REPUBLIC OF AZERBAIJAN

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ABSTRACT

of the dissertation for the degree of Doctor of Philosophy

USAGE AND APPLICATION OF NEW METHODS TO INCREASE THE PRODUCTIVITY OF SAND-FINE WELLS

Specialty: 2526.01- "Technology of development of offshore fields"

Field of study: Technical sciences

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Baku - 2025

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GENERAL CHARACTERISTICS OF THE WORK

Relevance of the topic and the degree of usage. One of the main indicators in sand wells is frequent stoppages and reduction of work time between repairs. The factors that increase the intensity of repairs are the complications created during operation by mechanical mixtures in the product produced from wells, and accidents, which are a manifestation of these complications. It is necessary to take measures to increase the efficiency of oil field development, restore normal operation of wells operating in difficult conditions and increase the interval between repairs. Although a number of technical and technological measures have been developed and applied in production to eliminate the negative impact of sand on the operation of oilfield equipment, which is one of the factors reducing the working time between wells, this issue remains relevant.

Due to the urgency of the issue, the gravel injection device, which serves to create a dense and homogeneous layer of gravel between the gravel-cracked filter and the layer released into the well to strengthen the wellbore zone, intensive leakage against the plunger-cylinder gap created by sand in sandy wells. In low-level borehole pump wells, the intake valve, which prevents the pump filling coefficient from increasing due to mechanical impurities and the pump intake is improved, is an improved rod well pump design controlled by the movement of the balance head. In order to combat the complications created by the harmful effects of sand, various methods have been reviewed.

The approach to avoiding the sand factor is done in two directions: prevent the entry of sand coming from the reservoir into the well and elimination of the harmful effect of sand on the operation of the sucker rod pump.

Goals and objectives of the study. Development of new methods to prevent the ingress of sand from the formation into the well to increase the productivity of sand-manifested wells and to prevent the negative impact of the sand inside the well on the operation of the rod depth pump

Object and subject of research

1. Creation of a dense, solid layer of gravel evenly distributed behind the gravel-slit filters released to the bottom of the well in sand-manifested wells;

2.Analysis of the operation of rod well pumps on the basis of mining research, investigation of characteristic repairs and sand-sensitive parts;

3.Development of a pump to prevent leakage by preventing the plunger-cylinder pair of rod depth pumps from being eaten away by sand;

4. Development of a pump with a special design of the intake valve, controlled by the movement of the balance head, to improve the liquid filling of the rod depth pumps in the lower liquid level wells and to protect the receiving part from sand exposed to intensive sand;

5. Development of a sand trap device that prevents sand entering the plunger-cylinder cavity in rod depth pumps.

Research methods

In order to solve the problem, the materials obtained on the basis of mining data were analysed, directions were identified, new methods were developed in the defined directions and solved by application in the mines.

Scientific novelty of the research:

1. In sand wells, a device has been developed to create a dense, solid gravel layer evenly distributed behind the gravel-slit filters discharged to the bottom of the well;

2. A leak-proof pump has been developed to prevent the plunger-cylinder pair of rod depth pumps from being eaten away by sand;

3. A pump controlled by the movement of the balancing head of the intake valve has been developed to improve the liquid filling of the rod depth pumps in the low fluid level well and to protect the receiving part from sand exposed to intensive sand;

4. A sand trap has been developed to trap sand entering the plunger-cylinder cavity of the pump.

The main provisions of the assertion:

1. A device for creating a dense, solid layer of gravel evenly distributed behind the gravel-slit filters released into the bottom of the well in sand-manifested wells;

2. Leakage pump, which prevents erosion of the plunger-cylinder pair of rod depth pumps by sand;

3. Pump to increase the filling ratio of rod depth pumps in low fluid level wells and to protect the receiving part from sand;

4. Sand trap device for trapping sand entering the plunger-cylinder cavity of the pump.

Theoretical and practical significance of the research.

The results obtained in the dissertation are applied in the oil industry.

The crushing unit was tested during the installation of a gravel-slit filter in well No. 133 of the OGPU named after H. Z Taghiyev. Quartz sand brought from Volgograd; Russia was used to hit the back of the filter. A 4% solution of carboxyl methyl cellulose (CMC) was used as the crushing fluid. After the event, the inter-repair work time of the well increased 2.5-3.0 times, and an additional 240 tons of oil was produced.

The sand trapping device, which prevents the ingress of sand into the plunger-cylinder cavity in rod depth pumps, was tested in wells 1087 and 1049 of Absheronneft OGPD.

Eurasian patent No. 035124 was obtained for the invention "Device for trapping sand in oil wells".

Approbation and application of the work. The provisions of the dissertation were reported and discussed at international and national conferences:

- Fundamental and applied research in the modern world. St. Petersburg, Proceedings of the XX International Scientific and Practical Conference, December 4, 2017, volume 1, p. 45-47.

- High intellectual technologies in science and education, Collection of materials, St. Petersburg, IV International Scientific and Practical Conference, December 26, 2017, volume 1, p. 95-97.

- Materials of the II International Scientific and Practical Conference; Bulatov Readings, Collection of articles March 31, 2018, p. 183-185.

- "Modern problems of innovative technologies in oil and gas production and applied mathematics" Proceedings of the international conference dedicated to the 90 th anniversary of Academician Azad Khalil Mirzajanzade Baku, December 13-14, 2018 p. 464-466

-International scientific and practical conference "Modern methods of developing fields with hard-to-recover reserves and unconventional reservoirs", September 5-6, 2019, Republic of Kazakhstan, Atyrau;

- Bulatov Readings, Proceedings of the V International Scientific and Practical Conference March 31, 2021, p. 178-181.

