IMPACT OF RESERVOIR WATER ON WELL PRODUCTIVITY AT THE SHARKI BERDAK GAS PROCESSING PLANT

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Annotatsiya: Maqolada 2016-2025 yillarda Sharqiy Berdak gaz kondensati konining quduqlarini gidrodinamik tadqiqotlar (GDI) natijalari ko'rib chiqilgan. Qatlam suvlarining qazib olish quduqlarining mahsuldorligiga ta'siri ko'rsatilgan. Gaz-suv siljishini ko'rsatadigan barqaror rezervuar bosimida gaz oqimining pasayishi va filtrlash qarshiligi koeffitsientining o'sishi qonuniyatlari o'rnatildi. Ish rejimini optimallashtirish bo'yicha tavsiyalar berilgan.

Kalit so'zlar: gazodinamik tadqiqotlar , qatlam bosimi, qarshilik, depressiya, gaz-suv aloqasi , suv, gidrodinamik model.

Аннотация: В статье рассмотрены результаты гидродинамических исследований (ГДИ) скважин газоконденсатного месторождения Шаркий Бердак за 2016–2025 гг. Показано влияние пластовых вод на продуктивность добывающих скважин. Установлены закономерности снижения дебита газа при стабильных пластовых давлениях и роста коэффициента фильтрационного сопротивления, что указывает на смещение газо-водяного контакта (ГВК). Даны рекомендации по оптимизации режима эксплуатации.

Ключевые слова: газодинамические исследования, пластовое давление, сопротивления, депрессия, газоводяной контакт (ГВК), обводнение, гидродинамическая модель.

Abstract: The article considers the results of hydrodynamic studies of wells in the Sharky Berdak gas condensate field for 2016-2025. The influence of reservoir waters on the productivity of producing wells is shown. Patterns of a decrease in gas flow rate at stable reservoir pressures and an increase in the filtration resistance coefficient have been established, which indicates a displacement of the gas-water contact (GVC). Recommendations on optimizing the operating mode are given.

Key words: gas dynamic studies, reservoir pressure, resistance, depression, gas-water contact (GVK), flooding, hydrodynamic model.

Introduction

The development of deposits in the Ustyurt region is complicated by the active manifestation of plantar waters. Their intrusion into the bottom-hole zone of wells reduces gas saturation and worsens filtration characteristics. Therefore,

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regular GDI is a necessary condition for monitoring and regulating the technological mode of operation. Before putting wells into operation or transferring them to other facilities, GDI is carried out to set the required parameters of well operation. In the conditions of development of deposits in the Ustyurt region, due to their complex geological structure and reservoir water activity, the solution to the problem of installing an appropriate technological mode of operation of wells is relevant, since it allows limiting the intensity of reservoir water movement into the gas extraction zone. In the development rules [1, 2, 3], it is recommended to conduct GDS of wells for the entire existing fund once a year.

At the Sharkiy Berdak GCM, GDS was carried out during its exploration and development. As part of the study , the results of GDS of 32 wells for 2016-2024, as well as the first quarter of 2025, were selected for analysis. In the years covered by the analysis, pilot development projects were compiledразработки, as well as adjustments to existing development projects.

METHODS. Theresults of GDS of 32 wells of the Sharkiy Berdak gas field for the period 2016-2024 and the first quarter of 2025 were used for analysis.Changes in reservoir pressure[4, 5], absolute free gas flow rate, and filtration resistance coefficient were considered . The method of analysis is based on comparing the dynamics of pressure and flow rate with changes in filtration resistance coefficients.

RESULTS. The analysis showed that in many wells there is a drop in gas production while maintaining pressure. This is confirmed by the active pull-up of the plantar water and the displacement of the GVK. The most illustrative examples are given below. (table 1).

