CONTROL OVER WELL CONSTRUCTION and REPAIR QUALITY BY IDENTIFICATION OF PRODUCED FLUID and GAS GENESIS

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The problem state. One of the typical problems in gas and gas condensate well operation is a gas shows at top of the well. They origin from:

- low cementing quality;
- poor tightness of threaded casing connections.

As far as the reserves are recovered the formation waters penetrate into the pay zone and well production. It complicates operation of intrafield gathering system, results in washing out of bottom hole formation zone and increase wellhead abrasion.

These phenomena can be prevented by improving technologies and perfecting construction and repair quality and applying materials and formulae of leading companies. The effectiveness of these operations also depends on reliable information on composition and genesis of gas and water shows. This knowledge makes it possible to locate the problem, specify the technical preventive solutions and evaluate the quality of performed works.

The target: to specify genesis of gas and water showы using isotope and geotechnical method [1-5, 8].

Methods.

Identification of inter-casing gas genesis.

Carbon isotope signature of two components - methane and the sum of its homologues was taken as an isotope criterion of inter-casing gas genesis [7]. The analysis involved gas samples from standard wells and inter-casing spaces. 128 samples from Zapolyarnoye oil-gas-condensate field (OGCF) include 20 standard samples from inter-casing space of 72 Valanzhinian producing wells. 36 gas samples from Yamburgskoye OGCF comprise 12 standard samples from inter-casing space of 10 Cenoman and Neocomian producing wells. Standard samples are field gases from each production zone: Cenomanian, Turonian (Upper Cretaceous), Valanzhinian and Neocomian. The samples were taken from the trunk line and from the annular space.

Identification of the type of the liquid contained in the well production.

The main water types contained in the well production are: produced waters; condensate waters separated from gas-condensate mixture; process waters injected into the well.

Standard samples are well known produced and condensate waters. They are selected from each production zone; Cenomanian and Valanzhinian as well as from water lines and open water basins of both fields. The water types and their content in well production are identified by their chemical composition [9] and isotope signature of oxygen and hydrogen. There were analyzed 85 samples of liquid from both fields. 46 samples were analyzed in the Zapolyarnoye OGCF; 23 of them were taken from standard Cenomanian and Valanzhinian wells with known type of water (produced and condensate) and 3 samples from the surface sources (the rivers: Pur, Great Khe-Yakha and water lines). In order to identify water origin in the production of 16 wells there were selected 20 samples from 12 Cenomanian wells and 8 samples from 4 Valanzhinian wells. All samples were selected at different gas offtake conditions.

39 analyzed samples of Yamburgskoye OGCF include 24 samples from standard wells with known types of water and 5 samples from surface sources (the Ob Bay, the river

Nuydya-Aduybrye-Poka, industrial water line). 10 samples from 4 wells were selected to identify genesis of the water contained in well production: 8 samples from 8 Cenomanian wells and 2 samples from 1 Neocomian well. All samples were selected at different gas offtake conditions.

The results

Fractional analysis of gases. The chemical composition of reference gases from Cenomanian and Turonian horizons of both fields is very similar (Fig. 1 and 3). They are "dry" gases with high content of methane (98% vol.) and low content of the sum of hydrocarbons (C_1-C_6) (0.24% vol.). They are free of hydrogen but contain helium (0.014% vol.).

The chemical compositions of reference gases from Valanzhinian horizon of Zapolyarnoye OGCF and Neocomian of Yamburgskoye OGCF (Table 1, 3) are similar and significantly differ from the gases of the overlaying zones. They contain 8.4% vol. of hydrocarbon of methane homologues and 0.016% vol. of helium, mass content of hydrogen varies from 0 % vol. to 0,833% vol.

The chemical composition of inter-casing gases from both fields is relatively equal (Table 2, 4). They are hydrocarbon gases of a wide range of methane content (from 71.8 % vol. to 98.8% vol.) and the sum of hydrocarbons (from 0.001% vol. to 16.7% vol.). A high content of nitrogen is registered in spot gas samples (up to 30.5-47.26% vol.) that probably have man-caused character (nitrogen purging of inter-casing space). High hydrogen content is typical for the pads where substantially all wells contain hydrogen. Resampling and analysis of inter-casing gases with a content of hydrogen 10% and more from Zapolyarnoye OGCF were performed in two years and also showed its high content. In three samples leveled to 52.92% vol., 47.5% vol. and 61% vol. correspondingly. The chemical gas composition cannot uniquely identify the origin of gas shows in inter-casing space of the most wells of fields.