- International online scientific conference "Innovative technologies in the oil and gas industry. Experience in implementing development prospects". Republic of Kazakhstan, Aktau, November 19, 2021, p.54

Publications. The main results of the dissertation are reflected in 15 scientific works, including 7 scientific articles, 7 conference proceedings and 1 Eurasian patent

The structure and scope of the work

The dissertation consists of 181,625 characters in total, including Introduction - 12,911, Chapter I - 86,624, Chapter II - 62,396, Chapter III - 17,483, and Conclusion - 2,211 characters.

SUMMARY OF THE WORK

The introduction shows the relevance of the dissertation, the goals and objectives of the research, methods, scientific innovations, the proposed arguments and the theoretical and practical significance of the research.

The dissertation work is devoted to the prevention of sand entering the well from the formation and the elimination of the negative impact of the product on the body of the well on the work of submersible depth pumps.

The first chapter provides an overview of the research conducted to combat obstacles in sand-operated wells. The presence of sanding creates great difficulties, leads to the intensity of the work of the complex of downhole and wellhead equipment.

The first chapter consists of three sections. The developed works devoted to the complications created by sanding and their prevention are analyzed, the harmful effect of sand on the operation of the rod pump and the developed equipment and devices in the fight against it are studied characteristic defects formed by sand in sucker rod pumps, current repairs in oil and gas production departments and the impact of sand on them.

The first half of the chapter examines the causes of the collapse of the area around the well, analyses the complications caused by the appearance of sand and the work done to combat them. When developing formations composed of weakly cemented and loose rocks during production, sand enters the well along with the liquid from the formation. The destruction of the bottom-hole formation zone, the removal of sand with the produced fluid, and the intensity of this process, together with geological reasons, are also affected by the technologies that open the reservoir, the level of drilling fluid contamination during drilling, clogging of the bottomhole pores, the quality of the cement stone formed behind the production string, type of perforation fluid, perforation method and the number of technological processes carried out.

The formation of sand production and the level of sand production depends on the depth of the reservoir, reservoir pressure, well production, the level of cementation, the characteristics of reservoir sand, on the carbonate content of the rocks that provide the strength of sandy-argillaceous rocks and the physicochemical parameters of the fluid that fills the rock of the productive reservoir. The influence of several factors, individually and in combination, must be taken into account for the formation of sand ingress and destruction of rock skeletons in the bottomhole zone of the well.

To combat sand intrusion, reinforcing technologies are used based on cement slurries with the addition of resin, polymers and other chemical components.

In order to combat sand intrusion, filters of various designs are lowered to the bottom of the well.

Since sand plugs are periodically formed in sand-producing wells and after some time these plugs prevent fluid from entering the well, it becomes necessary to clean the plugs.

In sand-producing production wells, to prevent sedimentation and removal of large fractions of sand at the wellhead, a certain volume of liquid is added to the annulus along with the production. Due to the addition of liquid, the rate of sand rise is regulated and the concentration of mechanical impurities in the composition of the product is reduced.

As a result of the appearance of sand, there are great difficulties in the operation of wells, the number of repairs increases, and the overhaul period decreases. All oil fields of Azerbaijan located on land and some fields located on the sea are composed of weakly cemented rocks. Wells exploiting these deposits are usually distinguished by high sand-producing ability, which during oil production leads to the removal of sand from the bottomhole zone to the bottomhole and into the wellbore.

All this necessitates the development of new techniques and technologies, taking into account the existing conditions.

In the second half of the chapter, an overview of the equipment and facilities developed to eliminate the harmful effects of sand in wells operated by rod depth pumps is given. With the assistance of mechanical impurities inside the produced fluid, all downhole equipment, a pair of plunger-cylinder and valve units of the pump become unusable within a short time.

Excessive amount of sand in the product accelerates the process of wear and tear of pump parts. When exposed to mechanical impurities inside the well, all downhole equipment, including the plunger-cylinder pair, valve assemblies fail. Mechanical impurities in a short time break the tightness in the pumps, between its parts. Since sand extracted with liquid has high strength, it intensively abrades the working areas of the plunger-cylinder pair. Therefore, preventing the harmful effects of sand on the operation of the pump is very important. Numerous theoretical and practical works have been carried out in order to study the leakage through the gap between the plunger and the cylinder. In addition to increasing the strength of the working surfaces of the plunger-cylinder pair, in order to prevent premature failure due to friction, it is also necessary to ensure uniform wear of the working parts, reduce the forces acting on the abrasive areas, and transfer the forces acting on important parts to other parts. In order to increase the service life of the pump, the implementation of the above measures is of great importance.

Studies show that the protection of rod depth pumps from sand is carried out in three directions: the pump itself is made of a special sand-resistant material, the development of new pump structures, the creation of sand protection devices for the pump.

The implementation of all protective measures did not lead to the complete prevention of sand ingress into the pump. Despite the decrease in the volume of sand entering the pump, a certain amount of sand still enters the pump cylinder with oil, and it can even collect in valves and form plugs. These particles entering the pump cylinder from there enter the tubing. In tubing, some of these sands begin to separate from the fluid and settle on the plunger surface. And when the plunger moves, they will be in the gap between the plunger-cylinder pairs, intensifying the process of abrasion of the working surfaces or leading to the plunger sticking in the cylinder, stopping the operation of the pumping equipment.

