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ҚАЙЫРЫМДЫЛЫҚ ҚОРЫ HALYK CHARITY FOUNDATION

«ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫ» РҚБ
«ХАЛЫҚ» ЖҚ

ХАБАРЛАРЫ

ИЗВЕСТИЯ

РОО «НАЦИОНАЛЬНОЙ
АКАДЕМИИ НАУК РЕСПУБЛИКИ
КАЗАХСТАН»
ЧФ «Халық»

N E W S

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NAS RK is pleased to announce that News of NAS RK. Series of geology and technical sciences scientific journal has been accepted for indexing in the Emerging Sources Citation Index, a new edition of Web of Science. Content in this index is under consideration by Clarivate Analytics to be accepted in the Science Citation Index Expanded, the Social Sciences Citation Index, and the Arts & Humanities Citation Index. The quality and depth of content Web of Science offers to researchers, authors, publishers, and institutions sets it apart from other research databases. The inclusion of News of NAS RK. Series of geology and technical sciences in the Emerging Sources Citation Index demonstrates our dedication to providing the most relevant and influential content of geology and engineering sciences to our community.

Қазақстан Республикасы Ұлттық ғылым академиясы «ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы» ғылыми журналының Web of Science-тің жаңаланған нұсқасы Emerging Sources Citation Index-те индекстелуге қабылданғанын хабарлайды. Бұл индекстелу барысында Clarivate Analytics компаниясы журналды одан әрі the Science Citation Index Expanded, the Social Sciences Citation Index және the Arts & Humanities Citation Index-ке қабылдау мәселесін қарастыруда. Webof Science зерттеушілер, авторлар, баспашылар мен мекемелерге контент тереңдігі мен сапасын ұсынады. ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы Emerging Sources Citation Index-ке енуі біздің қоғамдастық үшін ең өзекті және беделді геология және техникалық ғылымдар бойынша контентке адалдығымызды білдіреді.

НАН РК сообщает, что научный журнал «Известия НАН РК. Серия геологии и технических наук» был принят для индексирования в Emerging Sources Citation Index, обновленной версии Web of Science. Содержание в этом индексировании находится в стадии рассмотрения компанией Clarivate Analytics для дальнейшего принятия журнала в the Science Citation Index Expanded, the Social Sciences Citation Index и the Arts & Humanities Citation Index. Web of Science предлагает качество и глубину контента для исследователей, авторов, издателей и учреждений. Включение Известия НАН РК. Серия геологии и технических наук в Emerging Sources Citation Index демонстрирует нашу приверженность к наиболее актуальному и влиятельному контенту по геологии и техническим наукам для нашего сообщества.

ЧФ «ХАЛЫҚ»

В 2016 году для развития и улучшения качества жизни казахстанцев был создан частный Благотворительный фонд «Халык». За годы своей деятельности на реализацию благотворительных проектов в областях образования и науки, социальной защиты, культуры, здравоохранения и спорта, Фонд выделил более 45 миллиардов тенге.

Особое внимание Благотворительный фонд «Халык» уделяет образовательным программам, считая это направление одним из ключевых в своей деятельности. Оказывая поддержку отечественному образованию, Фонд вносит свой посильный вклад в развитие качественного образования в Казахстане. Тем самым способствуя росту числа людей, способных менять жизнь в стране к лучшему – профессионалов в различных сферах, потенциальных лидеров и «великих умов». Одной из значимых инициатив фонда «Халык» в образовательной сфере стал проект Ozgeris powered by Halyk Fund – первый в стране бизнес-инкубатор для учащихся 9-11 классов, который помогает развивать необходимые в современном мире предпринимательские навыки. Так, на содействие малому бизнесу школьников было выделено более 200 грантов. Для поддержки талантливых и мотивированных детей Фонд неоднократно выделял гранты на обучение в Международной школе «Мирас» и в Astana IT University, а также помог казахстанским школьникам принять участие в престижном конкурсе «USTEM Robotics» в США. Авторские работы в рамках проекта «Тәлімгер», которому Фонд оказал поддержку, легли в основу учебной программы, учебников и учебно-методических книг по предмету «Основы предпринимательства и бизнеса», преподаваемого в 10-11 классах казахстанских школ и колледжей.

