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Satbayev University

ХАБАРЛАРЫ

ИЗВЕСТИЯ

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STRENGTHENING OF THE WORKING SURFACE OF THE ROD CLUTCH OF A DEEP PUMP UNIT OPERATING IN VARIOUS OPERATING CONDITIONS

Abstract. The article discusses the methods of chemical-thermal treatment of increased hardness of the coupling surface to the level of the nitride layer. The wear resistance was studied under various operating conditions in the environment of triethanolamine when heated by high-frequency currents. It was determined that the couplings strengthened by nitrocarburizing were practically not subjected to corrosion. The conducted studies give grounds to recommend the selected hardening technology for further extensive industrial testing and implementation in machine-building production. In the operation of wells with downhole pumping units, in many cases, the cause of failures is the insufficient reliability of the rod strings. At the same time, 61% of the total number of failures are due to couplings, and 39% - to the rod body. Couplings that serve to connect the pump rods to each other play no less a role in the performance of the rod string than the rods themselves. Indeed, from the point of view of oil losses caused by a well shut-in, it is completely indifferent whether a failure occurs in the rod or the sleeve. Therefore, the choice of material. It is shown that for the correct choice of the material from which the couplings will be made, it is necessary to consider the conditions in which they operate. First of all, you should keep in mind the forces that act on the clutch. These forces differ from those acting on the rod in that the rod is mainly subjected to tensile variable forces, while the coupling is also subjected to compressive forces.

Key words: installations, rod coupling, steel, hardening, hardening, triethano-

lamine, nitrocarburizing, induction heating, hardness, wear, wear resistance, weight loss techhnology for the manufacture of couplings should be made as carefully as the rods.

Р.С. Ибрахимов[1*], А.А. Құлиев[1], А.Қ. Абасов[1], Ш.О. Бахшалиева[1], А.В. Шарифова[1], З.Р. Ибрахимов[2]

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ӘРТҮРЛІ ПАЙДАЛАНУ ЖАҒДАЙЛАРЫНДА ЖҰМЫС ІСТЕЙТІН ТЕРЕҢ СОРҒЫ АГРЕГАТЫНЫҢ ШТОК МУФТАСЫНЫҢ ЖҰМЫС БЕТІН НЫҒАЙТУ

Аннотация. Мақалада қосылыс бетінің жоғары қаттылығын нитрид қабаты деңгейіне дейін химиялық-термиялық өңдеу әдістері қарастырылады. Тозуға төзімділік жоғары жиілікті токтармен қызған кезде триэтаноламин ортасында әртүрлі жұмыс жағдайларында зерттелді. Нитро көміртегі арқылы күшейтілген муфталар іс жүзінде коррозияға ұшырамағаны анықталды. Жүргізілген зерттеулер одан әрі кең өнеркәсіптік тестілеу және машина жасау өндірісіне енгізу үшін таңдалған қатайту технологиясын ұсынуға негіз береді. Ұңғымалық сорғы қондырғылары бар ұңғымаларды пайдалану кезінде көптеген жағдайларда ақаулардың себебі штангалық бағандардың жеткіліксіз сенімділігі болып табылады. Сонымен қатар істен шығулардың жалпы санының 61% - ы муфталарға, ал 39% - ы шток корпусына келеді. Сорғы штангаларын бір-біріне жалғауға қызмет ететін муфталар штангалар бағанының жұмысында өзектерге қарағанда аз рөл атқарады. Шынында да, ұңғыманың тоқтап қалуынан туындаған мұнай шығыны тұрғысынан, штанганың немесе жеңнің істен шығуы мүлдем бей-жай қарамайды. Сондықтан муфталар жасалатын материалды дұрыс таңдау үшін олардың жұмыс істеу жағдайларын ескеру қажет екендігі көрсетілген. Ең алдымен, ілінісуге әсер ететін күштерді есте ұстау қажет. Бұл күштер өзекке әсер ететін күштерден ерекшеленеді, өйткені өзек негізінен созылатын ауыспалы күштерге ұшырайды, ал муфталар да қысу күштеріне ұшырайды.