Although many designs have been developed for the protection of rod submersible pumps from sand, the work has continued in this direction in the dissertation, as this problem has not been fully resolved.

In the third half of the year, the effect of mechanical mixtures on the current repairs carried out in the wells operated by the deep pumps of the OGPD of Azneft PU was studied.

During the operation of wells with deep rod pumps, for some reasons, complications may arise, including depending on the composition of the produced fluid. Wells operated in complicated conditions include sand-producing, gas-producing, corrosive, waxy, etc. The predominant amount of mechanical impurities and sand accelerates the wear of the pump and its parts. In this regard, in the pumps, the working units in a short time come into an unusable state. It is known that a pair of plunger-cylinder and valve assemblies are the main parts of the pump. The condition of these parts affects the performance of the pump. The correct choice of the gap between the plunger and the cylinder, the hermetic fit of the ball on the seat in the valves are important tasks. In natural cases, when there are no mechanical impurities even in the downhole production, these parts fail after a certain period of time due to wear, impact, and other reasons. Mechanical impurities and sand, along with the acceleration of this process, increase the likelihood of emergency situations in the operation of the well.

The diameters of sucker rod pumps are selected in accordance with the diameter of the production string and tubing string. With a decrease in the diameter of the pipe string, the diameter of the pump and its parts decreases accordingly. The depth of wells, high pressure, temperature and in general all operating conditions require high strength and reliability from the pump and its elements. Under the conditions created by the operational situation during the design of the pump, it is impossible to obtain the appropriate dimensions. Therefore, during operation, during the operation of the pumps, its parts are broken and the hydraulic resistance increases (during the process of suction and injection in the corresponding valves). Collected field materials on the repair work on the relevant wells.

The number of current repairs carried out at Absheronneft OGPD during the year was 2976. The number of repairs related to pump replacement and riveting was 663, and the number of repairs related to washing and cleaning the plug was 1308. The height of the washed sand plug was 89200 m and the height of the sand plug cleaned with bailer was 471 m. Washing and cleaning of the sand plug is more than other repairs -44%.

The total number of current repairs carried out at Bibi-Heybatneft OGPD during the year was 4852. The number of repairs carried out on rod submersible pumps was 1527, washing of sand plugs 154, cleaning of sand plugs 74, number of repairs related to breaking and opening of rods 457, number of repairs carried out to eliminate leaks in pump-compressor pipes 2374, the rest were other repairs. Repairs related to pump replacement, riveting, and rod breakage and opening account for 40.9%. PCP Troubleshooting Repairs are the most common repairs in OGPD, accounting for 48.9%. In addition to mechanical impurities, the presence of an aggressive environment also affects the intensity of pump replacement and pipe repairs. The number of repairs carried out at OGPD named after A.J. Amirov during the year was 5136. The number of repairs related to pump replacement and riveting was 2,168, and the number of repairs related to washing and cleaning the sand plug was 692. The height of the washed sand plug was 24043 m and the height of the sand plug cleaned with bailer was 692 m. Repairs related to pump replacement, riveting and rod breakage and opening in the OGPD account for 48.5%. PCP repairs were 34%. Repairs such as pump replacement and riveting, rod breaking and opening, and sand plug washing and cleaning accounted for 62.5%.

In terms of the presence of sand in the well product, the equipment is operated in more complex conditions. The total number of repairs carried out at OGPD during the year was 2126. The number of repairs related to pump replacement and riveting was 450, and the number of repairs related to plug washing was 685. The height of the washed sand plug was 39991 m. Repairs such as pump replacement, riveting, rod breakage, opening and sand plug washing together accounted for 53.8%.

Research has shown that the impact of sand on current repairs is unequivocally large and varies by facility. For example, in the wells of the Absheronneft OGPD, the plunger is more often riveted in the cylinder, which is explained by the granulometric composition of the strata there. The height of the sand plug in the wells of the OGPU named after H. Z. Taghiyev is higher per operation, which is the result of the very low strength of these rocks. The most common type of maintenance carried out at Bibi-Heybatneft OGPD is leaks in in-well equipment, which is due to the aggressiveness of the facility under development. The specified specificity of the objects should be taken into account when developing measures against complications in wells. Research shows that the problem of sand is unequivocally present in some offshore and all onshore oil fields in Azerbaijan[1]. Sand is always observed in the oil wells of these fields, which have a high percentage of irrigation in the final stage of operation and in the production of wells, and it is necessary to fight with it.

The second chapter of the dissertation is devoted to sand-treated substances to improve the operation of wells. The second half-chapter consists of four half-chapters.

In the first half of the second chapter, a graveling device was developed to create a dense and paid gravel layer in order to ensure the efficient operation of gravel-slit filters installed in sand-type wells[2].

The composition of rocks of the reservoir of oil fields of the Azneft Production Association is mainly weakly cemented and loose. And therefore, under the influence of the action of mechanical impurities approaching with the produced fluid in wells during operation, frequent complications of various types occur. The normal operation of downhole and wellhead equipment is disrupted and the possibility of operating wells in the optimal mode is limited. Sand particles in the composition of the produced fluid create favorable conditions in the bottomhole zone of the well for clogging, pollution, increased vibration and friction in the downhole equipment, premature

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[1] Mehdiyev, K.K, Ahmad, F.F., Hajikarimova, L.Q. Analysis of repairs related to mechanical mixtures in wells operated by rod depth pumps. ADNSU, NewsofAzerbaijanHigherTechnicalSchools, 2018, Volume 20, № 4, p. 39-48.