Помимо помощи школьникам, учащимся колледжей и студентам Фонд считает важным внести свой вклад в повышение квалификации педагогов, совершенствование их знаний и навыков, поскольку именно они являются проводниками знаний будущих поколений казахстанцев. При поддержке Фонда «Халык» в южной столице был организован ежегодный городской конкурс педагогов «Almaty Digital Ustaz.

Важной инициативой стал реализуемый проект по обучению основам финансовой грамотности преподавателей из восьми областей Казахстана, что должно оказать существенное влияние на воспитание финансовой грамотности и предпринимательского мышления у нового поколения граждан страны.

Необходимую помощь Фонд «Халык» оказывает и тем, кто особенно остро в ней нуждается. В рамках социальной защиты населения активно проводится

работа по поддержке детей, оставшихся без родителей, детей и взрослых из социально уязвимых слоев населения, людей с ограниченными возможностями, а также обеспечению нуждающихся социальным жильем, строительству социально важных объектов, таких как детские сады, детские площадки и физкультурно-оздоровительные комплексы.

В копилку добрых дел Фонда «Халык» можно добавить оказание помощи детскому спорту, куда относится поддержка в развитии детского футбола и карате в нашей стране. Жизненно важную помощь Благотворительный фонд «Халык» оказал нашим соотечественникам во время недавней пандемии COVID-19. Тогда, в разгар тяжелой борьбы с коронавирусной инфекцией Фонд выделил свыше 11 миллиардов тенге на приобретение необходимого медицинского оборудования и дорогостоящих медицинских препаратов, автомобилей скорой медицинской помощи и средств защиты, адресную материальную помощь социально уязвимым слоям населения и денежные выплаты медицинским работникам.

В 2023 году наряду с другими проектами, нацеленными на повышение благосостояния казахстанских граждан Фонд решил уделить особое внимание науке, поскольку она является частью общественной культуры, а уровень ее развития определяет уровень развития государства.

Поддержка Фондом выпуска журналов Национальной Академии наук Республики Казахстан, которые входят в международные фонды Scopus и Wos и в которых публикуются статьи отечественных ученых, докторантов и магистрантов, а также научных сотрудников высших учебных заведений и научно-исследовательских институтов нашей страны является не менее значимым вкладом Фонда в развитие казахстанского общества.

С уважением,
Благотворительный Фонд «Халык»!

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MULTIFUNCTIONAL VALVE FOR THE ARRANGEMENT OF SUBMERSIBLE DOWNHOLE PUMPS IN DOWNHOLE OIL PRODUCTION

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Abstract. In downhole oil production, a column of pumping and compressor tubing's is equipped with various operational and technological valves for their intended purpose. Each of these valves has a specific function. Therefore, the basic tubing arrangement may not initially contain a specific valve, the need for which may arise for individual operations during repair and maintenance work. This makes it necessary to carry out labor-intensive work involving special equipment for stopping and silencing wells, lifting underground equipment, completing tubing with the necessary technological valve and its descent into the well. The paper proposes to simplify the layout of a downhole pumping unit and increase its technological capabilities by equipping it with a multifunctional valve, which will

allow performing both operational tasks and a wide range of necessary technological operations directly in the well without lifting equipment.

