in formation conditions is 0.681 g/cm^3. Viscosity of reservoir oil is 0.4 mPa*s. Oil-gas saturation pressure averages 25.4 MPa. Gas content is 189.4 m^3/t, with a volume coefficient of 1.490.

In general, for T-III horizon, the dependence over the entire pressure range is very short, which may be an indication of under-saturation of the initial formation fluid (Fig. 3). Research results are contradictory and indicate not only low quality of samples due to unacceptable sampling conditions (two-phase state), but also fitting laboratory data to conditionally conditioned values [18], [19]. For example, many samples are taken at depths where the sampling pressure is much lower than the formation oil saturation pressure determined in the laboratory. At the same time, very often there is a parallel sample, measurements of which allegedly confirm the high quality of the samples (Aguilera et al., 2011). The density of oil in formation conditions is 0.685 g/cm^3. Viscosity of formation oil - 0.5 mPa*s. Oil saturation pressure with gas is 26.6 MPa. Gas content - 190.4 m^3/t, at volumetric coefficient 1.540.

The characteristic of formation oil of T-V horizon was characterized by 3 studies. The obtained results of the studies are contradictory. The density of separated oil was 0.889 and 0.780 g/cm^3, respectively. Low values of oil density such as 0.780-0.783 g/cm^3 are not typical for the Triassic deposits not only in the West Prorva field but also in the Sputnik - S. Nurzhanov field. It is likely that deep samplers did not take samples of formation oil, but saturated condensate - a product of condensate precipitation of the gas cap, which is present in the T-V horizon. Therefore, these samples cannot characterize the properties of the initial formation oil (Bourdet et al., 2009). The sample from well #400 was taken at a depth of 2,500 m, and the sample saturation pressure was 24.0 MPa, which is close to the hydrostatic pressure at this depth. Due to the presence of a gas cap in the reservoir, it was decided to mathematically resaturate the composition (Tiab, 2013) of reservoir oil to a saturation pressure equal to the reservoir pressure at the GOC. Gas content of the saturated formation oil was 227.0 m^3/m^3, density of separated oil - 0.889 g/cm^3. Oil density in formation conditions - 0.681 g/cm^3. Viscosity of formation oil - 0.5 mPa*s. Oil saturation pressure with gas - 34.0 MPa. Gas content - 195.8 m^3/t, with a volume ratio of 1.550.

Parameters of reservoir oil have been determined according to the model of reservoir oil, parameters of the equation of state of which have been adjusted to reproduce adequate experimental data (Abbaszadeh et al., 2010). As a result, we obtained a model characterizing the behavior of fluid properties, as close as possible to reliable parameter values, and having a physical relationship of properties not only under initial conditions, but also during simulation of reservoir development for depletion (table 2).

Conclusion. Analyzing the experimental material on the studied samples of surface oils we can make the following conclusions:

Properties of oil within individual horizons are quite close to each other. Visible distinctions can take place depending on a place of sampling, position of a well on structure of a deposit, affinity VNK, i.e. correspond to existing ideas about change of properties of oil within a deposit.

For oil of many fields of suprasalt complex the following regularity of change of physical and chemical properties is characteristic, the more depth of occurrence of a productive horizon, the lighter is oil.

Peculiarity of fluid systems of deposits of Karaton-Sarkamys block of Atyrau region is that parameters of reservoir and separated oil of deposits are characterized on the contrary by heavier oil with increase of depth of occurrence of horizons. So, for example, oils from Triassic horizons are more heavy and viscous than Jurassic, yield of light fractions, boiling up to 300°C is less, than at oils of Jurassic horizons though such parameters as the contents of sulfur, resins and paraffins are comparable.

