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INCREASING THE MANGYSTAU PENINSULA UNDERGROUND WATER RESERVES UTILIZATION COEFFICIENT BY ESTABLISHING THE MOST EFFECTIVE METHOD OF DRILLING WATER SUPPLY WELLS

Abstract. In the area of the Mangystau oilfields a severe deficit of potable and technical water exists. The reserves of the underground waters may play a significant role in its elimination. The prospecting works have been carried out there since 1960-s and a substantial reserves are discovered, which however are used in a very insufficient volume The principal cause of such situation is related to design of the water supply wells, whose total output does not meet the existing needs. In the presented paper the specifics of the principal methods of water supply wells are considered as related to the Samskoye underground water field. The focus is made upon drilling the large diameter wells with reverse flush fluid circulation, which is popular in western countries. The adduced materials are substantiating the significant advantage of that method in volume and quality of the produced water, as well as in the life period of the water supply wells. The paper demonstrates, that under the local conditions the advantages of the method can reveal themselves especially intensely, while its shortcomings would tell in minimal degree.

Study of the peculiarities of the main methods of drilling water intake wells; study of hydrogeological conditions of the Sama area.

Critical analysis of the main ways of turning is applicable to the Samsk region; justification of the choice of the most effective method of drilling.

The benefits of the circulatory system with a reverse wash over other methods of treatment can be considered proven. It provides a sharp increase in the coefficient of use of local resources of underground water, which is the main problem of local water supply to underground water. The need for a wide range of this method is obvious.

Key words: drilling technology, reverse wash, Mangystau peninsulas, water deficit, underground water, Samkoye mine, debit.

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ҰҢҒЫМАЛАРДЫ БҰРҒЫЛАУДЫҢ ТИІМДІ ТӘСІЛІН БЕЛГІЛЕУ АРҚЫЛЫ МАҢҒЫСТАУ ТҮБЕГІНІҢ ЖЕР АСТЫ СУЛАРЫНЫҢ ҚОРЛАРЫН ПАЙДАЛАНУДЫ АРТТЫРУ

Аннотация. Маңғыстау мұнай кен орындары ауданында ауыз су мен техникалық су тапшылығы бар. Оны жоюда жер асты суларының қоры маңызды рөл атқаруы мүмкін. Мұнда барлау жұмыстары 1960 жылдардан бері жүргізіліп келеді және айтарлықтай қорлар табылды, алайда олар өте жеткіліксіз көлемде пайдаланылуда. Бұл жағдайдың негізгі себебі жалпы шығыны бар қажеттіліктерге сәйкес келмейтін сумен жабдықтау ұңғымаларын жобалаумен байланысты. Ұсынылған мақалада жер асты суларының Сам кен орнына жататын ұңғымаларды сумен қамтамасыз етудің негізгі әдістерінің ерекшелігі қарастырылады. Батыс елдерінде танымал жуу сұйықтығының кері айналымы бар үлкен диаметрлі ұңғымаларды бұрғылауға баса назар аударылады. Жоғарыда келтірілген материалдар бұл әдіспен өндірілген судың көлемі мен сапасында, сондай-ақ су құбырларының қызмет ету мерзімінде айтарлықтай артықшылық бар екенін растайды. Мақалада жергілікті жағдайларда әдістің артықшылықтары әсіресе қарқынды түрде көрінуі мүмкін екендігі көрсетілген, ал оның кемшіліктері минималды дәрежеде әсер етеді.

Мақаланың мақсаты су ұңғымаларын бұрғылаудың негізгі әдістерінің

ерекшеліктерін зерттеу; Сам кен орнының гидрогеологиялық жағдайларын зерттеу.

Сақ кен орнына қатысты бұрғылаудың негізгі әдістерін сыни талдау; бұрғылаудың ең тиімді әдісін таңдаудың негіздемесі.

Бұрғылаудың басқа әдістеріне қарағанда айналмалы кері жуу әдісінің артықшылықтарын дәлелденген деп санауға болады. Ол жергілікті жер асты суларын пайдалану коэффициентінің күрт өсуін қамтамасыз етеді, бұл жер асты суларын жергілікті сумен қамтамасыз етудің басты мәселесі болып табылады. Бұл әдісті кеңінен енгізу қажеттілігі айқындалды.