Түйін сөздер: қондырғылар, штангалық муфталар, болат, қатайту, триэтаноламин, нитро көміртегі, индукциялық қыздыру, қаттылық, тозу, тозуға төзімділік, салмақ жоғалту муфталарды жасау технологиясы шыбықтар сияқты мұқият жасалуы керек.

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УПРОЧНЕНИЕ РАБОЧЕЙ ПОВЕРХНОСТИ ШТАНГОВОЙ МУФТЫ ГЛУБИННО-НАСОСНОЙ УСТАНОВКИ, РАБОТАЮЩЕЙ В РАЗЛИЧНЫХ УСЛОВИЯХ ЭКСПЛУАТАЦИИ

Аннотация. В статье рассмотрены методы химико-термической обработки повышенной твердости поверхности муфты до уровня азотируемого слоя. Изучена износоустойчивость в различных условиях эксплуатации в среде триэтаноламина при нагреве токами высокой частоты. Определено, что упрочненные нитроцементацией муфты практически не подвергались коррозии. Проведенные исследования дают основание рекомендовать выбранную технологию упрочнения для дальнейших широких промышленных испытаний и внедрения в машиностроительном производстве. При эксплуатации скважин глубинно-насосными установками во многих случаях причиной отказов является недостаточная надежность штанговых колонн. При этом 61% от общего числа отказов приходится на долю муфт, а 39 % – на тело штанги. Муфты, служащие для соединения насосных штанг между собой, играют в работоспособности штанговой колонны не меньшую роль, чем сами штанги. Действительно, с точки зрения потерь нефти, вызванных остановкой скважины, совершенно безразлично, произойдет ли поломка в штанге или муфте. Поэтому выбор материала и технологии изготовления муфт должен производиться также тщательно, как и штанг.

Показано, что для правильного выбора материала, из которого будут изготовлены муфты, следует рассмотреть условия, в которых они работают. Прежде всего, следует иметь в виду усилия, которые действуют на муфту. Эти усилия отличаются от действующих на штангу тем, что штанга в основном подвергается действию растягивающих переменных усилий, в то время как муфта подвергается действию и сжимающих усилий.

Ключевые слова: установки, штанговая муфта, сталь, упрочнение, закалка, триэтаноламин, нитроцементация, индукционный нагрев, твердость, износ, износоустойчивость, потеря массы.

Introduction. The considered circumstances were used in conducting research on the choice of the optimal method of hardening the surface of the rod coupling of a deep-pumping unit operating in various operating conditions.

Oil engineering occupies one of the most important places in the socio-economic development of the country. However, its reliable operation, high quality and competitiveness of products on the international market can be ensured by design and technological solutions tested experimentally at various stages of their creation. The quality and reliability of the equipment is largely determined by the quality of the parts and components of the equipment. The quality and reliability of the equipment is largely determined by the quality of the parts and components of the equipment. The conducted static analysis shows that almost 85% of machines fail due to wear of the rubbing elements, which disrupts the normal operation of machines and aggregates. Premature failures of machinery and equipment leads to environmental damage and environmental pollution as a result of the release of oil, gas and washing liquids (Babaev, 2003:562)

The operating experience of the SSHNU shows that failures of gearboxes of rocking machines, the converting mechanism of the column of rods and tubing, the borehole pump and other elements occur mainly as a result of the ingress of abrasive particles into the gaps between the rubbing surfaces. Traces of mechanical wear are detected. The performance of the SSNU is also significantly reduced as a result of wear and tear of the rod couplings. In order to study and establish the degree of failures of the column of rods during operation for various reasons (wear, metal fatigue, lapel, etc.), statistical field data were collected and analyzed. Increasing of wear resistance and strength of downhole pumping rods and its coupling was carried out by various methods, and the most effective ways to improve their performance were selected. According to the field data, more than 20 thousand pump rods of borehole that have worked for 25 years in 153 corrosive wells, OGPD by. A. Amirov “Azneft”, a comparative analysis of failures of three standard sizes of rods with diameters of 19.22 and 25 mm was carried out When operating wells with downhole pumping units, in many cases, the cause of failures is the insufficient reliability of rod strings. At the same time, 61% of the total number of failures are due to couplings, and 39% - to the rod body. The couplings use to connect the pump rods to each other. Indeed, from the point of view of oil losses caused by a well shut-in, it does not matter at all whether a failure occurs in the rod or the sleeve. Therefore, the choice of material and technology for the manufacture of couplings must be made as carefully as the rods.