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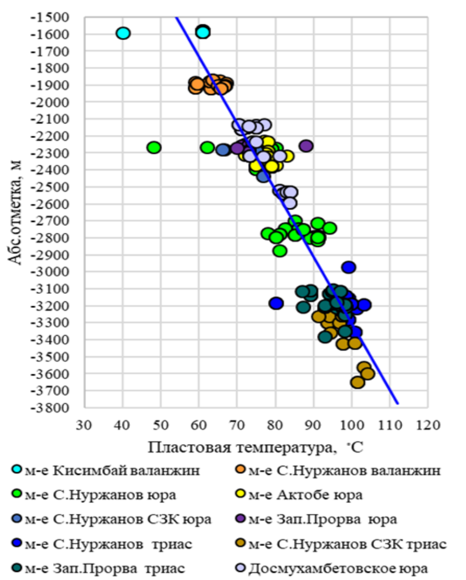

Fig. 2 Reservoir temperature change with depth of occurrence

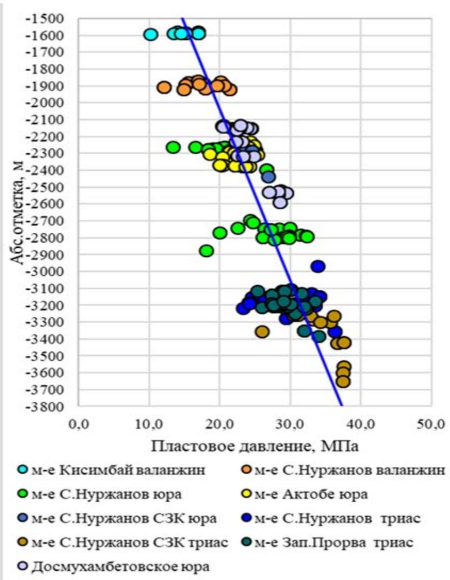

Fig. 3 Reservoir pressure change with depth of occurrence

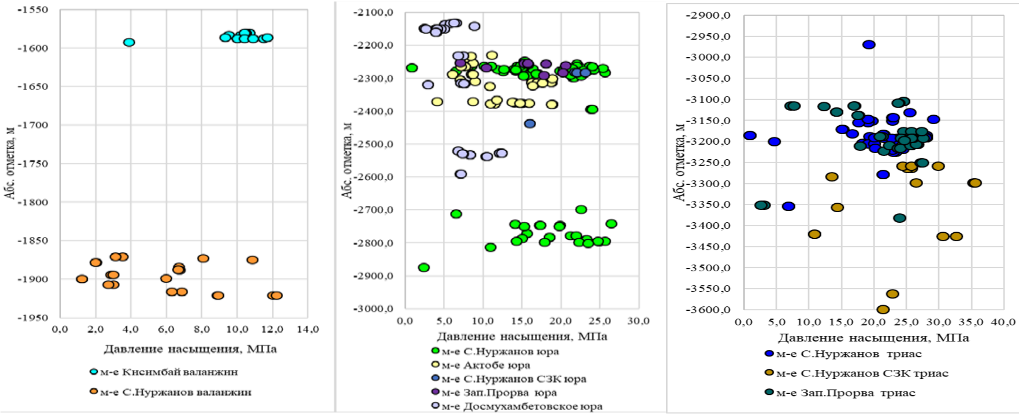

Fig.4 Change of formation oil saturation pressure with depth by horizon

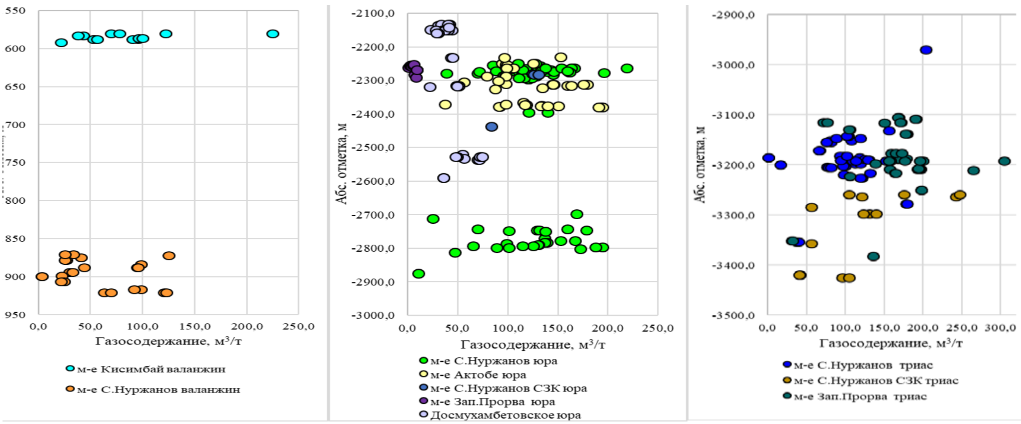

Fig.5 Change of gas content of formation oil with depth by horizon

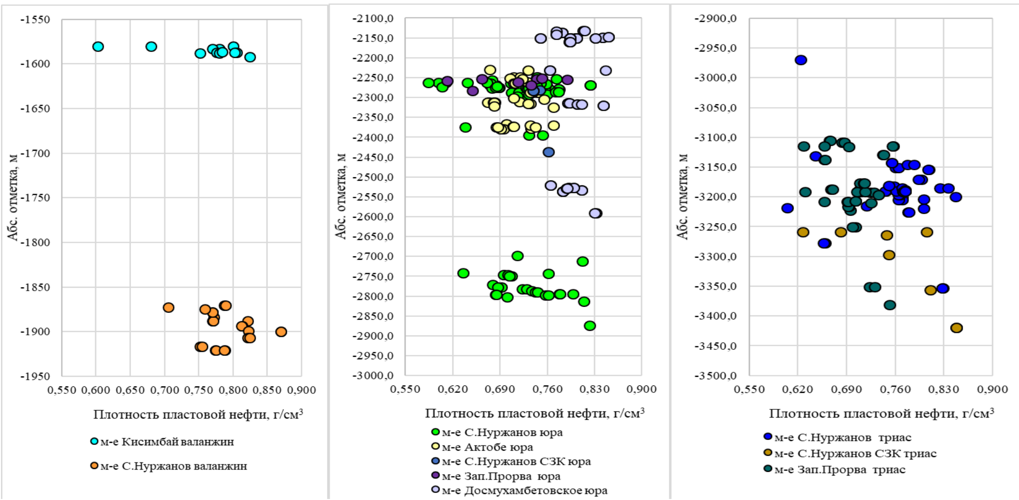

Fig.6 Variation of formation fluid density with depth by horizon

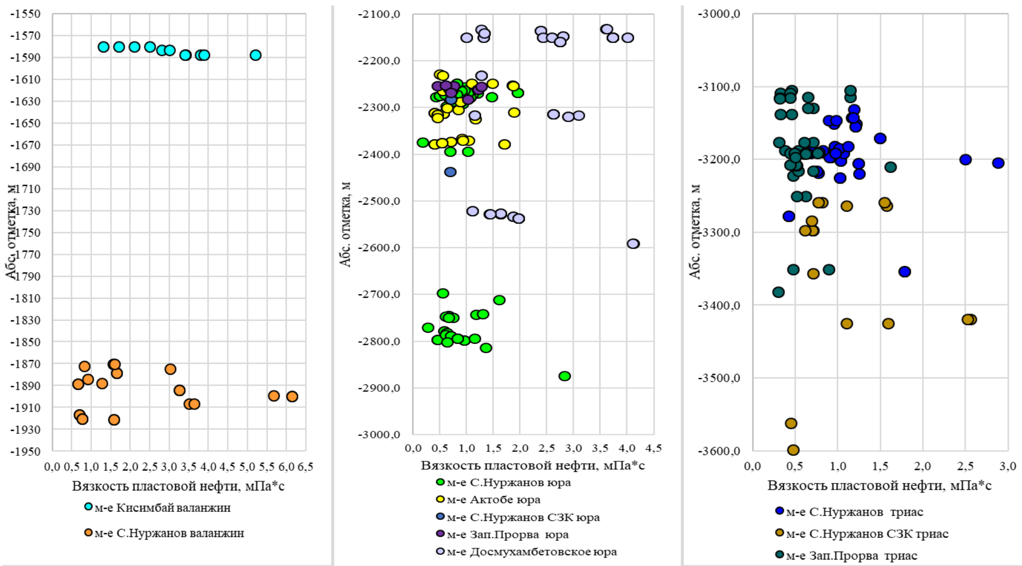

Fig.7 Change of formation fluid viscosity with depth by horizon

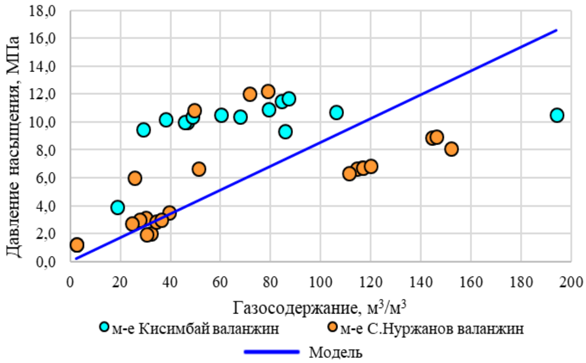

Fig.9 Dependence of volumetric ratio on gas content of reservoir oil

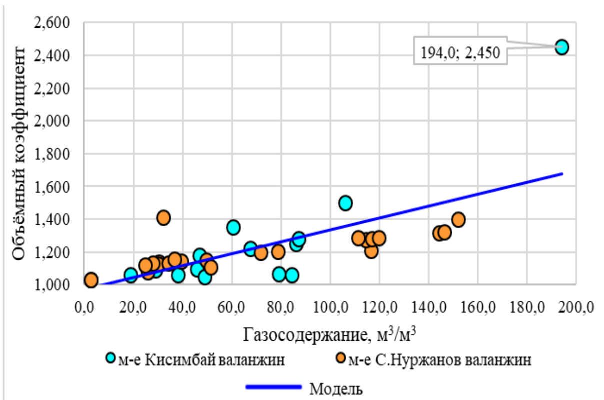