Түйін сөздер: бұрғылау технологиясы, кері жуу, Маңғыстау түбегі, су тапшылығы, жер асты сулары, Сам шахтасы, дебит.

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ПОВЫШЕНИЕ ИСПОЛЬЗОВАНИЯ ЗАПАСОВ ПОДЗЕМНЫХ ВОД ПОЛУОСТРОВА МАНГЫСТАУ ПУТЕМ УСТАНОВЛЕНИЯ ЭФФЕКТИВНОГО СПОСОБА БУРЕНИЯ СКВАЖИН

Аннотация. В районе нефтяных месторождений полуострова Мангыстау существует дефицит питьевой и технической воды. В его ликвидации большую роль могут играть запасы подземных вод. С 1960-х годов там проводятся разведочные работы и установлены их существенные запасы, которые, однако, используются в недостаточной мере. Основная причина кроется в проблемах, связанных со строительством водозаборных скважин, количество которых и их дебит не обеспечивают имеющихся потребностей. В работе рассматриваются особенности основных способов бурения водозаборных скважин. применительно к условиям Самского месторождения подземных вод.

Наибольшее внимание уделено широко распространенному в зарубежных странах при освоении запасов подземных вод бурению скважин большого диаметра с обратной промывкой. Приведенные материалы показали явное преимущество этого способа перед другими, как в части количества и качества добываемых вод, так и в сроках эксплуатации скважин. Показано, что в местных условиях преимущества этого способа могут сказаться особенно рельефно, а его недостатки проявятся в минимальной степени.

Исследование особенностей основных способов бурения водозаборных скважин; изучение гидрогеологических условий Самского месторождения.

Критический анализ основных способов бурения применительно к Самскому месторождению; обоснование выбора наиболее эффективного способа бурения.

Преимущества вращательного способа с обратной промывкой над другими способами бурения можно считать доказанными. Он обеспечат резкое повышение коэффициента использования местных ресурсов подземных вод, что является главной проблемой местного водоснабжения подземными водами. Необходимость широкого внедрения этого способа очевидна.

Ключевые слова: технология бурения, обратная промывка, полуостров Мангыстау, дефицит воды, подземные воды, Самское месторождение, дебит.

Introduction. Water resources play an essential role in the economy of any country. An important resource is groundwater extracted from boreholes. The problem of development and protection of underground waters of the Planet Earth is in the focus of attention of special UN organizations (Hydrogeological, 1988). In the Republic of Kazakhstan, there is a shortage of water resources. A significant part of its territory belongs to the zones of deserts and semi-deserts with rare precipitation and underdeveloped river networks.

The urgency of the problem. On the territory of the Mangystau peninsula, where large deposits of hydrocarbons are concentrated, there is a critical situation with water supply. A typical groundwater deposit here is the Samskoye deposit, which can play an important role in the water supply of the city of Zhanaozen; their depth does not exceed 50 m, and their diameter is 150 mm (Sydykov, 1970). According to the latest reports (The concept of water, 2012) the total water withdrawal from all wells does not exceed 18% of the explored reserves. It is obvious that the methods of construction of water wells do not meet the requirements.

Purpose of the work: The purpose is to increase the efficiency of water wells at the Samskoye field.

Tasks: Study of the features of the main methods of drilling water wells; study of the hydrogeological conditions of the Samskoye deposit; critical analysis of the main drilling methods in relation to the Samskoye field; rationale for choosing the most efficient drilling method.

Research methodology: Study of literary materials on the main methods of drilling water wells; study of materials on the hydrogeological conditions of well drilling in the considered groundwater field; comparison of the hydrogeological conditions of the field with the features of various drilling methods.

Study of the features of the main methods of drilling water wells.