Table 1

Results of GDS of wells Шаркий of Sharkiy Berdak GCM

№ sle nu mb er.	Date of the study	Interval perfor., m	the Coefficient of filtration resistance		Static pressure, kgf/cm2	pressure, kgf/cm2	Abs. free flow of gas at RPL, thousand m3/day
			And	In			
34	28.05.2018	1521-1515	of 9.29	0,0939	of 62.1	69.9 per	the 162.8
	01.04.2021		37,81	0,08553	of 37.8	42,5	of 43.47

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№ sle nu mb er.	Date of the study	Interval perfor., m	the Coefficient of filtration resistance		Static pressure, kgf/cm2	pressure, kgf/cm2	Abs. free flow of gas at RPL, thousand m3/day
			And	In			
	01.02.2022		77,768	0,0475 4	53,5	64	45,31
	01.02.2023		68,478	0,9218 8	of 52.00	58,60	34,30
	18.09.2023		21,349	0,2956 4	50,30	56,44	73,77
	26.07.2024		9,533	0,0998 5	50	56,11	136,1
	17.03.2025		-	-	-	47,25	24,507
	21.03.2021		98,792	0,0360 4	60	71,19	from 50.36
52	27.07.2021	2400-2394 1521-1517	32,304	0,7655 7	47,1	55,27	45,49
	27.02.2022		3,13	0,6411 7	37,9	44,4	of 53, 05
	27.01.2023		35,523	0,0984 3	37	43,28	of 46.66
	21.09.2023		36,189	0,0320 9	36	of 42.46	from 47.76
54	11.05.2021	2074-2067, 2053-2050	70,205	0,7819 2	58,2	68,91	45,04
54	04.03.2022	2053-2050	31,017	0,0964 8	45,8	54,04	of 76.11
	11.03.2023	2280-2278,	65,026	0,1332 7	of 40.20	47,14	32,05
	20.09.2023	2278-	93,746	0,0795	45,00	52,90	29,58

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№ slenumber.	Date of the study	Interval perfor., m	the Coefficient of filtration resistance		Static pressure, kgf/cm2	pressure, kgf/cm2	Abs. free flow of gas at RPL, thousand m3/day
			And	In			
	21.05.2024	2276, 2074-2067, 2053-2050	77,446	0,63612	45,00	52,71	28,97
49	23.03.2021	2264-2262	127,273	0,72649	75,1	91,28	52,07
	28.01.2022	2244-2241	149,19	0,21809	56,3	68,52	30,14
	19.02.2023	2520-2219	94,365	0,19621	of 51.00	60,97	36,6
	22.09.2023		94,667	0,07809	50	59,53	of 36.34
	26.08.2024		242,502	0,61401	of 59.30	70,80	of 19.69
62	30.09.2020	2206-2215	6,736006	0,01267	74,57	103,73	691,7
	23.03.2021	2240-2246	123,254	0,12567	63,5	77,09	46,05
	17.02.2022	2259-2262, 2264-2270	125,903	0,1966	64,2	77,55	44,65
	13.02.2023	2206-2215, 2240-2246, 2259-2262,	174,735	0,31538	56	66,57	24,29
	03.03.2024		9,654	0,85498	45	53,20	52,15
	04.02.2025		-	-	21,6	-	9,358

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№ sle nu mb er.	Date of the study	Interval perfor., m	the Coefficient of filtration resistance		Static pressure, kgf/cm2	pressure, kgf/cm2	Abs. free flow of gas at RPL, thousand m3/day
			And	In			
		2264-2270					
77	25.09.2020	2367-2360, 2354-2348	37,6543	0,02092	72,53	106,94	263,6
	03.03.2022		110,33	0,01145	61	is 73.55	48,77
	27.01.2023		131,893	0,34555	56	67,68	of 32.03
	05.04.2023		103,131	0,26569	50	60,89	by 33.11
	05.09.2023		37,651	0,07900	60	71,67	110,69
	29.02.2024		-	-	31,14	-	51,785
	19.08.2024		77,832	0,01190	57,740	69,62	61.68 per week
78	20.06.2023	2298-2244	25,361	0,02947	77	92,37	258,68
	26.02.2024		-	-	-	-	27,846
	02.09.2024		492,823	0,46658	75	of 88.88	15,79
	13.10.2024		743,859	5,00191	75	89,15	of 10.01

Table 1 and Figures 1-7 show that the development of all objects of the Sharkiy Berdak field is accompanied by the presence of reservoir water in the production of gas-producing wells, which worsens their productivity. This is especially clearly observed in sle. №№ 6, 25, 49, 62 and 78, working for a long time without stopping, where the absolutely free flow rate decreases in time or there is a clear fluctuation [5].