Fig.8 Dependence of saturation pressure on gas content of reservoir oil

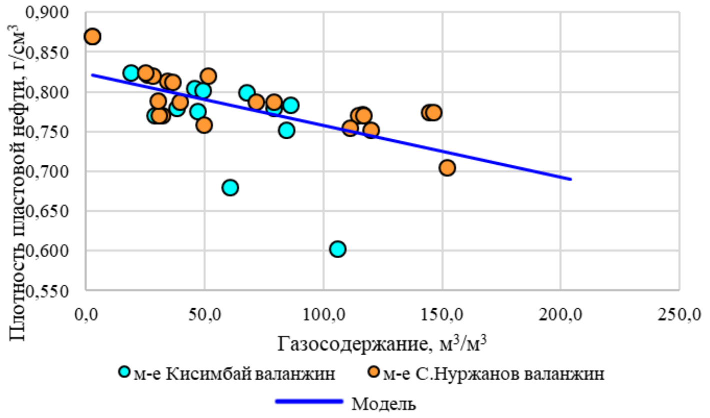

Fig.10 Dependence of density on gas content of reservoir oil

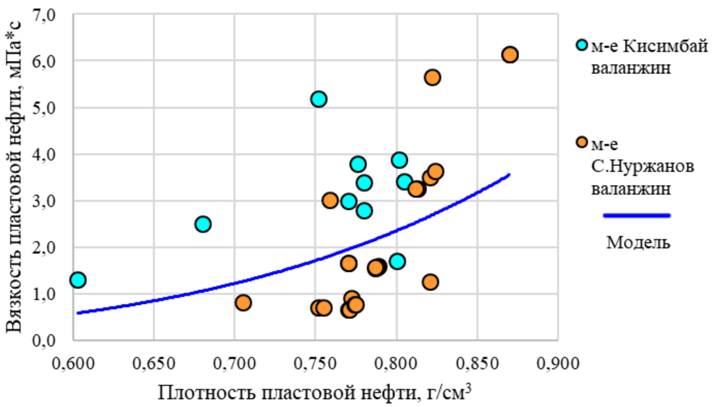

Fig.11 Dependence of viscosity on density of formation oil

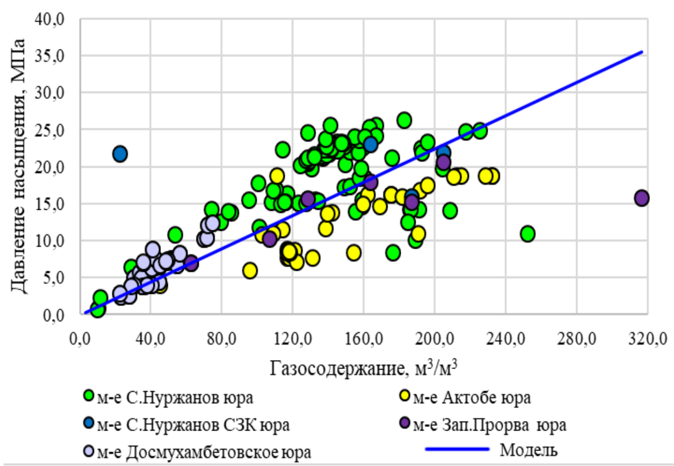

Fig.12 Dependence of saturation pressure on gas content of reservoir oil

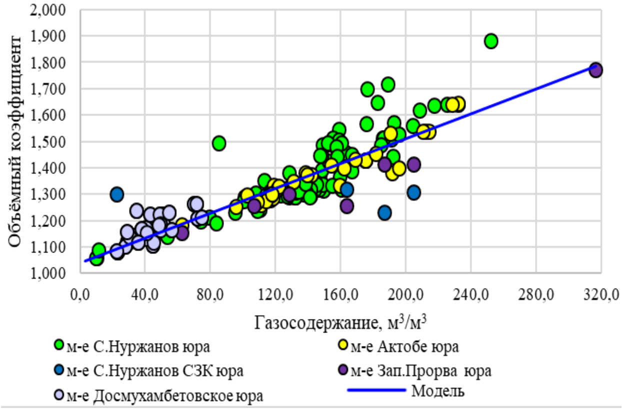

Fig.13 Dependence of volumetric ratio on gas content of reservoir oil

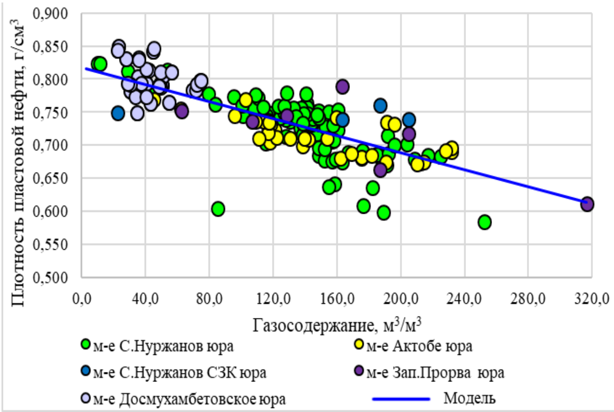

Fig.14 Dependence of density on gas content of reservoir oil

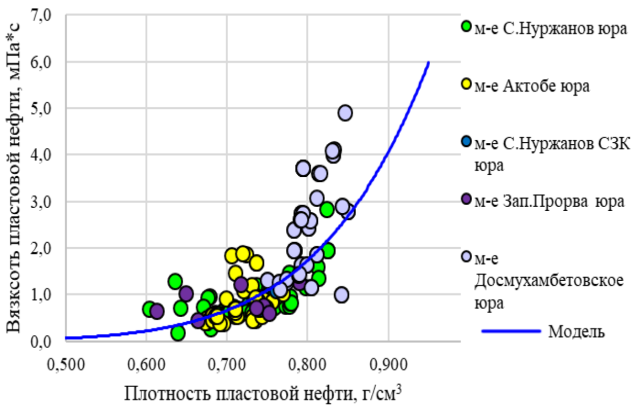

Fig.15 Dependence of viscosity on formation oil density

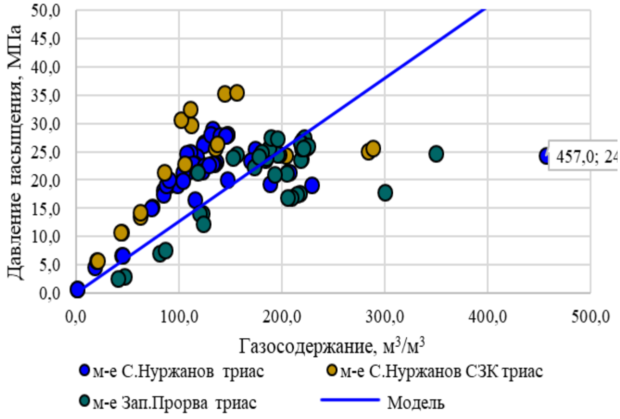

Fig.16 Dependence of saturation pressure on gas content of reservoir oil