Direct Flush Rotary Method: This is the most common and versatile drilling method. The drilling fluid supplied by the pump enters the drill pipe string, and then to the working bit. Together with the drill cuttings, it returns to the surface, where, after being cleaned, it is again sucked in by the pump. The solution is a suspension, the solid phase of which, penetrating into the pores of permeable formations, strengthens the walls of the well, preventing collapses. Before the opening of the aquifer, a casing string is lowered into the well and cemented to isolate it from the polluting effects of the passed rocks and their fluids (Bashkatov, 1979a). Drilling is continued with a smaller diameter and a production string with a filter is lowered into the well. The final diameter of the wells usually does not exceed 190 mm. Further development of the well is carried out - decolmatation of the near-well zone of the aquifer, namely, the removal of the solid phase of the drilling fluid from its pores.

Percussion drilling. A pit is created in which a casing pipe is installed (Bashkatov, 1988b). A drilling tool is lowered into the pipe on a rope, which is given a vertical reciprocating motion (chiselling operation). The chisel is removed, several buckets of water are poured into the pipe and a bailer is lowered, which absorbs the slurry slurry. Under the pipe, a well is formed with a depth of 0.5–1.5 m. At this distance, by blows of a woman on the upper end of the pipe, it is upset. Then resume chiselling. A second pipe is screwed onto the first pipe, and so on. With the length of the column, its friction against the rock increases. When the column ceases to respond to the blows of the woman, a column of smaller diameter is lowered into it and drilling continues. The replacement of the second and all subsequent columns occurs due to the stuck in the rock of those sections that go below the shoe of the previous column. With a limited output of the columns, the maximum achievable depth of the well is the greater, the larger the diameter of the first column and the smaller the diameter of the last one. Having passed the productive formation, the production string is freely lowered into the well. To expose its filter part, the last working column is lifted. Some of the used casing strings act as a reservoir isolation. The rest of the columns with the help of jacks are removed from the well for reuse.

Rotary drilling with backwash. This method allows drilling wells with a diameter of up to 1500 mm (Sudakov, 2019a:10). The flushing fluid (usually water.) flows by gravity from the settling tanks 1 to the wellhead, descends along the annular space and, washing the bottomhole and bit 2, rises along the drill string 3, through swivel 4, it enters the discharge sleeve and returns to the sump. It has been proven (Kenzhetaev, 2022:13) that in order to avoid collapses, it is necessary that the distance from the mouth of the well filled with water to its static level be at least 3 m.

Washing circulation is carried out in one of two ways (in Fig. 1. both are conditionally combined). When drilling with reverse-suction flushing, the discharge sleeve is connected to the inlet of a centrifugal pump 5, which sucks the fluid from the drill string and delivers it to the sump. When drilling is resumed after stops, the centrifugal pump cannot suck water to a height from the mouth to the swivel, since its suction height does not exceed 3–5 m. Therefore, a vacuum pump 6 is used to resume drilling.

The second way is to create a backwash using an airlift. Air is supplied by compressor 7 through pipe 8 to drill string 3, through mixer 9. The air and drill pipes are connected into a common string by means of welded flanges.

Backwash drilling is most effective in soft and medium formations and therefore pico-drill bits are widely used. Rotational speeds of 10 - 70 rpm are used. They drill on the sands almost at zero load and reach high speeds of the deep. In the enclosing rocks, the speed of deepening is 10 - 25 m/h. There are examples (Bashkatov, 1988b) when a well with a depth of 350 m was completed in 6 days.

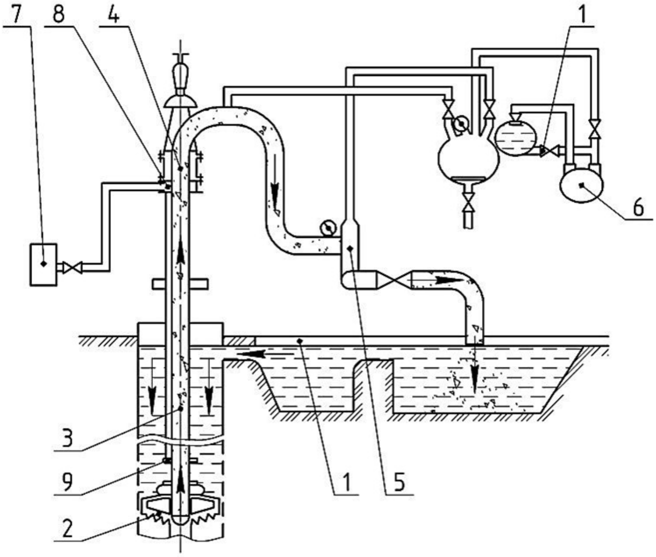

Figure 1. Scheme of drilling wells with backwash
1 - sump; 2 - chisel; 3 – drill string; 4 - swivel; 5 - centrifugal pump; 6 - vacuum pump; 7 - compressor; 8 - air supply channel; 9 - mixer.