[2] Ahmad, F.F., Ahadov M.A., Hajikarimova, L.G. Device for creating a layer of gravel behind a wire filter, Azerbaijan oil industry, 2017, № 07-08, p.39-43

failure of the tubing string, shut-off and control valves and in some oilfield equipment. Mechanical impurities create the prerequisites for the formation of sand plugs in the bottomhole of wells, makes underground equipment unusable, as well as disruption of the regime and frequent shutdowns of wells. Under the influence of sand, the resulting complications in the operation of downhole equipment and wells lead to highly paid repairs and losses in a large amount of oil in production. Along with the creation of appropriate complications, the sand factor leads to the removal of a significant amount of sand to the surface, forming large caverns in the bottomhole zone of the well. And such situations pose such realities as a decrease in the strength of the rock of the bottomhole zone, crushing and scrapping in the filter part of the production string. With the possibility of creating such emergency situations, there is always a danger of returning to another productive horizon if there is a sufficient amount of residual oil in the current horizon.

Prevention of particles from the formation into the well with the help of filters is considered to be a more acceptable method in the fight against sanding. From this point of view, among the anti-sand filters installed in the bottom of the well, the installation of gravel filters is more appropriate.

When installing gravel filters, the guarantor of efficient operation is a uniform and dense alluvium of gravel in the filter zone along the entire length of the productive strata. Uniform and dense distribution of gravel, preventing the flow of sand from the reservoir into the well and the formation of caverns in the bottomhole zone, restores the strength of the wellbore. The formation of a strong gravel layer in the near-filter zone, opposite the productive stratum, clearly depends on the quality of the gravel alluvium. Poor-quality alluvium of gravel in the behind-filter zone reduces the overall quality of the filter installation. The effective operation of the installed filters in the well mainly depends on the technology of gravel infiltration in the behind-filter zone. For this purpose, a gravel reclamation device (crossover) has been developed.

The device consists of gravel and liquid flow separator parts, left threaded special conductor, funnel, bracelet, retaining screw, fastener, packer body tightening ring, sealing bushing, short pipe, shirt pipe, sealing rubber ring, liquid outlet, separator, starting from the saddle, suspension ring, fluid lifting pipe, short pipe connecting the washer to the strainer, flat valve, tightening screw, PCP and guide screw. The difference between the developed gravel plant and existing ones is that its design ensures that the gravel is forced to settle behind the filter, and sits tightly and closely. The danger of getting sand from the formation is the same as damage to the propane-gravel unit for the installation of a safe screen layer, as well as improper selection of the carrier fluid. The gravel washing process must ensure that the gravel remains suspended within it. The deposition of gravel in the liquid during the crushing process reduces the quality of work and does not allow the formation of a barrier with the required density. A number of liquids, such as gravel, have been considered more suitable for their high carrying capacity and ease of detection of KMS-carboxylmethylcellulose. Based on the granulomeric composition of the rocks of the Azerbaijani deposits, it was considered expedient to use 3-5% aqueous solutions of the carrier fluid-KMS in water as a gravel.

Problems created by sand in offshore oil fields compared to fields on land are more labor-intensive and difficult to implement, since the cleaning of produced oil from sand requires both the construction of separate facilities and the delivery of sand cleaned from oil to the shore and storing it in a special polygon.

In the second half, a pump design is developed to eliminate the effect of the sandy liquid on the leak in the plunger cylinder cavity. With an increase in the concentration of sand in the produced fluid, wear is observed in the threaded connections of the pump, and the joints and surfaces of the rods and pipes at the bends wear out, or sand accumulates at the bends. On the other hand, sand entering the gap between a pair of plunger and cylinder causes the plunger to jam in the cylinder. In existing rod submersible pumps, fluid leakage from the gap between the plunger-cylinder pair is always existed. Over time, as a result of the friction, gap and the amount of leaking fluid increases. The entry of mechanical particles into the gap along with the fluid intensifies the growth of the gap and the leakage of fluid.

A new pumping unit has been developed to solve the problem[3]. The essence of the operation of the exhaust rod pump (Figure 1) is to prevent sandy liquid entering the cavity from above by creating a stable emulsion in the plunger-cylinder cavity. Obtaining the emulsion is achieved by opening specially designed holes on the pump plunger. The special shape of the holes ensures that the mixture of water and oil passing through them rotates at high speed, creating conditions for the formation of emulsion at the exit of the holes. The resulting emulsion, occupying the gap between the plunger and the cylinder, creates an obstacle to the leakage of fluid from the tubing. The rod well pump consists of the following parts:

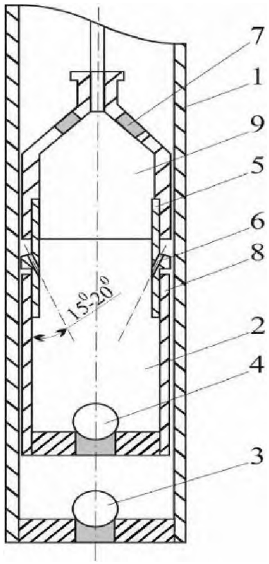

Figure 1. Pump to prevent leakage

[3] Kazimov, Sh.P., Gadzhikerimova, L.G. Reducing fluid leakage in the gap between a pair of cylinder and rod pump plunger. St. Petersburg, High intellectual technologies in science and education, Collection of materials, IV International scientific and practical conference (December 26, 2017) p.95-97