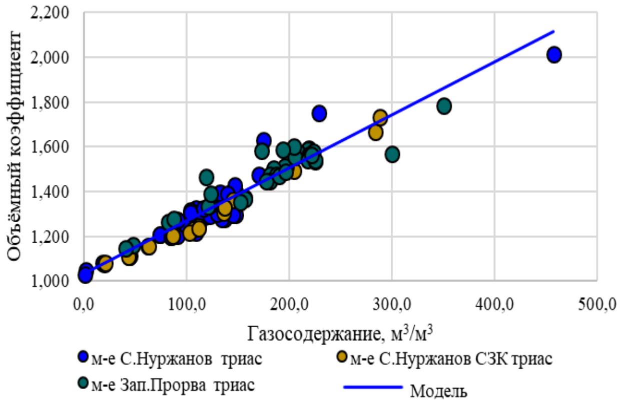

Fig.17 Dependence of volumetric coefficient on gas content of reservoir oil

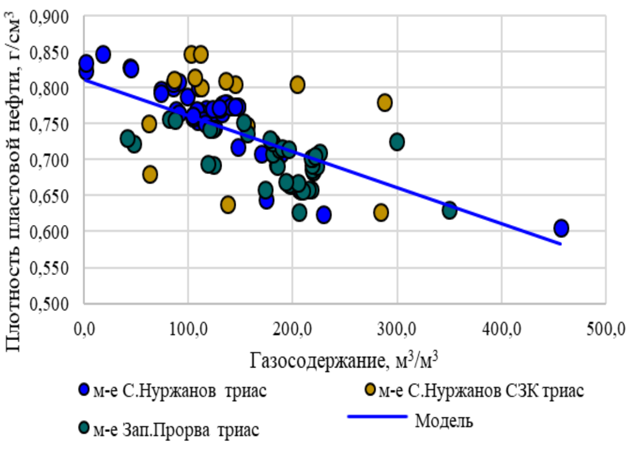

Fig.18 Dependence of density on gas content of reservoir oil

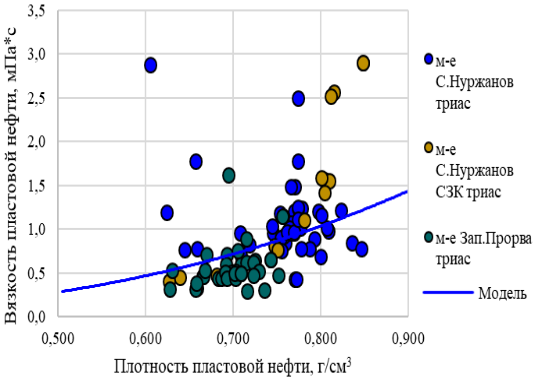

Fig.19 Dependence of viscosity on formation oil density

Table 2 - PVT properties of oil of the fields under consideration

The field	Horizon	Middle of the absolute mark, m	Parameters								
			Reservoir pressure, MPa	Formation temperature, C	Gas saturation pressure, MPa	Volume ratio	Gas content, m^3/m^3	Gas content, m^3/t	Oil density in formation conditions, kg/m^3	Reservoir oil viscosity, mPa*s	Oil density in surface conditions., kg/m^3
Kisimbay	valangine	-1585,0	15,4	61	10,4	1,184	64,9	74,6	0,757	3,1	0,873
West Prorva	Ю-II	-2254,8	24,9	73	24,9	1,460	165,0	194,2	0,688	1,1	0,850