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Experience in the development of gas fields with the presence of bottom water shows that:

- a sharp decrease in the absolute free flow rate of gas when the pressure stabilizes or increases indicates a possible displacement of gas by water;

- the observation of an increase in filtration coefficients A and B at a number of wells indicates an increase in hydrodynamic resistance, which is often caused by an increase in the water saturation of productive formations.

For example, in sle. 49 with an increase in the filtration resistance coefficient (A=242.5), the flow rate drops to ~19 thousand m3 / day at a moderately high reservoir pressure, which indicates the probability of water inflow and an upward displacement of the GWC. Also, in sle. 54 from 2021 to 2024, there is a relatively stable pressure (45-52 kgf/cm2), but a sharp drop in the flow rate from 76 to 28 thousand m3/day. A similar pattern is typical for cases of gas displacement by plantar water.

In addition, a decrease in productivity is observed in most other wells that do not operate for a long time, as a result of the intensive nature of water inflow to their bottomholes. An example is wells 21 and 34, which show an active decrease in the flow rate and growth of filtration resistance coefficients from the early stages of their operation. Taking into account the fact that in the early stages of operation in these wells a high depression on the formation was provided, the reason for the decrease in the flow rate and the growth of the coefficient A can be determined by the pull-up of plantar water. The presence of a perforation interval in the lower part of the formation in the wells under consideration can be used to confirm this reason.

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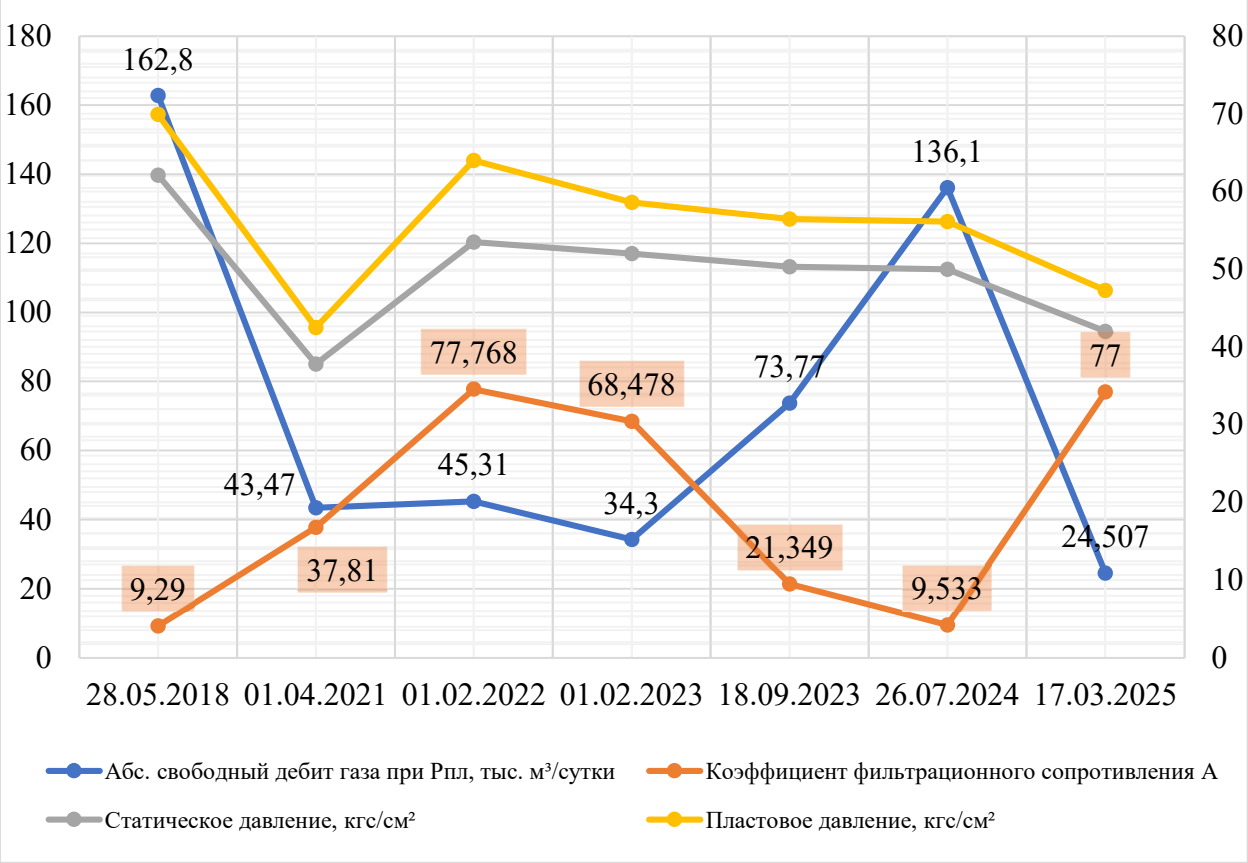