Consists of a cylinder 1, a plunger 2, a suction valve 3, a suction valve 4, a nipple connected to the plunger -5, a screw at 120 ° along the cross section of the nipple - three channels 6 opened in the form of a groove. The principle of operation of the pump is as follows: during the upward movement of the plunger 2, the suction valve 3 on the cylinder 1 opens under the influence of the static level of fluid at the bottom of the well, the liquid enters the cylinder 1, the suction valve 3 begins to close , the plunger 2 begins to move downward with the inside of the cylinder 1 and squeezes the fluid inside the cylinder 1, under the influence of the compressed fluid inside the cylinder 1 the inlet valve 4 opens and the liquid enters the cylinder 1 plunger 2 - pump-compressor pipes, the plunger 2 ends down, the injector valve 4 closes, the plunger 2 begins to move upwards, at which point fluid enters the cavity 6 from the channels opened on the nipple. The problem is solved by opening one of the three channels at an angle of 15-20 ° to the axis of the plunger on the nipple connected from above to the plunger of the rod pump, directed in the opposite direction of the fluid leaking from the cavity and at a cross section of 120 °. The screw-groove-shaped preparation of the opened channels is achieved by the formation of a stable emulsion, ensuring the rapid rotation of the water and oil mixture during the exit of part of the liquid inside the plunger into the cavity. The emulsion fluid from the channels enters the plunger-cylinder cavity and forms a high-viscosity barrier in front of the liquid directed from the pipes to the cavity.

The viscosity of the obtained emulsion is greater than the viscosity of the product coming out of the injection valve according to Einstein's equation

$$\mu_1 = \mu(1 + 2{,}5B)$$

here

μ_1 is the viscosity of the emulsion

μ -is the viscosity of the oil.

B - is the volume of water in the emulsion.

Opening one of the three channels at 120 ° on the nipple centres the plunger correctly inside the cylinder, ensuring that the emulsion leaving the channel is evenly distributed in the cavity. As a result, the gap is filled with emulsion evenly distributed over the entire cross section. As this process is repeated in each stroke of the pump, it provides the interstitial with continuous emulsion. This eliminates the effect of changes in the physical and chemical properties of the emulsion in the gap over time, mixing with the liquid inside the pump-compressor pipes. The opening of the proposed channels on the surface of the nipple connected to the plunger protects the strength of the plunger. Since the channels are open on the surface of the nipple, the design of the plunger is not subject to change and retains its strength

In the third half of the chapter, the structure and working principle of the pump used to lift the product from the fields in the final stages of development are given. In such fields, the fluid level in oil wells decreases due to lower formation pressure and reduced production which creates difficulties in the operation process. The pump is not immersed in enough liquid. That is, to ensure the opening of the receiving valve and the flow of fluid into the valve, the pressure created by the liquid column located at the bottom of the well is insufficient.

Due to the low level of the liquid column, the distance between the wellbore and the pump intake-suction valve is reduced, the mechanical impurities in the fluid cannot settle in the wellbore, and the sand falls into the wellbore, which does not allow the liquid to separate and settle. The decreasing in the dynamic fluid level of the well is due to the decreasing volume of fluid entering the well from the formation. One of the reasons for the delay in closing the intake valve is that when the plunger moves down the valve ball is tilted away from the center of the saddle as it sits on the saddle and the cross section in the saddle is not properly sealed.

One of the other reasons for the delayed closing of the valve is the insufficient amount of fluid inside the cylinder and, accordingly, its insignificant effect on the valve ball. The receiving product is more exposed to the liquid mechanical panels of the product itself, and in such wells the receiving valves of the pumps occur at a lower intensity than in other wells. In these wells, on the one hand, ensuring the immersion of the pump under the liquid, on the other hand, the receiving part of the pump is subjected to a great influence of mechanical impurities.

The intake valve is opened and closed by the action of the balancing head to ensure that the pump cylinder is filled, to prevent accidents during the downward movement of the plunger, to delay the opening and closing of the valve, and to prevent leakage of the intake valve parts due to mechanical impurities in the well product a rod depth pump has been developed[4] (Figure 2).

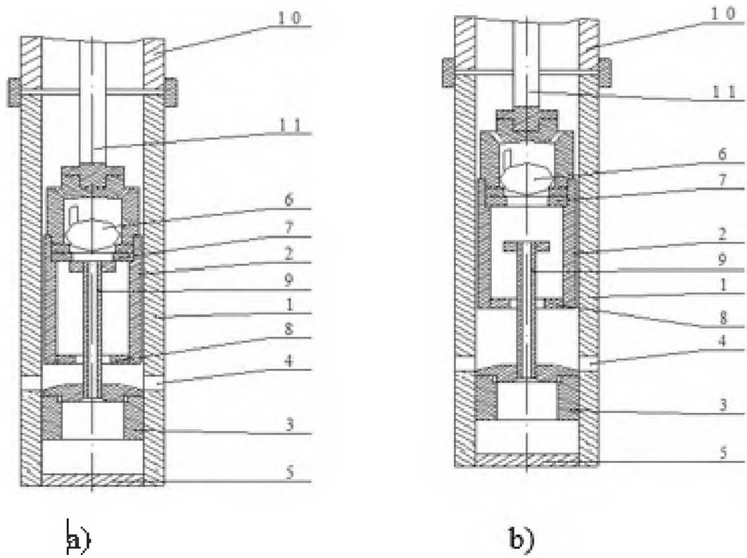

Figure 2. Improved rod well pump controlled by intake valve

a) the end of the downward movement, the beginning of the upward movement

b) intermediate position of upward movement

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[4] Ismailov, F.S., Kazymov, Sh.P., Gadzhikerimova, L.G. Innovative developments of sucker rod pumps to improve the performance of sand producing wells. // SOCAR Proceedings, 2021, No. 4, p. 80-86