When backwashing, the upward flow rate should be 2 - 3 m/s, respectively, the liquid supply should be 2000 - 4000 l/min. At the same time, in permeable formations represented by sands, circulation losses of the order of 80 l/min occur. In pebbles, these losses can reach 2500 l/min. Casing is usually limited to a guide tube.

Study of the hydrogeological conditions of the Samskoye field.

The deposit is composed of Quaternary deposits and has an area of 1500 km2. Groundwater horizons have the form of lenses of various shapes and sizes. According to the degree of mineralization of water are divided into two groups. The first includes fresh waters with salinity up to 1 g/l. To the second - water with mineralization - up to 3 g.l. They are suitable for the needs of agriculture. Water-bearing rocks are represented by fine-grained sands. with a filtration coefficient of 5.5 - 7.0 m/day. The host rocks are loams, sandy loams, and sandstones on lime cement. The fresh water depth ranges from 1.5 to 44 m, their thickness is up to 39 m with an average value of 14 m. Brackish waters are located below and are separated from the layers of aquicludes. Table 1. typical conditions for drilling water wells at the Samskoye field.

Table 1-Typical conditions for drilling water wells at the Samskoye field

№	Parameter name	Unit	Value
1	Drilling depth, N	m	50–200
2	Depth of the roof of the productive formation, H_p	m	10-150
3	Reservoir thickness, m	m	10–40
4	Filtration coefficient, K_F	m/day	5.5 –7.0
5	Static formation head, H_S	m	5–50
6	Category of its drillability (sand)		II
8	The same host rocks (loams, clays, sandstones)		III–IV

Critical analysis of the main drilling methods in relation to the Samskoye field.

Advantages of rotary drilling with direct flushing with drilling fluids: Drilling wells of any depth; drilling in rocks of any strength; high penetration speed.

Disadvantages: small final diameter; clogging of the productive formation with drilling mud (Sudakov, 2019b).

In local conditions, the first two advantages do not matter, because the depth of the wells is small and drilling is carried out in sedimentary rocks.

The disadvantages are very significant: In view of the low permeability of water-bearing sands, their clogging with drilling fluids and at small final diameters, the expected well flow rate is minimal. Small diameters make it difficult to create gravel packs.

Advantages of cable percussion drilling over conventional rotary drilling: minimal water requirement; significant increase in diameter: a sharp reduction in power costs.

Disadvantages: low speed of deepening; depth limitation by casing output; high costs of casing pipes.

In local conditions, all the advantages are very significant. A sharp decrease in the need for water is important in case of its existing deficit. The absence of drilling fluid as well as the increase in the final diameter provide a significant increase in flow rate.

It follows from the above that under local conditions the second and third shortcomings are insignificant, but the first one remains. drastically increasing the cost of the work.

Benefits of Rotary Backflush Drilling: very large diameter high upstream speeds; Possibility of washing with water.

Disadvantages: high costs of washing water; limited depth of wells; low deepening speeds in hard rocks; bulkiness and increased cost of drill pipes.

The large diameter of the water receiving part gives a significant inflow of water even in the fine-grained sands of the Samskoye field. The huge gap between the drill pipes and the well provides a very low downflow velocity, which contributes to the stability of the walls even when flushing with water, which eliminates the clogging of the near-wellbore zone. The large gap allows you to create a powerful gravel pack by backfilling gravel directly through the mouth. Such a filter improves the purification of the flow from mechanical impurities and significantly reduces the required pumping time during well development. The overhaul life of the well is many times longer (Boreng, 1988). The high speed of the upward flow provides complete cleaning of the bottomhole from cuttings and significant deepening speeds.