	Ю-III-1	-2281,0	24,9	73	24,9	1,460	165,0	194,2	0,688	1,1	0,832
	T-II	-3118,0	30	95	25,4	1,490	162,5	189,4	0,681	0,4	0,845
	T-III	-3202,0	32	98	26,6	1,540	168,3	190,4	0,685	0,5	0,884
	T-V	-3361,2	34	98	34,0	1,550	195,8	224,8	0,681	0,5	0,890
Dosmukhambetovsky	VIII-1	-2134,9	20,4	76	5,4	1,129	32,0	38,2	0,778	1,8	0,838
	VIII-2	-2148,6	22,7	71,8	4,4	1,152	36,3	41,7	0,802	2,9	0,868
	VIII-4-Б	-2231,0	22,7	74,5	7,1	1,172	44,0	49,4	0,805	3,1	0,878
	IX-2	-2316,4	23,5	75,9	7,4	1,200	50,0	56,6	0,800	2,4	0,880
	XIV	-2529,4	28,1	82,8	9,4	1,215	61,9	70,9	0,789	1,6	0,873
	XV	-2590,8	28,5	83,6	7,1	1,119	35,6	40,0	0,831	4,1	0,865
Aktobe	$VIII_1$	-2243,0	24,7	73	7,8	1,312	94,4	116,9	0,720	1,1	0,823
	$VIII_2$	-2254,0	24,1	76,7	8,0	1,322	99,3	121,5	0,719	0,6	0,821
	$VIII_3$	-2307,0	22,6	77,4	17,3	1,453	158,2	190,3	0,690	0,5	0,828