Isotope signature of methane carbon and the sum of homologue of gases from the same horizons had been controlled (Table 1, 3). It is shown that $\delta^{13}C$ value range for each component namely methane and sum of hydrocarbons (HC) are overlapped and by their isotope criteria they can be united into one group of Cenoman-Turonian and Cenomanian gases of both fields. This group of reference isotope-light gases with $\delta^{13}C$ value variations: methane from -53.4‰ to -57.5‰, and the sum of HC from -49.0‰ to -52.0‰.

The second group of reference gases (Valanzhinian (Table 1) and Neocomian (Table 3) is enriched by heavy carbon isotope. $\delta^{13}C$ value limits in this group: methane from -33.8‰ to -37.5‰, and the sum of HC from – 29.3‰ to – 33.2‰. The variations of the component`s isotope signatures for these two groups of gases do not overlap. The difference in average values makes: for methane – 19.5 ‰, for the sum of - 18.4‰. It may be concluded that the isotope signature enables reliably differentiate group gases.

The crucial result of isotope analysis of standard samples is that they differ not only in isotope signature of methane carbon but also in carbon isotope signature of the sum of methane homologues (the sum of HC). It made possible to use this feature as an additional isotope criteria [7].

The tested gases were gases accumulated between surface casing and intermediate casing (inter-casing space (ICS) – bottom), and gases accumulated between intermediate casing and production casing (ICS – top) from both fields. Isotope signature of methane and the sum of hydrocarbons are shown in the Table 2, 4.

General variation graph of carbon isotope signature of methane and the sum of hydrocarbons for reference gases and gas samples from ICS in both fields (fig. 1).was plotted in order to identify the gas source in ICS by isotope criteria. There are three highlighted areas of isotope signature values on the Fig.1 they are marked correspondingly: **K_2, K_1, K_1 +K_2**.

The K_2 area by $\delta^{13}C$ values is similar to the components of the Cenoman-Turonian reference gases. It comprises gas samples from ICS where methane and the sum of HC were enriched by light isotopes $\delta^{13}C$: methane from -51.8‰ to -55.9‰ ($\delta^{13}C_{average}$ = -54.0‰), the sum of HC from -41.4‰ to -48.9‰ ($\delta^{13}C_{average}$ = -44.2‰). So the source of annular gas is Cenoman-Turonian gas.

The K_1 area by $\delta^{13}C$ values is close to the components of Valanzhinian (Neocomian) reference gases. It includes gas samples from ICS where methane and the sum of homologues are enriched by heavy carbon isotopes. Their values: methane from -35.8‰ to -44.9‰ ($\delta^{13}C_{average}$ = -40.9‰), the sum of carbons from -29.0‰ to -39.9‰ ($\delta^{13}C_{average}$ = -32.2‰). The source is Valanzhinian (Neokomian) gas.

The K_1+K_2 area. It includes great number of samples where methane in its carbon isotope signature verges towards methane from Cenoman-Turonian standard wells. The $\delta^{13}C$ values: from -49.1‰ to -55.5‰ ($\delta^{13}C_{average}$ = -52.1‰), and the sum of HC by isotope signature is similar to the sum of HC of Valanzhinian (Neocomian) reference gases: $\delta^{13}C$ from -30.1‰ to -40.7‰ ($\delta^{13}C_{average}$ = -38.1‰). These gases are provisionally marked as mixed type gases.

The evaluation of gas portion (fraction) in each source demanded calculation of the isotope signature of model gas mixture with different content of Cenoman-Turonian and Valanzhinian reference gases by the formula (1):

$$\delta^{13}C_i = \frac{\delta^{13}C_{ср.сен.} * X_{ср.сен.} * N_{сен} + \delta^{13}C_{ср.вал.} * X_{ср.вал}}{X_{ср.сен.} * N_{сен.} + X_{ср.вал.} * N_{вал.}} \qquad (1)$$

The calculations (line 5 Fig. 1) display variations of methane carbon isotope signatures from the sum of homologues for this gas mixture according to the fractional (*N*) mixture of gas with mean values: isotope ($\delta^{13}C_{average}$) and chemical ($X_{average}$) compositions of Cenoman-Turonian and Valanzhinian reference gases correspondingly.