Figure 1-GDS results of well 34of the Sharkiy Berdak gas field

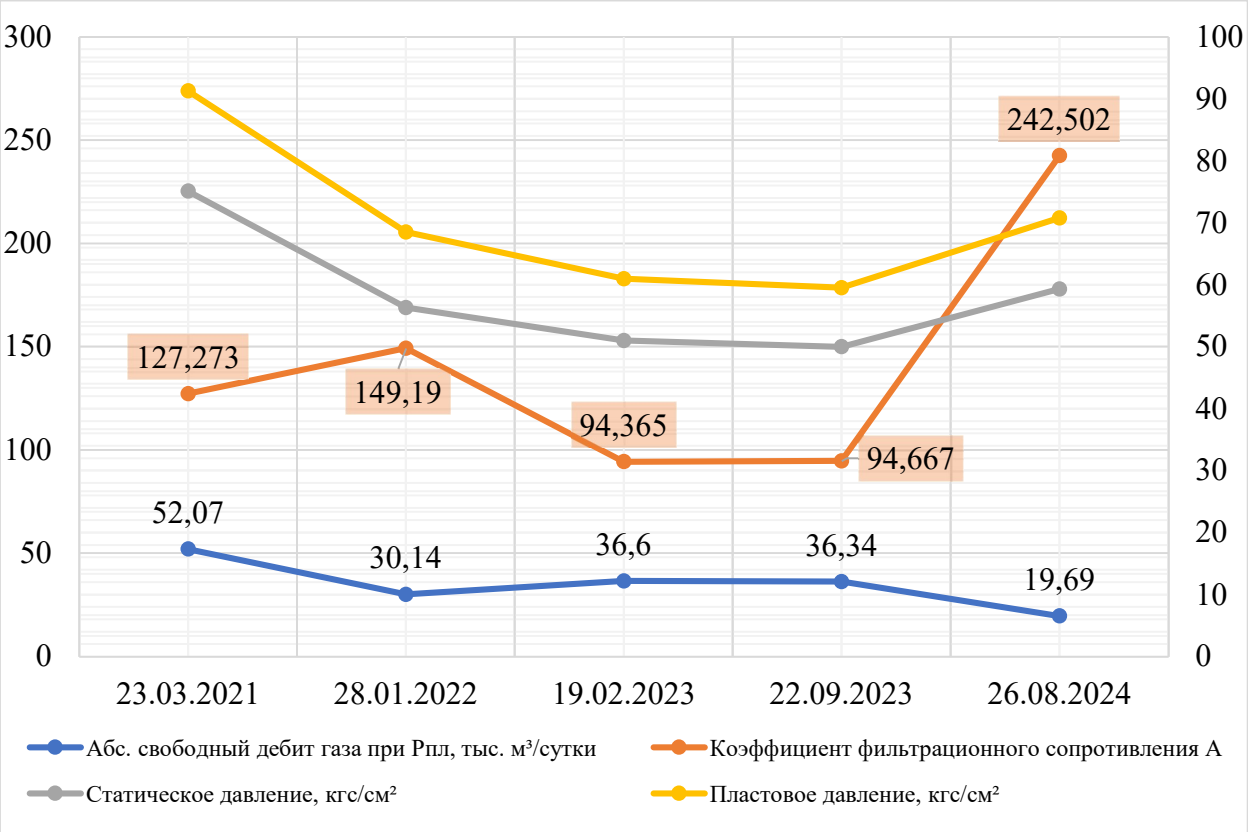


Figure 2-GDS results of