Keywords: borehole, layout, valves, mechanical impurities, tubing, down-hole equipment, filters

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МҰНАЙ ӨНДІРУДЕГІ БАТПАЛЫ ҰҢҒЫМАЛЫҚ СОРҒЫЛАРДЫ ҚҰРАСТЫРУҒА АРНАЛҒАН КӨП ФУНКЦИЯЛЫ КЛАПАН

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Аннотация. Мұнайды ұңғымалық өндіруде сорғы-компрессорлық құбырлардың колоннасы мақсаты бойынша әртүрлі пайдалану және технологиялық клапандармен жабдықталады. Бұл клапандардың әрқайсысы белгілі бір функцияны орындайды. Сондықтан, СКҚ-дың негізгі орналасуы бастапқыда белгілі бір клапанды қамтымауы мүмкін, оның қажеттілігі жөндеу және қалпына келтіру жұмыстары кезінде жеке операцияларды жүргізу үшін туындауы мүмкін. Бұл ұңғымаларды тоқтату және сөндіру, жерасты жабдықтарын көтеру, сорғы-компрессорлық құбырларды қажетті технологиялық клапанмен жинақтау және оны ұңғымаға түсіру бойынша арнайы техниканы тарта отырып, көп еңбекті қажет етеді. Жұмыста ұңғымалық сорғы қондырғысының орналасуын жеңілдету және оны көп функциялы клапанмен жабдықтау арқылы оның технологиялық мүмкіндіктерін арттыру ұсынылады, бұл операциялық міндеттерді де, жабдықты көтерместен тікелей

ұңғымада қажетті технологиялық операциялардың кең спектрін орындауға мүмкіндік береді.

Түйін сөздер: ұңғыма, құрастыру, клапандар, механикалық қоспалар, сорғы-компрессорлық құбырлар, терең сорғы жабдықтары, сүзгілер

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МНОГОФУНКЦИОНАЛЬНЫЙ КЛАПАН ДЛЯ КОМПОНОВКИ ПОГРУЖНЫХ СКВАЖИННЫХ НАСОСОВ В СКВАЖИННОЙ ДОБЫЧЕ НЕФТИ

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Аннотация. В скважинной добыче нефти колонна насосно-компрессорных труб оборудуется различными по назначению эксплуатационными и технологическими клапанами. Каждый из этих клапанов выполняет определенную функцию. Поэтому базовая компоновка НКТ изначально может не содержать определенный клапан, необходимость в котором может возникнуть для проведения отдельных операций в процессе ремонтно-восстановительных работ. Это вызывает необходимость проведения трудоемких работ с привлечением спецтехники по остановке и глушению скважин, подъеме подземного оборудования, комплектации насосно-компрессорных труб необходимым технологическим клапаном и его спуску в скважину. В работе предлагается упростить компоновку скважинной насосной установки и повысить его технологические возможности путем оснащения

его многофункциональным клапаном, которое позволит выполнять как эксплуатационные задачи, так и широкий круг необходимых технологических операций непосредственно в скважине без подъема оборудования.

Ключевые слова: скважина, компоновка, клапаны, мехпримеси, насосно-компрессорные трубы, глубинно-насосное оборудование, фильтры

Introduction

The column of pumping and compressor pipes (PaCP) is a universal downhole pipeline for all existing technologies of extraction of liquid minerals using various kinds of pumping equipment. Moreover, the tubing string, in addition to its main purpose, is used to solve many other tasks related to the repair of the well and the restoration of its productivity.

To ensure the normal operation of submersible pumping equipment and carrying out repair and remedial operations (RRO) at the well, the layout of lifting pipes may include various operational and technological valves for their intended purpose – drain, check valves, shut-off valves, equalization valves, circulation, inhibitory and others. Even the simplest operational layout of lifting pipes provides for the presence of at least two valves in its composition: a drain valve for draining liquid from it during underground repairs and a reverse valve for retaining a column of liquid in the tubing when the pump is stopped (installed above the deep pump), which also complicates its layout and installation (Miguel Ferraz et al., 2016).

Each of these valves is usually designed to perform only a specific technological function. The completion of the tubing with the necessary valve leads both to the downtime of the well and the shortage of products during this period, and significantly increases the cost of production.

Another, no less important problem in the operation of deep-pumping equipment (DPE) in wells with a weakly cemented bottom-hole zone is the frequent clogging of the filter with mechanical impurities in the arrangement of the pumping and compressor pipes in front of the pump, and their regeneration in borehole conditions is practically impossible.