Two sources of gas presence in annular space (49 producing Valanzhinian wells in Zapolyarnoye OGCF and 10 producing Cenomanian and Neocomian wells in Yamburgskoye OGCF) were identified by these isotope criteria. They were divided in three groups:1st group – the gas source is mainly from Cenoman-Turonian (ZOGCF) or Cenomanian (YOGCF) deposits; 2nd group – Valanzhinian (ZOGCF) or Neocomian (YOGCF) horizons; 3rd group – mixture of gas from both complexes, fraction of each was calculated by the formula (1). Monitoring of gas sources in inter-casing space in Zapolyarnoye OGCF has shown that 14 samples after restudies conducted in 5.5 months (4 samples) and in 2 years (10 samples) contained the gas of the same source but isotope and chemical composition of gas components had changed.

Cenomanian standard produced waters of the fields have slight difference in chemical composition. It is a sodium chloride type of waters with mineralization of 17-21 g/dm^3, and high bromine and iodine content (Table 5). Neocomian standard waters in Yamburgskoye OGCF have chloride and sodium bicarbonate composition with higher mineralization about 5-7.0 g/dm^3 and less content of bromine and iodine then in Cenoman (Table 5). Standard samples of condensate water of both fields have similar chemical composition. If compared with produced waters they have low mineralization (28-1255 mg/dm^3), chloride bicarbonate sodium calcium type, low bromine and iodine content (Table 5). Mineralization range of standard process waters – samples of surface waters and water line waters is 5 -194 mg/dm^3 (Table 6).

Consolidated data on chemical composition of waters contained in well production of both fields is shown in Table 7. Production of explored wells of Zapolyarnoye OGCF contains 4 water groups which differ in their chemical composition: the waters of 1st group – in 4 wells are filtrates, probably mixtures of condensate and process waters. They are characterized by low mineralization and have bicarbonate sulfate, calcium sodium composition; the 2nd group – 1 well contained produced water from Valanzhin with mineralization ~ 5 g/l and chloride sodium composition; the 3rd water group from 4 wells is similar to chemical composition of Valanzhinian condensate waters (low mineralization and low concentration of iron); the 4th group are waters from CGTU. It may be referred to the condensate waters of mixed type – they are mineralized, bicarbonate chloride and chloride bicarbonate waters with changing (up to high) content of iron.

Well production in Yamburgskoye OGCF contains 2 water groups with different chemical composition: the 1st group is the chloride waters from 2 wells – condensate diluted with relatively low mineralization and high iron fraction in cation composition; the 2nd group from 1 well – produced sediment waters of Valanzhin. The production of other wells from explored fields contains, probably, a mixture of different types of waters. It is impossible to identify uniquely the content of each type of water by their chemical composition.

Hydrogen and oxygen isotope signature of water is identified by isotope-geochemical method. Isotope signature of standard water samples of known type was compared with isotope signature of waters contained in well production. Variations of hydrogen isotope signature and deuterium of produced and condensate waters from standard wells of explored stratigraphic horizons, surface waters and waters contained in well production of Yamburgskoye and Zapolyarnoye OGCF are presented in Table 5-7 and Fig.2