well 49of the Sharkiy Berdak gas field

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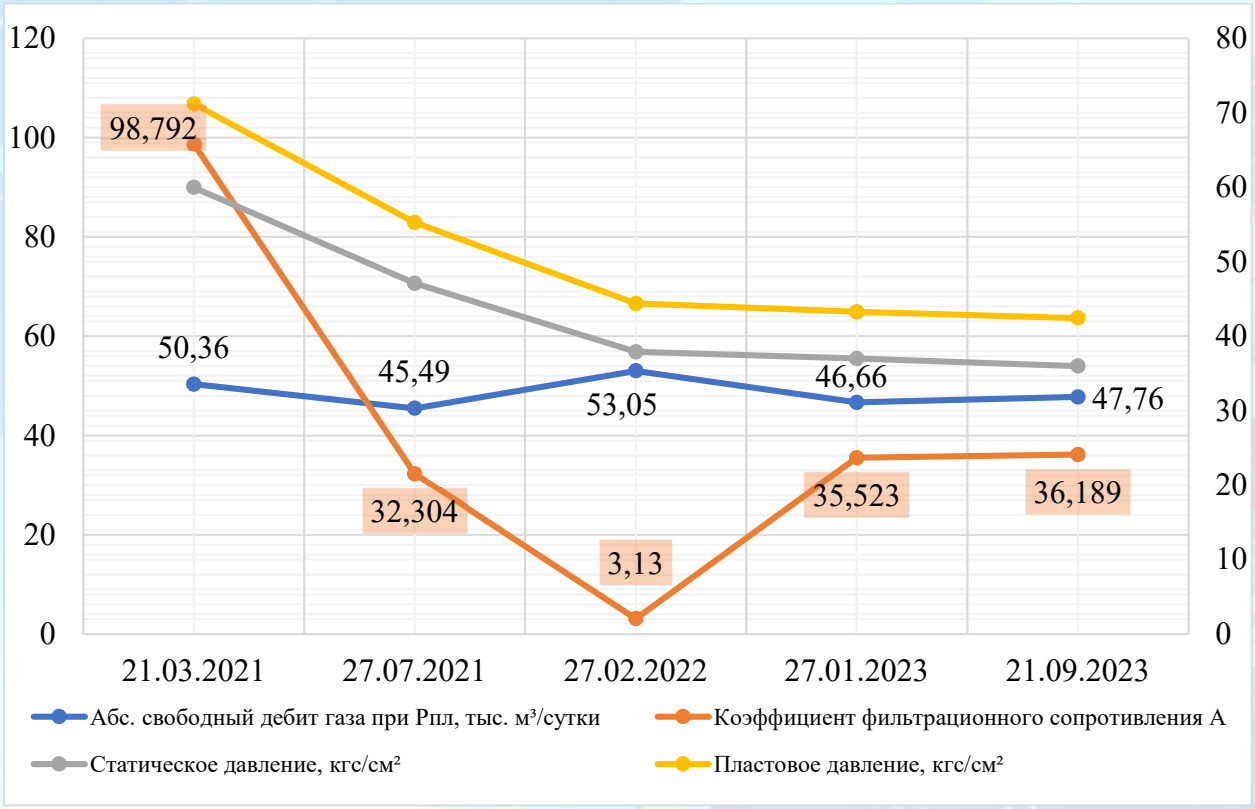