The specially designed rod well pump, controlled by the movement of the balance head, consists of a cylinder 1, a plunger 2 and a threaded intake valve 3. The lower side of cylinder 1 has holes 4 to replace the intake valve and a cap 5 at the lower end. The plunger consists of 2 feed valves 6, a ring limiter 7 and a cap with a hole in the middle 8. The rod pump cylinder is discharged into 10 wells by means of 1 pump-compressor pipeline, and the plunger is discharged into 11 wells through the rod pipe until it sits in the required position inside the 3 cylinders 1 with 2 grooves. The bar stem hangs from the suspension head suspension of 11 pins. Depending on the movement of the balance head, the pump plunger 2 is moved up and down by means of the rod 10.

At the end of the plunger 2 downward movement, the 9 protrusions of the carving 3 rod 9 rest against the annular limiter 7 under the feed valve 6, and by pushing the carving 3 down, the gun opens 4 of the strong holes. In the upward movement of the plunger 2, the feed valve 6 closes and the liquid above it rises, and since the intake valve is open, fluid enters the pump unit from well 1. At the end of the plunger 2 upward movement, the protrusions 9 of the 3 carving rods 8 rest on the plunger cover 8 and the carving 3 is forcibly raised, as a result of which the devices cut 4 holes in front of the plunger and 2 liquids do not enter the well. When the plunger 2 is lowered, the feed valve 6 opens and the device passes over the liquid feed valve 6. At the beginning of the upward movement of the plunger 2, the feed valve 6 closes and 1 fluid begin to enter the device from the well. Up-and-down movement of the balance head. The plunger of the rod pump moves 2 cylinders 1 up and down. At the end of the plunger's up-and-down movements, the intake valve groove 3 is forcibly raised or lowered. fluid enters the pump unit from the well and is installed in the system where it is located. In standard and series-produced submersible pumps, the opening of the intake valve depends on the dynamic level in the well and the position of the plunger. During the pumping process, the liquid cannot enter the pump from the well unless it is relieved of the load on the intake valve. However, in the developed pump design, the valve is constructively connected to the plunger and the upward movement of the beam's head necessarily ensures the opening of the intake valve. When the balancing head and, accordingly, the plunger act upwards, the pump intake valve opens and there are no obstacles in front of the liquid to penetrate the valve.

The design of the exhaust pump ensures the forced opening and closing of the suction valve below the electric power of the liquid column in the well.

Apparently, the design of the pump ensures that the suction valve is forced to open and close regardless of the pressure of the liquid column in the well. While in existing pumps, when the plunger moves upwards, despite the fact that the receiving valve is released from the load acting on it, it is not yet open, for opening it is necessary that the pressure of the liquid column located at the bottom of the well is sufficient to push the ball and open the valve. Since the height of the liquid column is not large, this process of performing the opening of the valve is not completely ensured, or is only half performed. That is, the pump, not having time to be completely filled, the receiving valve is already closed. As a result of the changes made to the design of the pump, the filling of the pump cylinder is ensured and the premature failure of the intake valve is eliminated.

In the fourth half of the chapter, a device was developed to prevent sand from falling into the plunger-cylinder cavity in sand-bearing wells[5] (Figure 3).

In rod submersible pumps, the size of the gap between the plunger and the arms is large. In practice, it often happens that these pairs of additional gaps are riveted and eroded under the influence of sand and mechanical equipment. It is considered to be suitable for the purpose of protection from above in order to obtain a reserve for the entry of its pumps into the mechanical gap. In rod-type submersible pumps, the control of the pump-compressor pipes above the plunger reduces the probability that the liquid formal mechanical parts fall into the plunger-cylinder gap, and prevents these parts from entering the gap, eliminating its operation.

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[5] Hajikarimova L.G. Development and application of the device for capture of large granular mechanical particles falling between plunger cylinder pairs in rod depth pumps, Azerbaijan oil industry, 2020, № 9, p. 43–45

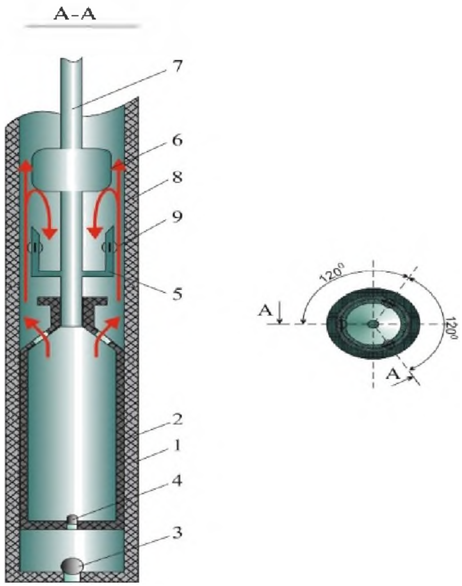


Figure 3. Sand trapping device

1-pump cylinder; 2-plunger; 3-suction valve; 4-stroke valve; 5-holder; 6-pressure differential; 7- barbell; 8 pump-compressor pipes; 9 - holder balls;

This can be explained in such a way that some of the mechanical impurities in the composition of the produced fluid do not enter the tubing. When the plunger moves upwards, mechanical impurities, together with the liquid, are directed towards the gap between the plunger and the cylinder.