According to various sources more than 60% of problems with DPE are caused by solid mechanical impurities contained in the reservoir fluid. This leads to an increase in production problems associated with a decrease in the efficiency of pumps and their service life, a decrease in the production rate, an increase in the probability of equipment failure due to the destruction of working elements. All this leads to a decrease in production volumes and an increase in costs.

The problem of sand formation and commutation of wells is also characteristic of the technology of uranium extraction by the method of underground borehole leaching during the drilling of technological wells and the opening of productive layers. This leads to the need for repair and restoration work to clean the filter with a well stop or the application of additional measures to decolmatize well faces (Robello Samuel et al., 2010; Sereda et al., 1980).

If downhole filters can be cleaned by applying a pressure pulse from the wellhead along the production column, then filters installed in a pumping and compressor pipes with a check valve above the EDCP cannot be cleaned in this way. This leads to the need to stop the well and remove the tubing from the EDCP to clean the filter.

The most common and well-proven in practice are borehole filters, in which slit gratings made of V-shaped wire made of high-strength steel are used as a filter element. The size of particles trapped by the filter in the FFIM is 100–200 microns and depends on the design of the filter surface. Among the well-known filters in the IoaECP there are filters of the ZhNSH shore IMofF type. In the latter case, self-cleaning may partially occur due to pump vibration. For additional cleaning (for example, from clay rocks), a IMofF auger is used. However, vibration and screw device do not always allow cleaning the filter element from mechanical impurities. Similar problems arise when using downhole screw pumping units (Tanzharikov et al., 2023).

Materials and methods

In recent years, development work has been intensively carried out on the creation of specialized downhole equipment for the assembly of tubing, in particular, for various purposes of process valves such as KCPT, KCPZ, KCPTS KUM, KUMG-S and others for the operation and conduct of technological operations for underground well repair.

There are also attempts to create multifunctional well equipment, in particular, to develop designs of multifunctional valves that simplify the layout of tubing.

Thus, according to the patent of the Eurasian Patent Organization (EAPO) No. 038348 and the Republic of Kazakhstan No. 34414, No. 34415, designs of multifunctional valves are proposed for equipping installations with an electric submersible pump (ESP) and rod screw pumping units (RCPU), which additionally combine the functions of several valves for technological purposes.

The valve design proposed in them consists of two main components – the drain valve assembly itself and the control unit for its actuation delay (Figure 1). The drain valve assembly includes a movable cylindrical spool 2, adjacent to the side surface of the inner wall of the housing 3 and locking the drain holes 4, as well as its activator 1, locking the passage hole in the spool 2. In the lower part, the spool of the drain valve is supported by an adjustment spring 5, with a locking ring 6 on the thread, which allows you to adjust the tightening force of the spring 5.

The control unit for the delay time of the start of activation of the drain valve is located under the drain valve and consists of a check valve 7, a drain valve 8 with a bellows type activator 9. A gas lift valve from the so-called «mandrel» of the gas lift installation can be used as it.

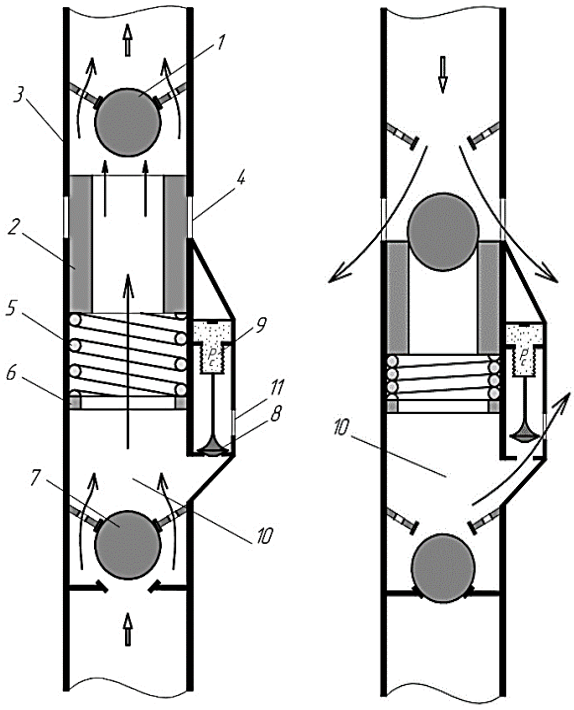


Figure 1. Multifunctional valve for rodless pumping units

Between the drain and check valves, in their closed positions, a sealed cavity 10 is formed, which can communicate with the annular space by means of a drainage valve 8 through drainage windows 11.