There are outlined nonoverlapping domains of isotope signature of different types of standard waters. Isotope-light waters locate: a) in surface basins and rivers - **T_1** domain (δD= -154.8 ÷ - 142.2 ‰ where $\delta D_{av.}$= -148.1 ‰ and $\delta^{18}O$ = -20.8 ÷ -18.4‰ where $\delta^{18}O_{av.}$= -19.3 ‰); b) in low water-bearing horizon (water conducts) – **T_2** domain (δD= -126.4 ÷ - 121.7 ‰ where $\delta D_{av.}$= - 124.1 ‰ и $\delta^{18}O$ = - 17.0 ÷ -15.7‰ where $\delta^{18}O_{av.}$= - 16.3 ‰). Both domains **T_1** and **T_2** go along Craig line that conforms to the isotope composition of meteoric waters of this region. It was identified that produced waters are divided in two separate domains (according to their deuterium number): **FK_2** – Cenomanian produced waters (δD= - 80.5 ÷ - 62.5 ‰ where $\delta D_{av.}$= - 70.9 ‰ and $\delta^{18}O$ = - 11.8 ÷ -4,6‰ where $\delta^{18}O_{av.}$= - 8.7 ‰); and **FK_1 –** Neocomian produced waters (δD= - 91.1 ÷ - 74.7 ‰ where $\delta D_{av.}$= - 81.3 ‰ and $\delta^{18}O$ = - 12.2÷ -4.9‰ where $\delta^{18}O_{av.}$= - 7.6 ‰). We observe isotopic and oxygenic change (enrichment by heavy oxygen isotopes) in waters from deeper horizons – Neocom (Valanzhin). Variations of condensate water isotope signature occupy intermediate position (Fig.2). They are divided in two domains as well: **CK_2** – Cenomanian condensate waters (δD= - 119.3 ÷ - 98.0 ‰ where $\delta D_{av.}$= - 107.4 ‰ и $\delta^{18}O$ = - 15.2÷ -11.2‰ where $\delta^{18}O_{av.}$= - 13.5 ‰) and **CK_1 -** Neocomian (Valanzhinian) condensate waters (δD= - 128.8 ÷ - 96.8 ‰ where $\delta D_{av.}$= - 109.6 ‰ и $\delta^{18}O$ = - 11.4÷ -8.1‰ where $\delta^{18}O_{av.}$= - 10.0 ‰). These differences in isotope composition of different type of waters serve to identify the source of waters contained in well production.

Variations of oxygen and hydrogen isotope signature of samples taken from well production of both fields are shown in Fig.2. In production of 15 wells of ZOGCF 18 samples according to their oxygen and hydrogen isotope signature pertain to a broad domain of condensate waters of Cenomanian and Valanzhinian horizons correspondingly. 2 samples from 2 wells production were enriched by heavy isotopes and therefore they were referred to the domain of isotope composition of Valanzhinian produced water. It was revealed that the main source of water in production of 3 wells from 4 in Yamburgskoye OGCF is a mixture of two types of water; 2 wells (6 samples) contained condensate and produced waters, 1 well (2 samples) contained process water with a slight fraction of produced water from corresponding deposits. The source of water in one well (2 samples) was Cenomanian produced water.

The conclusions

For the first time the carbon isotope signature of two gas component: methane and the sum of its homologues were used as gas genesis criteria. It made possible to divide inter-casing gases in two genetic groups:

- 1st group is isotope-light Cenomanian-Turonian (Cenomanian) gases;
- 2nd group is Valanzhinian (Neocomian) gases, where methane and the sum of HC are enriched by heavy carbon isotopes.

Two sources of gas show in inter-casing space of 72 Valanzhinian producing wells in Zapolyarnoye OGCF and 10 Neocomian and Cenomanian producing wells in Yamburgskoye OGCF were identified by isotope criteria.

Carbon isotope composition of methane and the sum of HCs identifies gas show origin at the different stages of prospecting and operational works in the oil and gas fields.

Isotope composition analysis of waters from standard wells of Zapolyarnoye and Yamburgskoye OGCF has proved that:

- produced waters in comparison with condensate waters are enriched by heavy isotopes of oxygen and deuterium;
- in produced and condensate waters we can observe the change (enrichment by heavy oxygen isotopes) of waters from deeper Neocom horizons for approximately 2.4‰;
- Surface waters are enriched by light oxygen and hydrogen isotopes and their isotopes composition is equivalent to the composition of the meteoric waters in the region.

Isotope composition of different types of waters identifies the sources of waters in production of gas-condensate wells.