	$VIII_4$	-2325,0	22,6	77,3	16,7	1,442	153	183,6	0,700	0,6	0,850
	$VIII_5$	-2372,6	22,1	77,9	10,7	1,307	99,3	119,7	0,726	0,9	0,833
	IX_1	-2376,1	23,0	77,4	14,6	1,395	131,8	158,3	0,707	0,6	0,836

Table 2 continued

The field	Horizon	Middle of the absolute mark, m	Parameters								
			Reservoir pressure, MPa	Formation temperature, C	Gas saturation pressure, MPa	Volume ratio	Gas content, m^3/m^3	Gas content, m^3/t	Oil density in formation conditions, kg/m^3	Reservoir oil viscosity, mPa*s	Oil density in surface conditions, kg/m^3
S. Nurzhanov (all deposits)	Valangine South Field	-1900,9	19,3	64,0	7,3	1,295	103,1	124,1	0,767	0,7	0,830
	Valangine S-V Field	-1893,4	17,4	66,0	10,4	1,164	54,3	62,8	0,789	1,86	0,843
	Yu-I	-2262,5	22,2	74,0	15,6	1,233	85,0	95,0	0,773	0,8	0,873
	Yu-II	-2274,0	24,1	74,1	21,6	1,34	123,8	141,4	0,734	0,8	0,870