Valve-activators in the anti-sand valve can be different. For example – rotary, dish-shaped and others, or combine them in various combinations in one device.

The drain valve activation delay time is regulated by changing the pressure P_c of inert gas in the drain valve bellows during its filling and depends on: the dynamic level and viscosity of the fluid in the well, the concentration and fractional composition of mechanical particles and their sedimentation time (Myrzakhmetov et al., 2020; Rakishev et al., 2022).

Figure 1 in position (a) shows – the position of its elements during the operation of the deep pump, and in position (b) – the position of the valve elements after stopping the deep pump at the moment of activation and discharge of part of the column of liquid with mechanical impurities into the annulus.

The device works as follows:

During the operation of deep-pumping equipment (Figure 1a), when a liquid pressure appears from the electric centrifugal pump, both check valves – the upper 1 and the lower 7 are open and the process of pumping the liquid out of the well. The drain holes 4 in the valve body are blocked by the spool 2 of the drain valve

under the opening of the spring 5 and partially, due to the hydraulic resistance to the fluid flow, are drained by the spool 2 itself.

When the pump stops (Figure 1b), due to the lack of pressure, the activator valve 1, under the action of gravitational forces and the hydrostatic pressure of the liquid column in the tubing, sits on the spool seat 2. However, the force generated by hydrostatic pressure is not enough to move the spool 2, since it is balanced by the force of the spring 5 and the residual pressure of the liquid in the closed volume 10 with the lower check valve 7 closed and the drain valve 8 closed.

The drain valve 8 will be closed as long as the set pressure in the bellows 9 is greater than the liquid annular pressure. As the fluid inflows from the formation, the static fluid level in the annulus gradually rises, and when it exceeds the pressure P_c in the bellows 9, the drain valve 8 opens and begins to bleed the fluid from the closed volume 10 into the annulus, lowering the pressure in it.

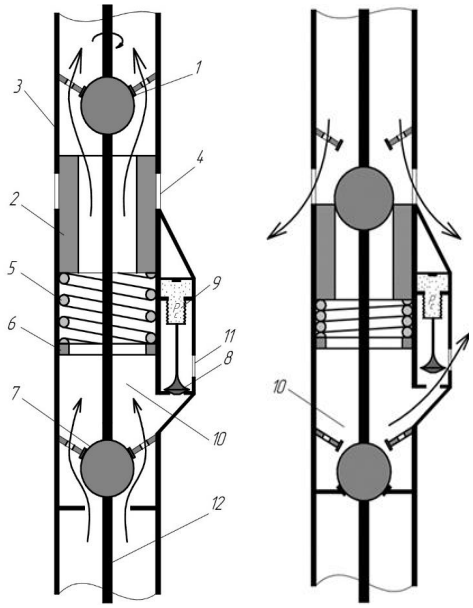
Now when the pressure drop across the drain valve 2 is sufficient to overcome the force of the spring 5, the spool of the drain valve 2 moves down, opening the drain holes 4 in the body 3. The process of discharge of the liquid column from the tubing into the annulus begins. In the process of draining the liquid from the tubing, the liquid level in the annulus will rapidly increase, which will lead to a more intensive increase in the external pressure on the bellows 9. If the annular pressure of the liquid exceeds the pressure in the bellows P_c, the drain valve 8 will open, which will lead to a decrease in pressure in the closed volume 10. The latter will contribute to the further movement of the spool 2 and the full opening of the drain windows 4 to discharge fluid with sand from the tubing. When the elastic forces of spring 5 exceed the hydrostatic pressure of the residual liquid column in the tubing, the spool of the drain valve 2 moves upward, closing the drain windows 4 and returning the valve to its original state (Mashrapova et al., 2021).