The device consists of two main parts - a pressure differential (6) and a ball-bearing (9) holder (5), which moves comfortably inside the pump-compressor pipes. The pressure differential is designed to reduce the pressure of the liquid and change the direction and reduce the speed of mechanical impurities moving inside the liquid. The sand trap, thanks to the differentiator, ensures accumulation in changed directions and reduces the speed of mechanical impurities.

During the upward movement of the plunger (2), the liquid enters the space inside the pump compressor tubes (8) through the opening of the suction valve (3), the liquid cylinder (1), the downward movement of the plunger and the closing of the suction valve. The speed and pressure drop when the liquid passing through the narrowed area between the holder and the PCP falls into a relatively large area between the differential and the holder. Under the current conditions, the speed of mechanical particles decreases due to the liquid falling on a strong field, and is all wed for their precipitation. There is an impulse for their subsidence, which is achieved by differentiating the sand.

The liquid enters the space inside the pump compressor tubes (8) through the opening of the suction valve (3), the liquid cylinder (1), the downward movement of the plunger and the closing of the suction valve. The speed and pressure drop when the liquid passing through the narrowed area between the holder and the PCP falls into a relatively large area between the differential and the holder.

The liquid moving upwards and the particles inside it collide with the differential, at which point the sand particles change direction and move towards the lower holding part and collect here. The device moves smoothly inside the tubing thanks to three balls distributed from each other at the same distance.

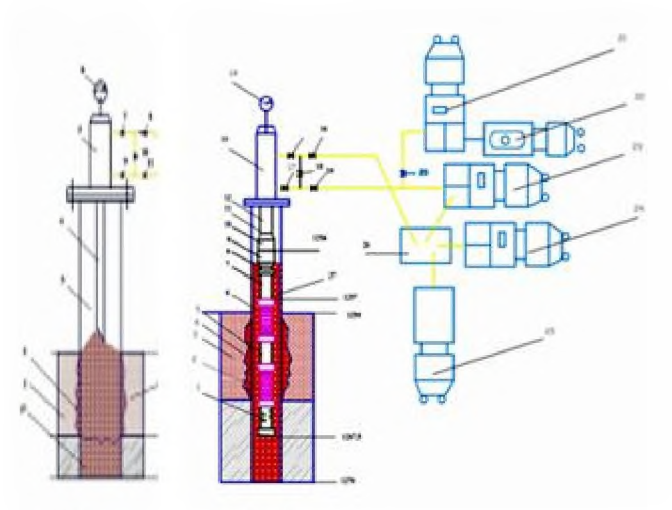
The balls, which ensure that the holder moves well inside the PCP, the resulting surface friction force, generated between the ball and the surface, serve to replace the surface friction force created by the contact of the inner surface of the tube with the surfaces of the holding chamber, and the point contact force between the ball and the surface. Thanks to this, the sand trap moves easily inside the pipes.

Due to the developed device, a barrier is formed between the pump and the pipe during the deposition of mechanical particles in the liquid inside the pump-compressor pipes. Depending on the amount of mechanical impurities in the product from the well, the number of these devices can be increased. These devices can be installed on inclined wells, on bends in bent parts. can be increased. A European patent has been obtained for the developed device[6].

The third chapter shows the mining tests of the developed measures and the results obtained.

The first half of the third chapter shows the results of the mining tests of the developed crushing plant. Well No. 133 in the Buzovna-Mashtagha field was selected to test the gravel rig[7].

The graveling operation was carried out in 2 stages according to the scheme shown in Figure 4, based on the dimensions of the formation sand.



a) b)

Figure 4. Laying scheme of gravel laying and installation of gravel filter

The cementing head was combined with 5 injection pump units 12. At the same time, the pump unit 12 was connected to the tank 18

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[6] Ismailov, F.S., Suleimanov, B.A., Kazimov, Sh.P., Gadzhikerimova, L.G. Eurasian patent No. 035124, 2020, Oil well sand catcher

[7] Ahmad, F.F., Ahadov M.A., Hajikarimova, L.G. Device for creating a layer of gravel behind a wire filter, Azerbaijan oil industry, 2017, № 07-08, p.39-43

for washing liquid and the tank 14 for gravel 14 to the sand truck 15 by means of a mixing tank 13. The liquid circulation was created by injecting the washing liquid taken from 12 tanks of the unit and 18 from the cistern through the PCP 4 with the valves 7, 8, 9, 11 open and 10 closed. At the same time, the mixer was pumped into 12 wells with a mixing unit obtained by pouring gravel from 14 tanks into 14 tanks and sand from 15 trucks. The sand-liquid mixture is 300 g / l and 3870 l of the mixture up to the volume of NKB-4 (2769 + 1000 kg) is pumped and the valve 9 is closed. Filter set consisting of connecting junction 1, filter sections 2, intermediate short pipe 5, 89 mm short pipe 7, 48 mm lift pipe 8, left threaded funnel 9, left threaded conductor 10 and valve joint 11 73 mm PCP 12 for safe lifting of the filter from the well was lowered into the well by means of and kept in front of the well filter.