Figure 3-GDS results of well 52of the Sharkiy Berdak gas field

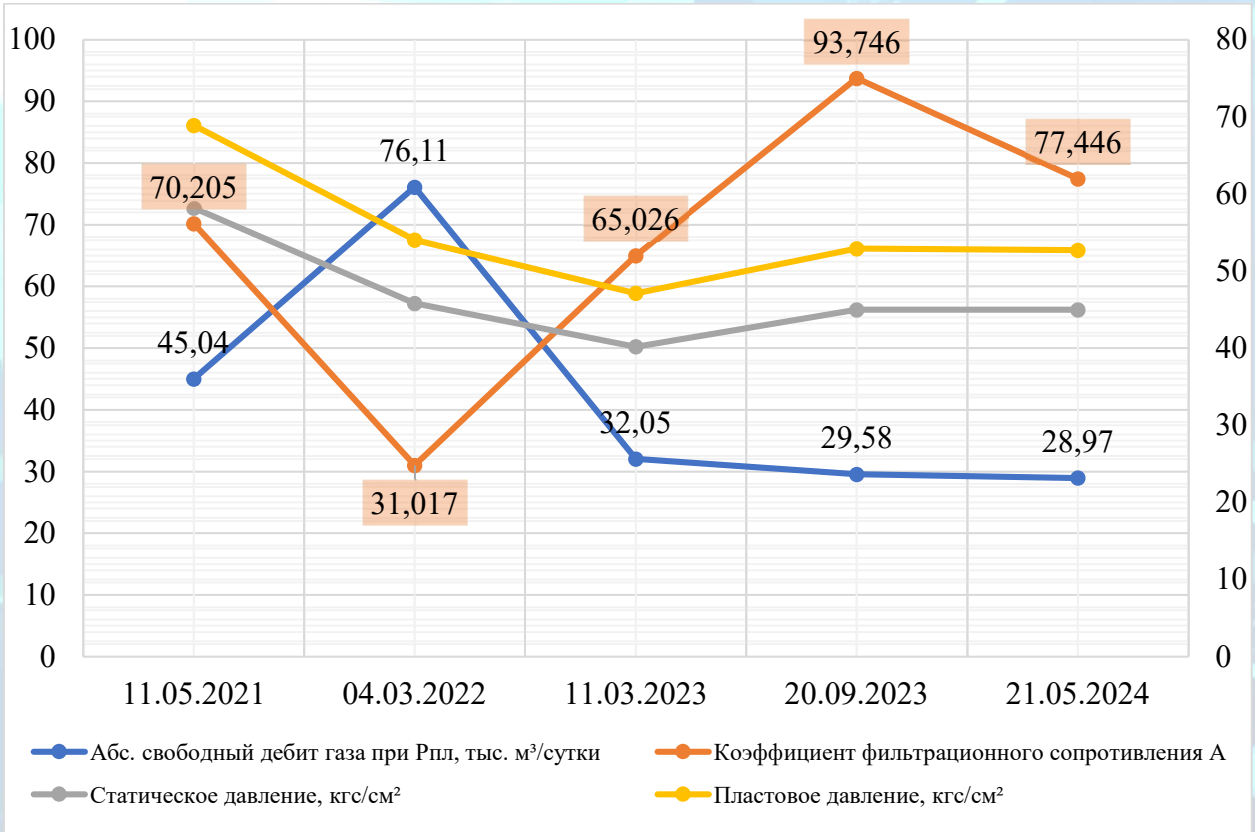


Figure 4-GDS results of well 54of the Sharkiy Berdak gas field

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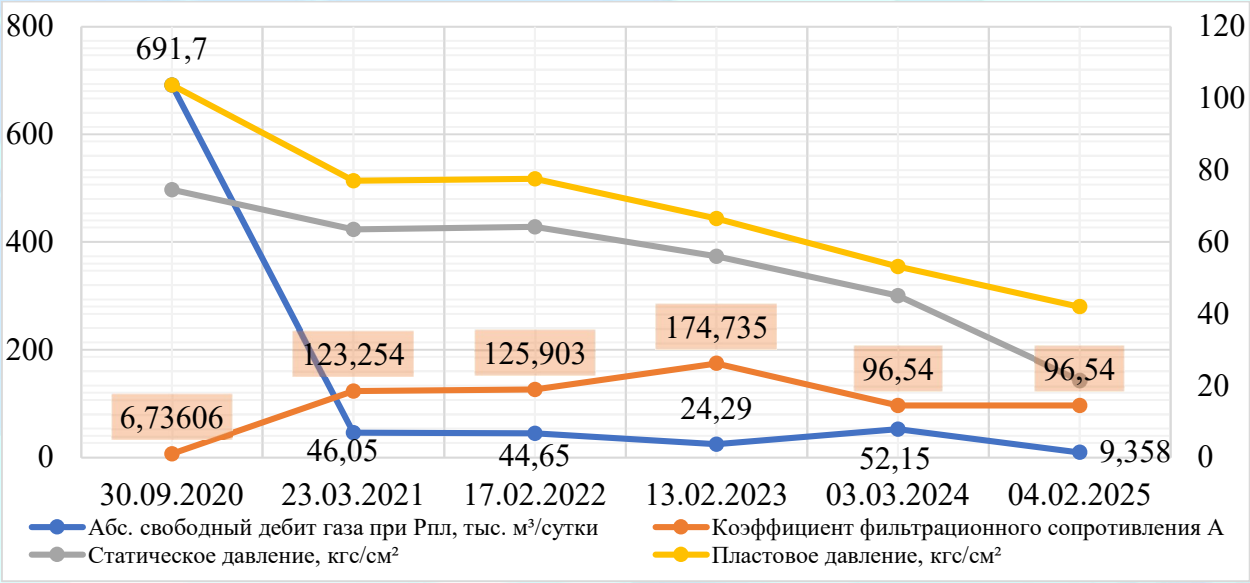