During the period from pump shutdown and annular pressure growth to a value sufficient to trigger the drain valve, sedimentation of the largest particles of mechanical impurities occurs, which can form a stable sand plug. The duration of this period can be controlled by the internal pressure in the drain valve bellows depending on the concentration and sedimentation rate of sand in the formation fluid and the recovery time of the hydrostatic fluid level in the well.

Such a delay in the operation of the anti-sand valve allows you to dump the liquid column most highly concentrated in mechanical impurities from the tubing, prevent the formation of sand plugs above the pump and reduce the power consumption for filling the vacated part of the lift pipe during subsequent start-up.

The cylindrical shape of the drain valve spool has a larger through hole for pumping liquid (hence, it creates less hydraulic resistance), its side locking surface is less susceptible to hydroabrasion wear.

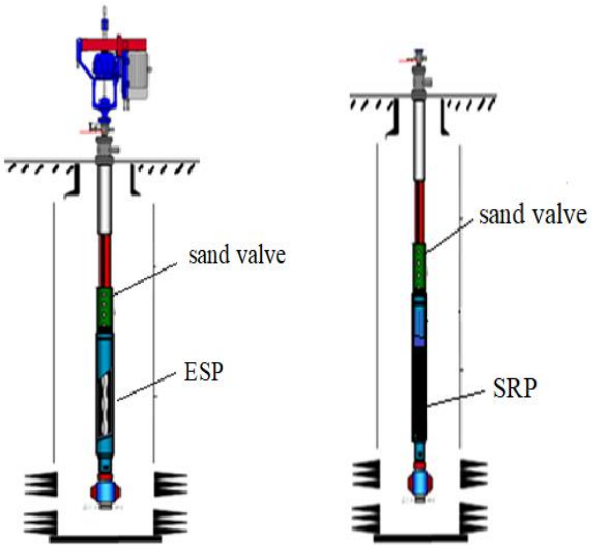
The anti-sand valve for sucker-rod pumping units has a similar design (Figure 2). Structurally, it differs in that the activator valves 1 and 7 are movably mounted on the rod (Kenzhetaev et al., 2022; Karmanov et al., 2021).



a) b)

Figure 2. Multifunctional valve for rodless pumping units

The anti-suspension valves are installed on the tubing string above the stator of the sucker-rod pumping (SRP) or the electric module centrifugal pumps (ECP) and control the communication between the pipe and annular space (Figure 3).



a) b)

Figure 3. Layout diagram of tubing with electric submersible pump (ESP) (a) and sucker-rod pumping (SRP) (b)

In case of possible formation of a small sand plug after a prolonged stop of the pump, at its subsequent start, there is a danger that the liquid pressure from the pump at the initial moment will not be enough to flush it. In this case, the drain valve 8 will work as a safety valve, and the liquid will be partially discharged into the annular space. This will prevent a sharp increase in pressure between the anti-suspension valve and the pump and partially neutralizes a sharp increase in the load on the electric motor.

Due to the presence of this device, there is no need to assemble downhole-pumping equipment with standard check and drain valves, the functions of which it can simultaneously perform. The same device allows you to carry out various technological operations related to flushing tubing from asphalt-resinous and paraffin deposits (ARaPD), pumping process fluids into the annulus when the pump is turned off. The proposed design also makes it possible to communicate the tubing channel with an annular space for the complete discharge of liquid from the tubing by pneumatic action from the ground part (from the wellhead) during well repairs (Kuandykov et al., 2022).

Results and discussion

To solve the problem of cleaning module filters, there are separate technical solutions for their cleaning in borehole conditions. However, most of these technical solutions require either stopping the well and lowering the flushing tool, or are limited to performing one specific operation. But there are developments that allow performing filter cleaning functions directly in downhole conditions without the use of special devices.

Thus, according to patent №2415253 a design of a submersible pump with a filter cleaned directly in the well is proposed (Figure 4).