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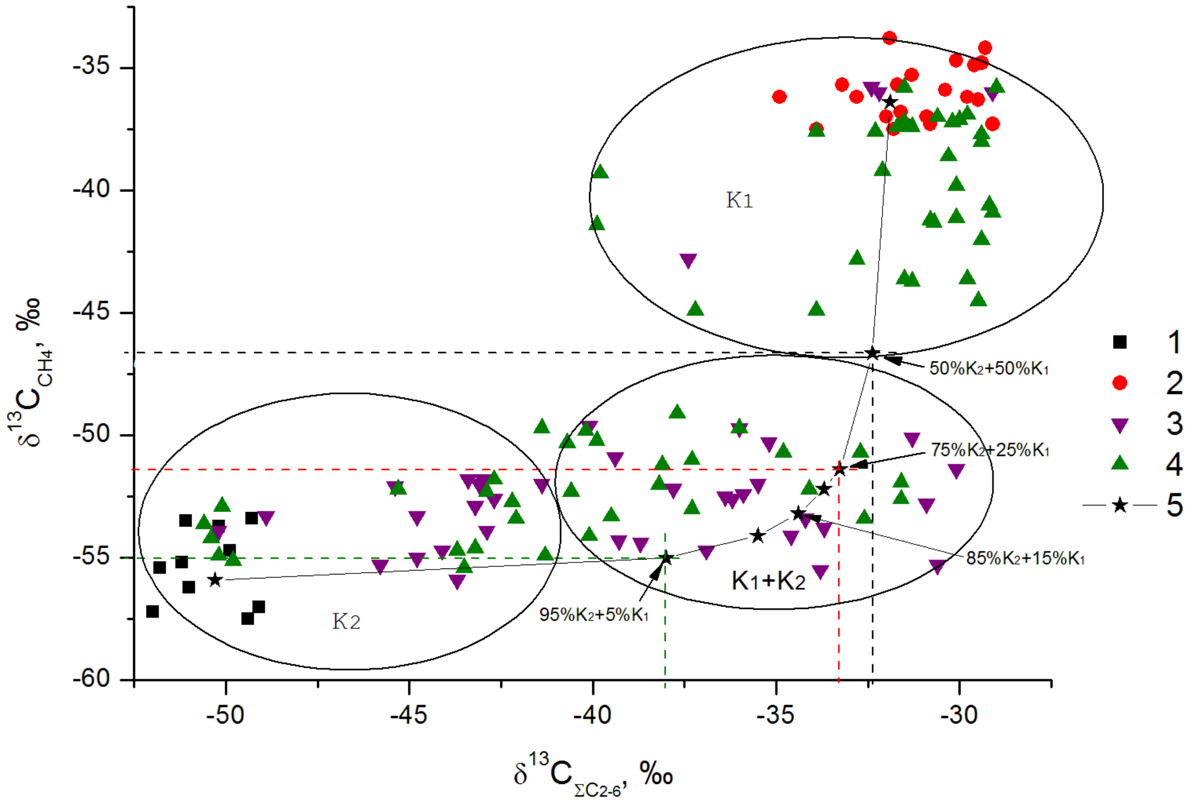

Fig. 1 Variations of methane carbon isotope signatures from the sum of homologues for reference gases and gas samples from inter-casing space of Yamburgskoye and Zapolyarnoye OGCF wells.

Symbols: 1- Cenoman, Turon; 2 – Valanzhin, Neocom; 3 – annular gas (bottom bend); 4 – annular gas (top bend); 5 – line where dots are calculated by formula (1)