	Yu-III	-2315,8	20,7	78,0	16,9	1,241	95,5	109,6	0,775	0,77	0,848
	Yu-IV	-2394,5	26,6	75,0	23,9	1,331	130,6	149,5	0,743	0,86	0,876
	YU-V	-2775,7	29,2	88,1	20,8	1,475	134,3	153,6	0,715	0,74	0,878
	T-II-A	-3050,4	33,4	98,0	22,4	1,690	179,6	202,0	0,635	1,19	0,891
	T-III	-3219,0	29,9	97,4	24,2	1,375	116,5	147,3	0,761	0,94	0,897
	T-IV	-3185,0	29,9	97,4	24,2	1,375	116,5	147,3	0,761	0,94	0,895
	T- V	-3263,2	32,1	99,8	27,9	1,298	129,5	146,2	0,774	0,78	0,891
S. Nurzhanov Northwest Wing	Yu-II	-2283,0	24,2	75,0	22,3	1,310	127,1	147,3	0,746	0,7	0,865
	Yu-IV	-2436,8	26,9	76,8	16	1,231	83,5	95,8	0,778	1,1	0,873
	T-II-A	-3299,4	34,6	97,4	26	1,342	128,7	143,5	0,751	0,7	0,899
	T-IV-A	-3259,9	36,2	97,4	25,4	1,698	244,8	286	0,653	0,4	0,856
	T-V	-3518,8	36,9	99,5	28,7	1,229	99,1	106,5	0,818	1,8	0,933

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