Research materials and methods. For correct choice of the material from which the couplings will be made, it is necessary to consider the conditions work environment. First of all, it should be borne in mind the forces that act on the coupling. These forces differ from those acting on the rod in that the rod is mainly exposed to the action of tensile variable forces, while the coupling is also exposed to compressive forces (Janakhmedov, (1996:326). In addition, the safety margin of the couplings exceeds the safety margin of the rods (especially in couplings without bald). This difference determines the possibility of using simple type 35 and 40 steels for couplings.

However, the presence of curved and inclined (directional) wells raised the question of using a harder material that would have sufficient wear resistance. The use of destruction of any steel without heat treatment to combat this type makes no sense, at the same time, the use of conventional hardening would lead simultaneously with an increase in hardness to a sharp decrease in plastic properties – to brittleness (Mustafayev, 2010: 678).

Therefore, it was proposed to use cemented steel, which makes it possible to obtain a coupling with a hard surface (after cementation, quenching and tempering) and a viscous core that prevents brittle destruction of the couplings.

In the USA, couplings made of 15NM grade steel, subjected to cementation, quenching and tempering, have become particularly widespread. This grade of steel, due to the presence of molybdenum, allows for single quenching after cementation instead of double quenching and, in addition, the transition zone from the carbonized layer to the non-carbonized one turns out to be especially smooth.

Thus, couplings made of this steel, after appropriate chemical and thermal treatment (cementation), acquire the strength and hardness they need while maintaining maximum viscosity. However, taking into account the scarcity of nickel and especially molybdenum, we solved this issue somewhat differently: for the manufacture of couplings, grade 40 carbon steel was used with subsequent treatment of its surface with high-frequency currents (Mustafaev, 1990:3).

As a result, deficient impurities are saved, and the necessary heat treatment is carried out in a very short time. At the same time, not only the time required for the manufacture of a coupling with a hard surface is saved, but also the production area and labor force.

Results. Research methodology. In the practice of operation, there are cases when the environment in which the rod column operates is particularly corrosive. The result of such an environment is shown in Fig.1.

Here it is clearly visible that not only the rods, but also the couplings hardened by high-frequency currents were subjected to sharp corrosion, and there is a kind of “eating up” of the hardened layer.

In this situation would be useful to use non-hardened couplings grade 40, coated with copper and zinc (Fig. 2) by the thermal diffusion method.

Fig.1.Pronounced corrosion of couplings (service life 1.5-2 months).

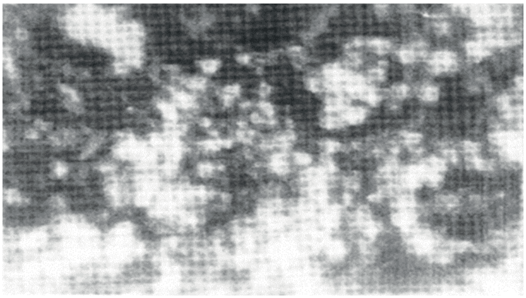

Fig.2. Mixed structure couplings are not hardened grade 40, copper-plated.

The main dimensions of the rods and couplings must correspond to Fig.3 and Table 1.

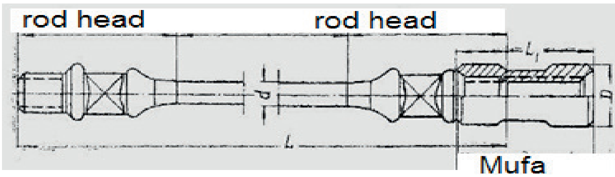

Fig.3.Designation of the pumping rod with a size of 19 mm - the pumping rod 19N618-52.