Figure 5-GDS results of well 62of the Sharkiy Berdak gas field

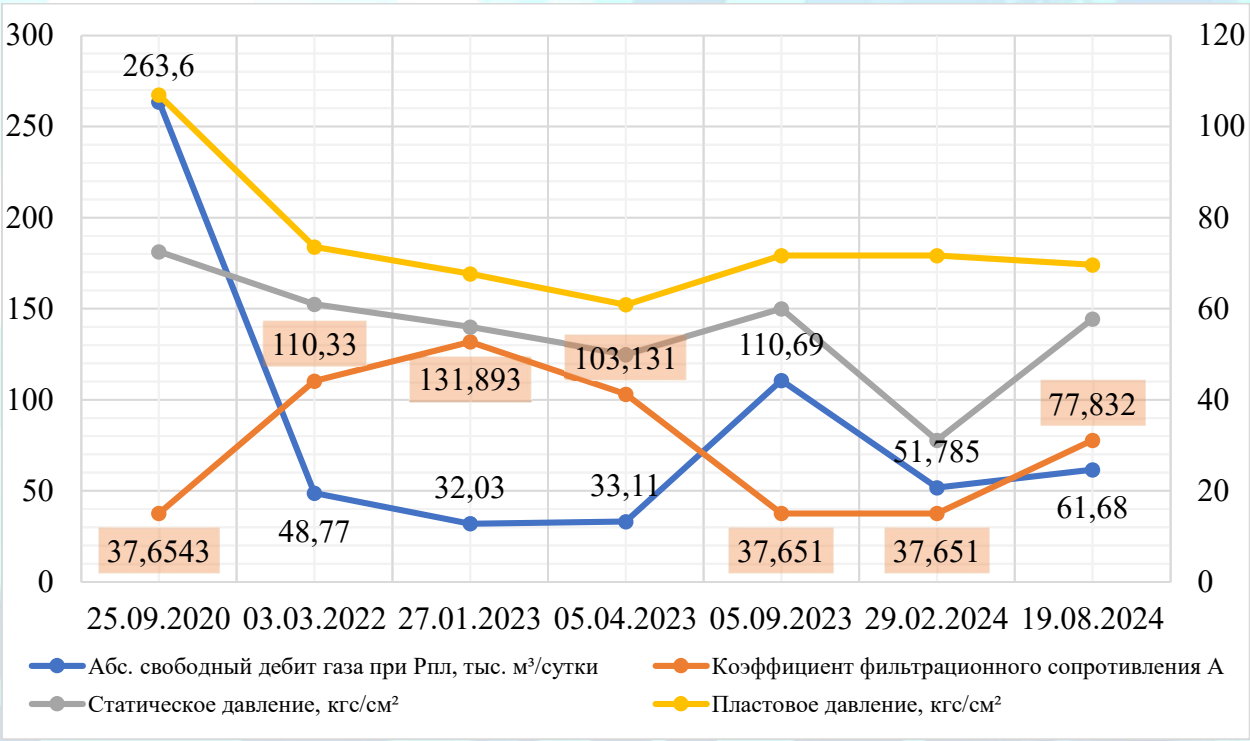


Figure 6-GDS results of well 77 GCM Sharkiy Berdak

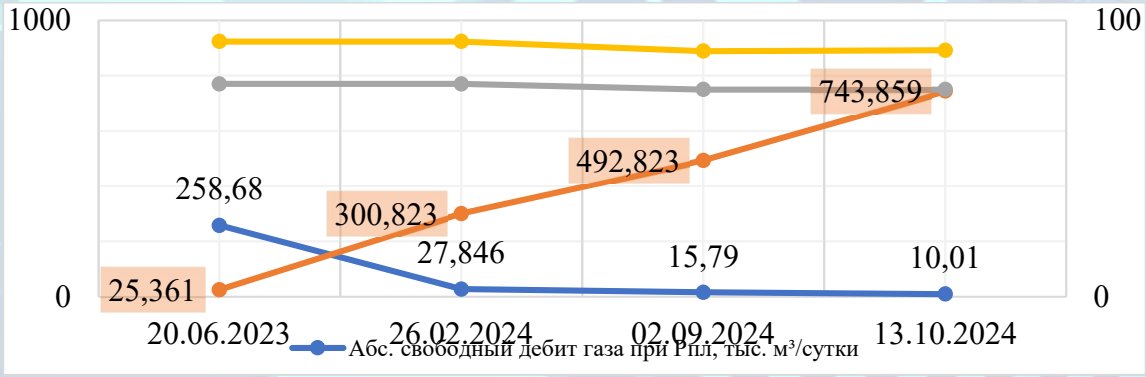


Figure 7-GDS results of well 78 ГКМ of the Sharkiy Berdak gas field

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It is worth mentioning that the result of pulling up the bottom water to the bottom of producing wells is a displacement of the GVK. Long-term international experience points to the impact of GVC displacement on the productivity of producing wells.

A drop in the flow rate at stable pressures and an increase in the filtration resistance coefficient indicate water intrusion into the drainage zone. Consequently, the intrusion of water into the drained zone, i.e. the displacement of the GWC, leads to partial or complete replacement of gas with water in the lower perforated intervals, resulting in:

- reduced gas saturation;
- the filtration resistance coefficient increases.
- может - a cone of water may form in the drained area of the formation, within a radius of 3-5 meters from the face.

The above-mentioned phenomena are clearly observed in well 78. Studying the GDI results of this well in 2023-2024, we can note a sharp increase in resistance (up to 743) and a drop in flow rate from 258 to 10 thousand m3/day at stable pressures. Such a phenomenon is considered a classic scenario when the GVK is displaced [6].

Thus, the analysis of the GDI results of the Sharkiy Berdak GCM wells showed that the bottom waters of the Sharkiy Berdak field, as noted earlier, are present and actively participate in the filtration process, especially in wells with lower perforation and high depression.

In a number of wells (especially No. 49, No. 54, No. 78, etc.), there is a steady trend towards water uptake and displacement of the GVC, which is accompanied by a drop in productivity.