The first disadvantage is the increased need for flushing fluid, which will have a minimal effect in the conditions of the Samskoye field, due to the minimal absorption of fluid in fine-grained sands. The second and third disadvantages do not matter (see Table 4). The fourth drawback relates to the nature of backwash drilling and is practically irremediable.

Rationale for choosing the most efficient drilling method.

When pumping, the maximum allowable filtration rate (Bashkatov, 1979a) in m/h:

$$U_F = 2.71\sqrt[3]{K_F} \tag{1}$$

where K_F – filtration coefficient in m/day

Accordingly, the highest allowable flow rate in m3 / h:

$$Q_{MAX} = L\pi DU_F \ , \qquad (2)$$

where L and D are the length and diameter of the receiving part of the well, respectively.

Q_{MAX} can be achieved by extending the filter to a size of:

$$L_{MAX} = \frac{Q_{MAX}}{\pi DU_F} \qquad (3)$$

But L_{MAX} cannot exceed the thickness of the productive formation m.

Considering this, the practically achievable debit is:

$$Q = m\pi DU_F \qquad (4)$$

The maximum possible thickness of the gravel layer:

$$\delta = (D - D_S)/2 \qquad (5)$$

where D_S – filter diameter

The algorithm was applied to the conditions shown in Table. 2

Table 2 - Conditions for drilling a typical well (Sydykov, 1970, Biletskiy, 2018:9, Ratov, 2019a:8, Fedorov, 2017:7, Rakishev, 2022:12, Buravleva, 2022:13, Ratov, 2020b:6, Rasulov, 2020:7, Isheyskiy, 2022:18, Sysoyev, 2021:12, Karasawa, 2016:9, Mashrapova, 2021:6)

№	Parameter name	Unit	Value
3	Reservoir thickness, m	m	14*
4	Filtration coefficient, K_F	m/day	6.3*
5	Maximum filtration rate, U_F	m/h	5.01
6	Filter diameter, D_S	m	0.146

* Average values for the field

Table 3 - Results of calculations for various drilling methods

Name	D. m	δ,m	Q, m^3/h
Rotary direct flush	0.190	0.022	42.
Shock rope	0.324*	0.089	71.4
Rotary with backwash	0.800	0.327	176

* The last member of the series of diameters: 508, 426, 377, 324, mm with an average column output of 50 m:

According to Table 3, the flow rate when drilling with backwash is 2.46 times higher than with the percussion method and 4.12 times higher than with the conventional rotary method; - the corresponding values for the thickness of the gravel layer - 3.67 and 14.86 times.

The method of drilling large-diameter wells with reverse flushing has become widespread abroad - table. four.

Table 4 - Foreign drilling rigs for drilling wells with reverse penetration (Bashkatov, 1988b)

Index	'Soltgitter", Germany		"Wirth", Germany	Sandrill USA	Roma-nia
	P-300	P-150	T-3	P-102	FA-12
Well depth up to., m	350	180	500	225	250
Its diameter, m	0.5 – 1.5	0.45– 1.2	1.0	1.52	0.45
power, kWt	41	41	88	29	44
Flow.c/b.pump l/min	*	4000	*	3800	4000
Rotor frequency, rpm	6-74	6-56	8, 16, 32	16 – 73	6 – 40
Copra height, m	13	15.5	18.5	8.2	11
Its carrying capacity, t	32	20	40	15	12.5
Diam. Dril. pipes, mm	216	150	112.5	155	154
Installation weight, t	14	13.2	-	-	16.6

* Airlift

Conclusion. Under the conditions of the Samskoye field, the rotary method of drilling large-diameter wells with reverse flushing allows: reduce their required number; improve the quality of produced water; drastically reduce the well completion time; significantly lengthen the time of operation of wells; provide high speed deepening; reduce the cost per cubic meter of produced water.

Thus, the advantages of the rotary backwash method over other drilling methods can be considered proven. It will provide a sharp increase in the utilization rate of local groundwater resources, which is the main problem of local groundwater supply. The need for widespread implementation of this method is obvious.

The present work, in the case of implementation of its results, can significantly improve the current situation.

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