Here, the submersible pump 1 with a filter being cleaned in the well 2, 3 includes a submersible borehole pump 1, which is lowered on a pipe column 4, which is placed in a hollow cylindrical casing 5 hermetically and rigidly fixed from above and allowing the flow of the pumped liquid to move through the gap between the casing 5 and the pump 1, a hollow cylindrical shank 6, fixed from the side the lower open end of the casing 5 and equipped in the lower part with a filter 3, and a check valve 7 located behind the pump 1 in the direction of movement of the pumped liquid. The casing 5 is connected by an opening 8 with the inner space of the pipe column 4 above the check valve 7, which passes only from the bottom up, and is equipped with an adjustable valve 10 pressed by a spring 9, blocking the flow of liquid in the casing 5 between the intake opening 11 (shown conditionally) of the pump 1 and the opening 8 of the pipe column 4 and retaining pressure in the pipe column 4, arising under the action of the pump operation 1.

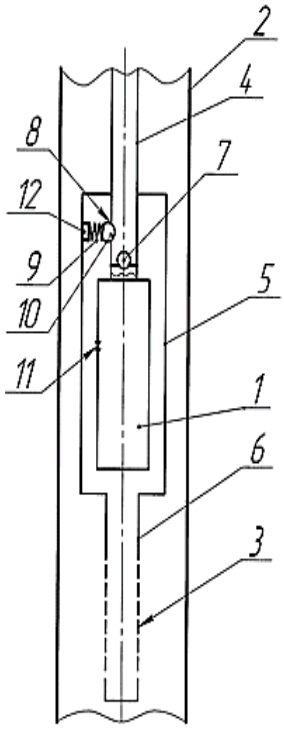


Figure 4. Diagram of a submersible pump with a filter being cleaned in a well

The disadvantages of the layout of a downhole pumping unit with such a device are:

– the need for multiple valves (at least two) in the device layout: a bypass valve for transmitting a pressure pulse to the filter for cleaning it in the casing and a check valve above the pump along the fluid flow to hold the liquid column in the tubing string above the pump when it stops) installed in different parts of it, which complicates the design;

– unreliability of actuation of the bypass spring-loaded adjustable valve when installed in the casing, since with an unforeseen increase in hydraulic resistances associated, for example, with the deposition of asphalt-resinous and paraffin deposits (ARaPD) on the inner walls of the tubing string above the pump and an increase in hydraulic resistances at the mouth of the column, the bypass valve may work to bypass part of the liquid through the casing from filter back to the pump inlet. The latter is fraught with overheating of the submersible ESP (Kuandykov et al., 2020; Myrzahmetov et al., 2020).

Multifunctional valve with filter cleaning capability

Based on the experience of development and the results of semi-industrial tests of a number of multifunctional valve designs, we offer several options for the layout of submersible pumps with a multifunctional valve with the possibility of cleaning the filter directly in downhole conditions (Figure 5). Here, option (a)

is – for rod screw pumping units, and option (b) is – for centrifugal pumps (ECP) (Akhymbayeva et al., 2023).

When assembling rod screw pumping units (Figure 5 a), a multifunctional valve is placed above the screw pump in the direction of fluid movement and its drain windows in the tubing body are enclosed in a hollow cylindrical casing, hermetically and rigidly fixed from above and allowing the flow of the pumped liquid through the gap between the casing and the pump into a hollow cylindrical shank fixed with the sides of the lower open end of the casing and equipped in the lower part with a dust filter, similar to the design according to the patent. The up arrows show the directions of fluid movement during operation and down – during emptying or cleaning the filter.

Such an arrangement of a multifunctional valve as part of submersible borehole pumps will allow it to provide the functions of a screw pump check valve (to prevent reactive rotation of the pump rotor during stops and jamming from mechanical impurities entering the pump), a drain valve when performing a SS during PW, as well as the possibility of flushing the borehole filter and tubing string directly in borehole conditions.