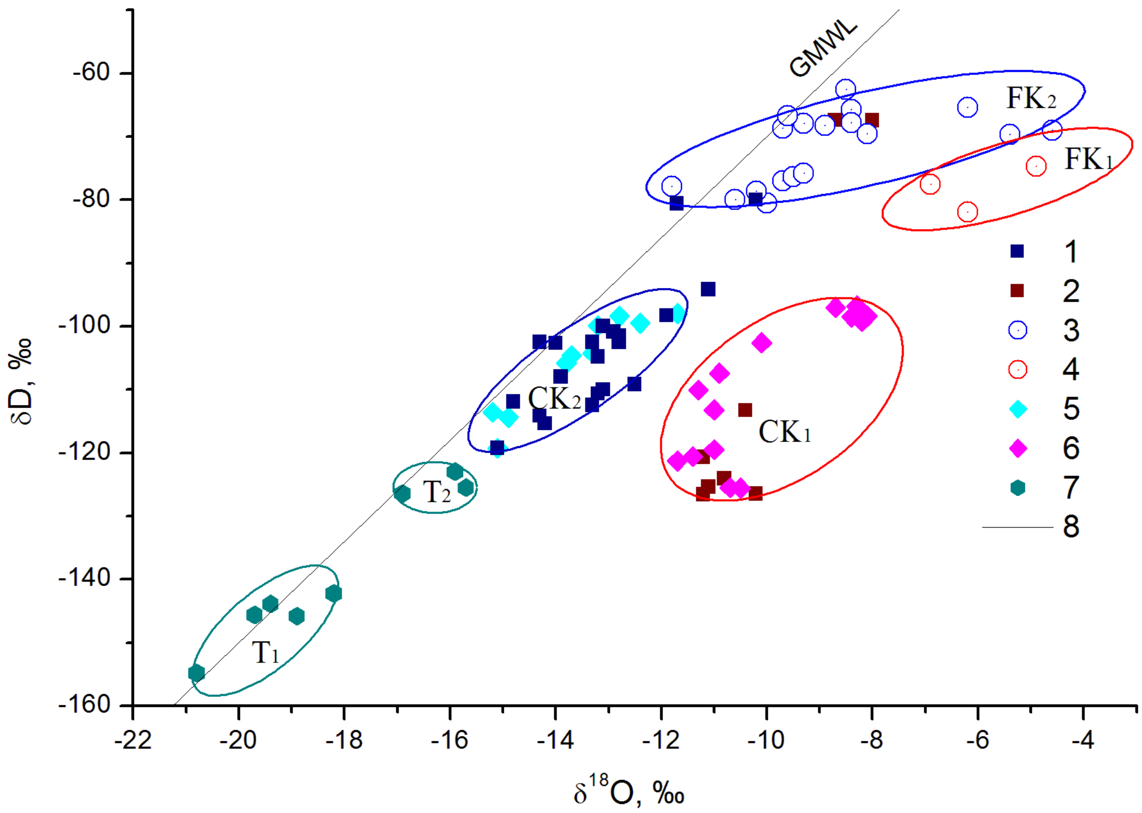

Fig. 2. Variation of hydrogena and oxygen isotope signature of different water types from Yamburgskoye and Zapolyarnoye OGCF.

Symbols: water from well production: 1- Cenomanian, 2- Neocomian.
Water from reference wells: produced water – 3- Cenomanian, 4- Neocomian; condensate water – 5- Cenomanian, 6- Neocomian;
surface and water line water – 7; line of meteoric waters (GMWL)- 8 by the data [1, 4].
Variation of different types of waters: surface meteoric waters - T_1, T_2; condensate water – CK_2 - Cenomanian, CK_1 - Neocomian;
produced waters – FK_2 - Cenomanian, FK_1 - Neocomian.

Table 1

Chemical and isotope composition of gases from reference wells of Zapolyarnoye OGCF

Stage, formation	n samples	CH_4		∑HC		Content of atmospheric components, %, (vol.)		
		%, об.	$\delta^{13}C$, ‰	%, об.	$\delta^{13}C$, ‰	Hydrogen	Nitrogen	Helium
Turon	3	97.3 – 98.4	-57.5 ÷ -53.4	0.32 – 0.38	-51.8 ÷ -49.3	0.000 - <0.004	0.78 – 1.30	0.011 – 0.016
Cenoman	5	96.5 – 99.5	-57.2 ÷ -53.7	0.08 – 0.100	-52.0 ÷ -49.0	0.000 - 0.006	0.80 —1.71	0.011 – 0.014
Valanzhin, БТ-6-8	7	84.8 – 89.2	-36.3 ÷-35.9	8.68 – 10.83	-32.8 ÷ -29.5	0.010 – 0.030	0.53 – 2.07	0.009 – 0.025
Valanzhin, БТ-10	5	89.3- 90.0	-36.8 ÷ -34.7	6.87 – 8.96	-32.0 ÷ -30.1	0.011 – 0.040	0.57 – 1.60	0.010 – 0.019

Table 2

Chemical and isotope composition of gases from Valanzhinian wells of Zapolyarnoye OGCF