Table 1

Dimensions and limit deviations, mm										Weight, kg
Rod sizeи	rods				Coupling couplings				rods	Couplings (connecting
	Diameter d		Length L		Diameter D		Length L_1			
	НР*	ПО*	НР	ПО	НР	ПО	НО	ПР		
16	16				34*		70		12,93	0,398
19	19				42		80		18,29	0,545
		+0,4	8000	+80		±0,4		±1,0		
22	22	-0,5		-120	46		80		24,50	0,64
25	25				55		100		31,65	1,15

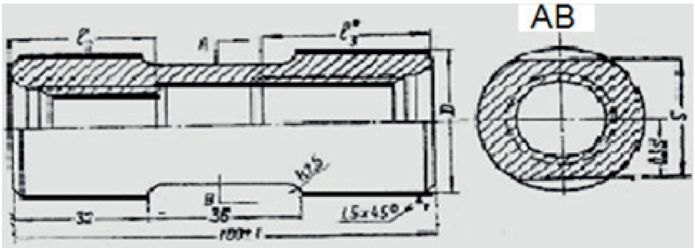

Fig.4. Rod couplings

Study of hardening by heat treatment. In fishing practice, it is of great importance to prevent accidents with rod columns due to wear of the connecting couplings and, much less often, the rods themselves. The wear of the body of the rods most often occurs after the wear of the couplings, and only in rare cases, with a large curvature of the well, the body of the rod can wear out earlier or simultaneously with the couplings.

The wear of the couplings leads to the loss of oil due to the downtime of the well during the change of couplings, pipe wear and overspending of rods (Chernysh, 1991:3).

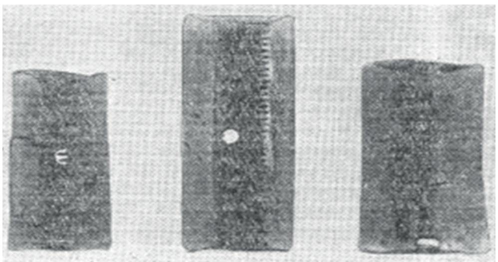

Fig.5. Wear of "raw" non-hot couplings in a curved well (duration of operation - 5 days).

In order to combat the wear of pumping rods and couplings, studies of couplings with a hard grinding surface, wooden and roller guides for rods (replacement of sliding friction by rolling friction) were carried out in the AzNII DN (Mustafaev,1990:3).

In accordance with the accepted studies, devices have been developed, the description of which is given below.

The hard surface of the hot-tempered couplings can be obtained in two ways:

1) by cementation followed by quenching, provided that the couplings are made of alloy cemented steel;

2) by surface quenching with high frequency currents, even if the couplings are made (as is being done now) of simple carbon steel grade 40.

In order to study the reduction in the cost of couplings with a hard surface, as well as saving alloy steels, studies were conducted on couplings made of carbon steel grade 40, which were hardened by high frequency currents. The depth of the hot layer is 2-3 mm.

Due to the fact that the presence of turnkey bald patches leads to an uneven thickness of the hardened layer, hardening was carried out with belts (Fig.5). The hardness distribution can be seen from Fig.6 and Table 2.

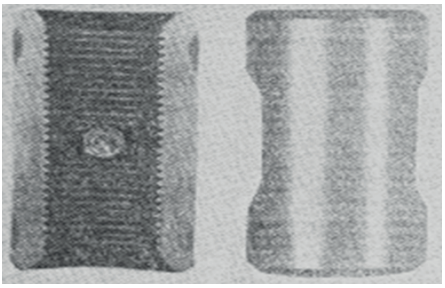

Fig.6. Couplings hardened from the surface by belts using high frequency currents

Table 2

The results of hardness measurements of hot-belted couplings

№ Point	Hardness HRC		№ Point	Hardness HRC	
	coupling №1	coupling №2		coupling №1	coupling №2
1	31,5	26,0	11	15,5	15,5
2	42,0	23,5	12	14,5	18,5
3	42,0	28,0	13	17,0	20,0
4	44,0	26,0	14	19,5	29,0
5	44,0	28,0	15	30,0	30,5
6	37,0	28,0	16	41,5	39,0
7	26,0	20,0	17	40,0	43,0
8	16,0	18,0	18	36,0	33,0
9	17,0	14,0	19	35,0	-
10	15,0	16,5	20	38,0	-