Displacement of the hot water supply reduces drainage efficiency, causes hydrodynamic degradation of the WPC, and requires adjustment of operating modes and possible use of insulation works.

Based on the identified problems and assigned tasks

In the process of further development of the Sharkiy Berdak field, it is recommended to:

-clarification of the current state of gas and water saturation in the bottom-hole zone of the formation by re-conducting GDI wells with subsequent modeling of fluid saturation, which will justify the need for perforation restrictions, the choice of methods for selective insulation exposure;

-limiting the depression in sensitive intervals to ensure a stable gas inflow, reduce the likelihood of flooding the well and extend its inter-repair period;

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-assessment of the dynamics подршвеннойof the subsurface water front and the prospects for gas displacement from the lower part of the reservoir by creating a 3-D hydrodynamic model taking into account the multi-layered structure of the field;
-Calculation of the rates of vertical and radial displacement of the GVK, and identification of the zone of each face.

We also note that if high-quality geophysical monitoring is carried out and a petrophysical model is created, it is also possible to visualize the risk of water cone formation in the bottom-hole zone; calculate the maximum depression at which water will break through into the productive reservoir; ensure maximum efficiency of wells with NDCS and phase equilibrium [5, 6].

CONCLUSION. Plantar water at the Sharkiy Berdak GCM is actively involved in the filtration process and has a significant impact on well productivity. To minimize flooding and stabilize the flow rate, we recommend:

- carry out repeated GDI and modeling of fluid saturation;
- limit depression in sensitive intervals;
- develop a 3D hydrodynamic model of the plantar water front;
- apply insulation measures in wells with pronounced signs of water pulling up.

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