Formation	n samples	CH_4		∑HC		Content of atmospheric components, % (vol.)		
		%,об.	$\delta^{13}C$, ‰	%,об.	$\delta^{13}C$, ‰	Hydrogen	Nitrogen	Helium
БТ 6-8	42	76.3 – 98.4	-55.4 ÷ -37.6	0.02 - 9.06	-43.7 ÷ -29.8	<0.004 – 15.38	0.33 – 5.81	0 – 2.470
БТ 6-8	29	71.8 – 98.2	-55.9 ÷ -42.8	0.07 – 0.59	-45.4 ÷ -30.8	<0.004 – 3.4	0.0 - 14.1	0.000 – 0.1430
БТ10	27	72.2 – 98.8	-54.6 ÷ -37.4	0.05 – 8.96	-45.3 ÷ -29.4	<0.004 – 17.95	0 – 12.3	<0.004 – 1.650
БТ10	10	97.0 – 98.3	-55.3 ÷ -50.4	0.10 – 0.31	-48.9 ÷ -38.1	0.048 - 6.593	0.59 - 8.77	0.006 - 0.013

Table 3

Chemical and isotope composition of gases from reference wells of Yamburgskoye OGCF

Stage, formation	n samples	CH_4		∑HC		Content of atmospheric components, % (vol.)		
		%, vol.	$\delta^{13}C$, ‰	%, vol.	$\delta^{13}C$, ‰	Hydrogen	Nitrogen	Helium
Cenoman	2	96.8 – 7.8	-55.2 ÷ -53.5	0.012—0.047	-51.2 ÷ -51.1	0.000 – 0.006	1.12 – 1.16	0.011 – 0.013
Neocom, БУ-3,4	1	88.7	-37.3	8.621	-30.8	0.012	2.23	0.008
Neocom, БУ-8	7	82.9 – 91.3	-37.5 ÷ -33.8	3,077 - 15,496	-33.2 ÷ -29.3	<0.004 – 0.833	0.51 – 2.50	<0.004 – 0.011
Neocom, БУ-9	2	70.1 – 88.9	-37.0 ÷ -34.8	8.061— 23.977	-30.9 ÷-29.4	<0.004 – 0.326	0.72 – 2.59	<0.004 – 0.004

Table 4

Chemical and isotope composition of gases from annular space of Cenomanian and Neocomian wells of Yamburgskoye OGCF

Stage, formation	n samples	CH_4		∑HC		Content of atmospheric components, % (vol.)		
		%, vol.	$\delta^{13}C$, ‰	%, vol.	$\delta^{13}C$, ‰	Hydrogen	Nitrogen	Helium.
Cenoman	5	95.4 – 96.8	-55.1 ÷ -52.9	0.001 – 0.005	-50.6 ÷ -49.8	0 – 1.104	1.08 – 1.79	<0.004 – 0.014
Cenoman	1	95.3	-53.9	0.001	-50.2	<0.004	1.98	0.017
Neocom, БУ-3	1	8.2	-37.4	0.636	-31.7	0.032	91.08	<0.004
Neocom, БУ-8	11	86.8 – 94.4	-42.8 ÷ -35.8	0.300 – 9.328	-32.8 ÷ -29.1	<0.004 – 3.654	0.72 – 5.29	<0.004 – 0.019
Neocom, БУ-8	2	91.2 – 92.5	-36.0 ÷ -35.8	6.584 – 6.664	-32.4 ÷ -32.2	0.046 – 0.815	0.77 – 1.31	0.005 – 0.006
Neocom, БУ-9	3	79.9 – 90.1	-37.2 ÷ -36.9	8.917 – 16.704	-31.5 ÷ -29.8	0.113 – 0.154	0.91 – 1.02	<0.004 – 0.005
Neocom, БУ-9	1	74.8	-36.0	8.854	-29.1	0.138	1.84	<0.004

Table 5

Variations of chemical and isotope composition of reference samples of produced and condensate waters