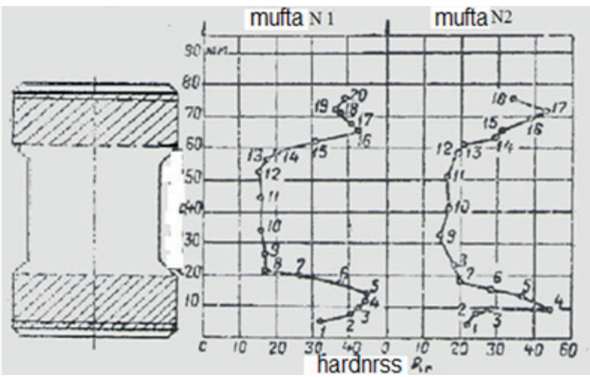

Fig.7. HRC hardness distribution along the length of the coupling hardened by belts

Table 3

Mark	Hardness, HB	Weight, g		Wear and tear, %	Coupling diameter, mm		Wear depth, mm
		Before the test	After the test		Before the test	After the test	
Couplings installed by the smooth part							
1	163	548	471,0	12,22	44,5	40,50	4,00
2	170	555	501,5	8,83	44,5	41,40	3,00
3	163	549	480,0	12,57	44,5	40,60	3,90
4	170	550	467,0	15,10	44,5	39,80	4,70
5	149	537	473,0	11,90	44,5	39,90	4,60
6	156	537	452,0	15,83	44,8	38,85	5,95
		Average wear 12,74					4,37
Couplings installed with lashes							
7	140	560	434,0	22,48	44,4	37,90	6,50
8	143	567	469,0	17,12	44,5	39,00	5,50
9	159	572	473,0	17,30	44,8	38,70	6,10
10	163	547	455,0	16,85	44,5	38,75	5,75
		Average wear 18,44					5,95

It can be seen from Tables 4 and 5 that the percentage of wear determined by the weight loss of raw couplings, compared with couplings, rock belts, is greater:

When worn on the smooth part by 12.74/3.1 = 4.16 times;

When worn on the side with patches in 18.44/2.61 = 6.7 times;

Table 4

Mark	Hardness HRC	Weight, g		Wear and tear, %	Coupling diameter, mm		Wear depth, mm
		Before the test	After the test		Before the test	After the test	
Couplings installed by the smooth part							
12	45-46	545,5	536,0	1,75	44,5	48,5	1,0
13	37-44	558,9	540,0	3,30	44,6	42,8	1,8
14	43-45	553,0	544,0	1,63	44,5	43,8	0,7
15	32-51	524,0	518,0	1,15	43,8	43,3	0,5
16	42-51	559,0	520,0	6,60	44,6	41,9	2,7
20	38-45	551,0	527,5	4,26	44,6	43,0	1,6
		Average wear 3,10					1,38
Couplings installed with lashes							
11	48-49	561,0	547,0	2,50	44,8	42,5	2,3
17	49-52	547,0	540,0	1,28	44,5	43,6	0,9
18	51-52	542,0	525,0	3,14	44,1	41,6	2,5
19	51-46	554,0	534,0	3,50	44,4	42,0	2,4
		Average wear 2,61					2,02

The wear of the couplings, determined by the thickness of the worn layer, also characterizes the greater wear resistance of the wheel couplings, namely:

With wear on the smooth part by 4.37 / 1.38 = 3.17 times;

When worn on the side with patches in 5.95/2.02 = 2.95 times;

The average wear resistance of the couplings, hot belts, compared with the raw couplings, measured by weight loss, is an increase of 5 times, and the thickness of the worn layer is 3 times.