12 cementing heads 13 are connected to the PCP and hermetically sealed by placing them on 6 flanges of the pipeline. The tube is inserted into the field. The liquid lifting pipe passing through the 2 slits of the filter compartments rises up by 8 and enters the PCP 12 and the fluid circulation is established. Closing the valve 20, the unit injects a mixture of 300 g/l sandblasting liquid with a 4% polymer (KMS) solution prepared in 23 tanks into 26 tanks. 300 kg of sand 1 m3 4% polymer solution mixture with dimensions of 0.6-0.8 mm was injected into the filter screen area and then compressed by injecting compression fluid from the unit 22 and the tank 22 in the open position of the valve 20. The gravel is lifted to the surface by means of a lifting pipe 8 and PCP 12 through 2 cracks of the filter units. The gravel particles are stored around the filter to form a gravel layer 27. In order to prevent the gravel-liquid mixture from remaining in the pipe area, the unit 21 is connected to the center line and injection fluid is injected from 22 sisters. The compressor opens the 11 flat valves of the liquid valve junction and lifts the liquid-gravel mixture above the conductor 10 to the surface by squeezing it out of the pipe space. By dismantling the wellhead equipment and turning the PCP 12 to the right, the left threaded conductor was removed from the well together with the lifting pipe 8 by opening 9 of the 10 funnels. The well was put into operation.

After the event, the inter-repair work time of the well increased by 2.5-3.0 times, and an additional 240 tons of oil was extracted.

In the second half of the third chapter, tests of the sand trap are shown[8]. Wells 1049 and 1087 operated from the QA horizon in the Pirallahi field were selected for testing purposes. In the wells operating the Piralahi field, high sand production is observed, and this leads to the production of mechanical impurities along with oil, during the development process, the destruction of the bottomhole zone of the formation increases and the formation of sand plugs in the well and the productivity of the formation decreases. Including creating conditions for the rapid failure of downhole equipment, leads to a decrease in service life.

In these wells, these parts break down quickly due to the intense impact of the sand between the pump plunger and the cylinder.

The well was stopped, the equipment inside the well was raised, and the pump and unit were lowered into the well.

The unit is mounted on the rods above the plunger of the boom depth pump. Well TAM 1049 increased from 42 days to 101 days, and an additional 34 tons of oil was extracted. In well 1087, the TAM increased from 58 to 117 days, and an additional 76 tons of oil was extracted. After the installation of the unit, repairs were reduced due to the replacement of the pump, the working time between well's repairs was increased by 2.0-2.5 times, and an additional 110 tons of oil was extracted. In general, according to the results of testing, an additional 350 tons of oil was obtained, the time between repairs increased by 2.0-2.5 times. This is reflected in the ICT issued by the OGPU named after Absheronneft and H.Z. Taghiyev.

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[8] Abbasov, E.M., Kazimov, Sh.P., Abdullaeva, N.R., Gadzhikerimova, L.G. Fluid leakage in a downhole rod pump, Oil Industry, 2019, No. 4, p. 87-89

CONCLUSIONS AND SUGGESTIONS

1. Statistical processing of mining data shows that the impact of different factors on current repairs varies by facility. Riveting of the plunger in the cylinder is more common in the wells of Absheronneft OGPU. The height of the sand plug in the wells of the OGPU named after H.Z. Taghiyev is higher per operation. Most of the current repairs at Bibi-Heybatneft OGPD are leaks in in-well equipment.

2. In order to prevent sand from entering the well from the formation, a graveling device was developed to create a dense and even layer of gravel behind the installed gravel-cracked filters, and as a result of the research, 3-5% KMS was selected as the gravel-impact fluid. Mining tests of the device were carried out in well No. 133 of OGPD named after H.Z. Taghiyev. After the event, the inter-repair work time of the well increased by 2.5-3.0 times, and an additional 240 tons of oil was extracted.

3. In rod depth pumps, a specially designed pump has been developed to reduce leakage by preventing the plunger-cylinder pair from being eaten away by sand. On the surface of the nipple, which is connected to the plunger from above, groove-screw channels are opened, each of which is 120 ° in cross section, forming an angle of 15-20 ° with the axis and directed in the opposite direction to the leaking fluid. The threaded-screw design of the channels ensures the formation of a stable emulsion in the cavity due to the rapid rotation of the water and oil mixture during the exit of part of the liquid inside the plunger from the channels to the cavity.

4. A pump has been developed to increase the filling coefficient of rod depth pumps in low fluid level wells and to protect the receiving part from sand. In the exhaust pump design, the intake valve opens and closes with the movement of the balance head.

5. In order to prevent the ingress of sand into the plunger-cylinder cavity of the pump, a sand trap has been developed to be installed on the pump rods inside the PCP. Thanks to the possibilities of the sand trap design, the mechanical impurities in the liquid inside the PCP are precipitated and collected in a special trap.

6. Sand trapping device was tested in wells 1049 and 1087 of Absheronneft OGPD operated by rod depth pump. After the introduction of the device, well production increased by 20-25% and TAM by 2.0-2.5 times. As a result of the application of the facilities, an additional 110 tons of oil was obtained.

7. As a result of the application of the developed methods in production, an additional 350 tons of oil was extracted.

The main content and results of the dissertation are published in the following works.

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Candidate's personal contribution

[8, 10, 11,12] works were performed freely.

[1,2, 3, 4, 5, 6, 7, 9,13,14,15] problem setting, implementation of theoretical and experimental researches, analysis of results and was closely involved in the design work.

The defense will be held on 11 March, 2025 at 11:00 at the meeting of the Dissertation council BED 2.03 of Supreme Attestation Commission under the President of the Republic of Azerbaijan operating at Azerbaijan State Oil and Industry University.

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Dissertation is accessible at the Library of Azerbaijan State Oil and Industry University.

Electronic versions of dissertation and its abstract are available on the official website of the Azerbaijan State Oil and Industry University.

Abstract was sent to the required addresses on "07" February 2025.

Signed for print: 04.02.2025

Paper format: A5

Volume: 38100

Number of hard copies: 20