№	OGCF	Formation	Type of water	N of samples	Sum of salts, mg/dm^3	Br^-, mg/dm^3	I^-, mg/dm^3	δD, ‰	$\delta^{18}O$,‰
1	Zapolyarnoye	Cenoman	Produced water	3	15837—16869	16.1—23.5	9.1—14.2	-69.6 ÷ -62.5	-8.9 ÷ -8.1
2	Zapolyarnoye	Cenoman	Condensate water	7	28—476	<3.0—4.0	<0.2	-119.3÷ -98.0	-15.2 ÷ -11.7
3	Zapolyarnoye	БТ 6-8 Valanzhin	Condensate water	11	183,7—1255,8	<3.00—7.36	<0.20—7.78	-125.6 ÷ -96.8	-11.3 ÷ -8.1
4	Zapolyarnoye	БТ 10/1 Valanzhin	Condensate water	2	144,9—154,8	<3.0	<0.2	-120.6 ÷ -119.5	-11.4 ÷ -11.0
5	Yamburgskoye	Cenoman	Produced water	15	13329—21131	35.0—77.5	9.8—21.7	-80.5 ÷ -65.4	-11.8 ÷ -4.6
6	Yamburgskoye	Neocom	Produced water	4	5159—7037	33.1—44.6	2.8—3.9	-81.9 ÷ -74.4	-6.9 ÷ -4.9
7	Yamburgskoye	Neocom	Condensate water	1	627	7.6	0.59	-121.3	-11.7
8	Yamburgskoye	Cenoman	Condensate water	4	226—1176	10.6—15.6	0.26—3.70	-109.1 ÷ -104.3	-13.8 ÷ -11.2

Table 6

Chemical and isotope composition of samples from water lines and surface waters (sources of process waters)

№	OGCF	Place of selection	Sum of salts, mg/dm^3	Br $^-$, mg/dm^3	I $^-$, mg/dm^3	δD, ‰	δ^{18}O,‰
1	Yamburgskoye	Nyudya-Adlyubrye-Poka river	10	<3.0	<0.2	-143.9	-19.4
2	Yamburgskoye	Water line	119	<3.0	<0.2	-123	-15.9
3	Yamburgskoye	Water line	121	3.5	<0.2	-125.5	-15.7
4	Zapolyarnoye	The Pur river	20	<3.0	<0.2	-145.8	-18.9
5	Zapolyarnoye	Great Khe-Yakha river	15	<3.0	<0.2	-142.2	-18.2
6	Zapolyarnoye	Water conduct	194	<3.0	<0.2	-126.4	-16.9
7	Yamburgskoye	Ob Bay 1,5км offshore	5	<3.0	<0.2	-154.8	-20.8
8	Yamburgskoye	Ob Bay by the shore	81	<3.0	<0.2	-145.6	-19.7

Table 7

Variations of chemical and isotope composition of waters samples taken from production of the Zapolyarnoye and Yamburgskoye OGCF

OGCF	Type of water by isotope data	Formation	N of samples	Sum of salts, mg/dm^3	Br $^-$, mg/dm^3	I $^-$, mg/dm^3	δD, ‰	δ^{18}O,‰
1	2	3	4	5	6	7	8	9
Zapolyarnoye	Condensate	Cenoman	12	546 – 60	<3.0 - 5.5	<0,2	-112.0÷ -100.9	-14.8 ÷ -12.8
	Condensate	Valanzhin	6	925 - 471	<3.0 – 5.4	0.2 – 1.4	-128.7 ÷ -113.3	-11.2 ÷ -10.2
Zapolyarnoye	Produced	Valanzhin	2	5147 -4929	18.4 – 21.6	8.5 –9.6	-67.5 ÷ -67.4	-8.7 ÷ -8.0
Yamburgskoye	Condensate	Cenoman	1	1347	8.0	1.0	-109.2	-12.5
Yamburgskoye	Produced	Cenoman	2	1554-2062	<3.0	<0.2	-80.6 ÷ -80.0	-11.7 ÷ -10.2
Yamburgskoye	Produced+condensate	Cenoman	5	8281 - 3072	3.5 – 14.8	<0.2 – 6.5	-100.0 ÷ -94.2	-13.3 ÷ -10.1
Yamburgskoye	Produced+condensate	Cenoman	2	45512 - 42095	11.5 – 10.6	-	-102.0 ÷ -101.1	-12.4 ÷ -11.0