So, to clean the filter from deposits from the ground part of the well, a sufficient pressure pulse is created by the washing liquid, under the action of which the spool 1, overcoming the force of the spring 3, moves down. As a result, bypass windows 7 in the tubing string body are opened to allow liquid to pass through the gap between the casing 5 and the pump 8 to the inner cavity of the filter 11 for cleaning. At the same time, the tubing string is washed from deposits. This prevents chemicals from entering the pump.

To drain the liquid from the tubing string during the SS during underground repairs at the well, it is possible to pump gas from the mouth, which will also trigger the valve and empty the tubing string.

The layout of the electric submersible pump (ESP) (Figure 5 b) may have a similar design.

Thus, the very designs of the valves discussed above with a delayed actuation node can be significantly simplified if they exclude a delayed actuation node, and they can be used as simply discharge valves for draining fluid from the tubing string when the DPE stops. In this case, the filter will be simultaneously cleaned and flushed with a discharge column of liquid from the tubing string, the starting load of the DPE will decrease, since the filter resistance will be minimal, and the remaining column of liquid in the tubing string after discharge will be significantly less (in extreme cases, it will be equal to the depth of immersion of the pump) (Akhymbayeva et al., 2021; Ismailova et al., 2022).

Conclusions

1. The use of multifunctional valves is a promising direction in improving the efficiency of technological processes in the downhole extraction of liquid minerals and makes it possible to simplify the layout of the downhole pump pipe column by

reducing the number of valves of different purpose and the multifunctionality of technological operations carried out by it.

2. If it is necessary to carry out specific technological operations of underground well repair, these multifunctional devices will eliminate the need for additional descent and lifting operations to complete the tubing string with the necessary technological equipment with the involvement of special equipment and human resources.

3. The valve design fits well into the tubing string layout and will reduce operating costs associated with equipment failures and increase the inter-repair period of wells.

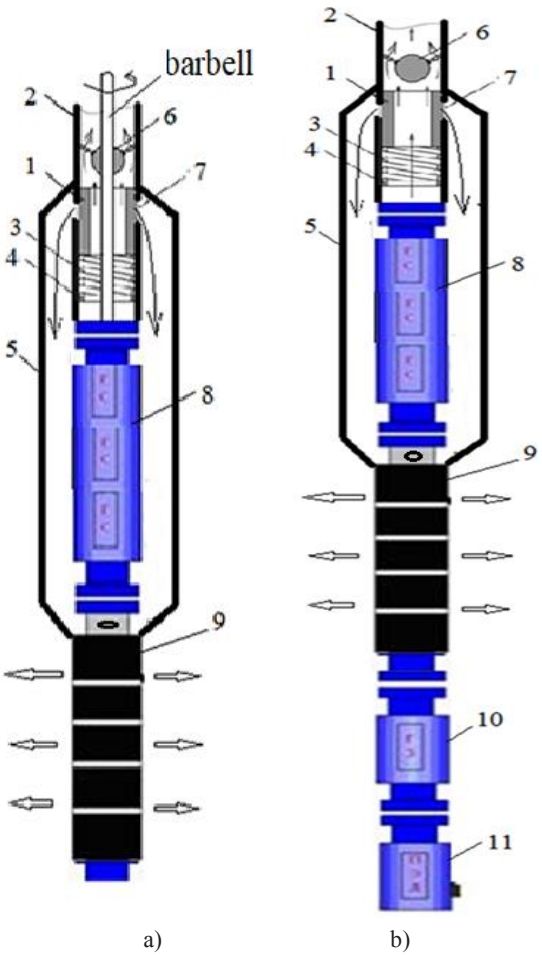


Figure 5. Submersible pump layout options with multifunctional valve
The scheme of submersible pump layout with filter to be cleaned in the well:
a) for rod screw pumping units; b) for electric submersible pump (ESP)
1 – valve spool; 2 – tubing string; 3 – spring; 4 – stopper; 5 – casing; 6 – check valve; 7 – drain holes in the tubing string body; 8 – screw pump section; 9 – filter (ARaPD); 10 – protector; 11 – SEM

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