It can be seen from Tables 4 and 6 that the percentage of wear determined by the weight loss of raw couplings, compared with couplings, heated over the entire surface, is greater:

With wear on the smooth part in 12.9 / 0.51 = 25.3 times;

With wear on the side with patches of 17.5/1.13 = 15.5 times;

Table 5

Mark	Hardness HRC	Weight, g		Wear and tear, %	Coupling diameter, mm		Wear depth, mm
		Before the test	After the test		Before the test	After the test	
Couplings installed by the smooth part							
21	30,35,39	551	548	0,55	44,5	44,2	0,3
22	33,36,40	550	548	0,36	44,5	44,3	0,2
23	44,45,47	552,5	550	0,45	44,5	44,4	0,1
24	33,40,45	557	555	0,35	44,5	44,4	0,1
25	22,38,45	550	547	0,55	44,5	44,4	0,1
26	28,31,37	550	546	0,80	44,5	44,0	0,5
		Average wear 0,51					0,22
Couplings installed with lashes							
12	34,43,49	532	526	1,13	44,5	43,2	1,3
13	37,42,50	535	526	1,68	44,5	43,2	1,3
14	31,52,54	540	534	1,11	44,5	43,2	1,3
15	48,50,52	513	50	0,59	44,8	43,2	0,6
		Average wear 1,13					1,13

The wear of the couplings, determined by the thickness of the worn layer, also showed greater wear resistance of the wheel couplings entirely, namely:

With wear on the smooth part by 4.37 /0.22 = 19.9 times;

With wear on the side with patches of 5.95/1.13 = 5.3 times;

The average wear resistance of the couplings, heated over the entire surface, compared with raw couplings, measured by weight loss, is an increase of 20 times, by the thickness of the worn layer - 13 times.

The testing of roller guides, carried out according to the accepted methodology, did not give noticeable wear of either the trunnions of the rollers or the housing sockets. In addition, we tested roller guides at an accepted load of 50 kg in water, but within 24 hours. Such a test also did not give noticeable wear.

Testing of wooden guides under selected test conditions showed unacceptable wear at 30 minutes of operation.

The results of laboratory tests of couplings are summarized in Table 6.

Table 6

Types of couplings	Wear resistance	
	By weight	By thickness of the worn layer
Couplings raw	1	1
Couplings, red-hot belts	5	3
Couplings, red-hot over the entire surface	20	13

Failures on couplings occur mainly as a result of their wear. At the same time, rod couplings in slightly curved wells have characteristic signs of corrosion-mechanical wear: the surfaces are mostly free of scratches and breakouts, and in some cases with areas of corrosion. However, when operating inclined and curved wells, the rod couplings are subjected to significant wear, leading to the breakage of the column of rods.

The steam rod coupling - pipe is a slow-moving unit, the nature of the loading of which depends on the nature of the slope (curvature) of the well. During the reciprocating motion of the rod column, along with the sliding friction of the rod coupling -pipe pair, shocks occur at the joints of the connections of the tubing ("edge effect") (Quliyev, 2006) Issues of improving surface reinforcement processes. AATMX, N6 (46), Baku, (in Azerbaycan). Although the rod coupling is also exposed to abrasive particles present in the moving fluid, however, in this case, abrasive wear due to the low speed of fluid movement, apparently, cannot play a significant role.

The wear process of the rod coupling, which occurs under the conditions of a bully, is significantly influenced by the load, sliding speed, roughness of the contacting surfaces, materials of the friction pair, temperature, physical and mechanical characteristics of the medium, etc. It is particularly necessary to highlight the influence of the method of hardening the surface of the contacting bodies from the point of view of the formation of a metal structure that is extreme pressure under these conditions.

The existence of direct contact of bodies in slow-moving friction nodes increases the likelihood of micro- and macro-jamming. The main factors leading to jamming in this case are the increased wear of the protective surface layers of the parts, plastic deformation and the likelihood of hardening setting points in contact. Physicochemical characteristics and the level of mechanical properties of materials, methods of hardening technology, lubricating properties of lubricants that provide shielding of surfaces and the recoverability of protective layers have a significant impact on the load-bearing capacity for jamming at low speeds.

Study of hardening by chemical-thermal treatment. The considered circumstances were used in carrying out the rod coupling investigated by choosing the optimal method of hardening.

The paper (Raskatov,1980: 511) presents the results of laboratory studies on the structure and microhardness of 40, 40X, 38X2MYA steels hardened by nitro cementation in a triethanolamine medium under induction heating by high-frequency currents, single-phase and two-phase boration and borochromation.

High wear resistance in various operating conditions is provided by nitrocementation in a triethanolamine medium when heated by high frequency currents. It increases the hardness on the surface of the products factually to the level of hardness of the nitrided layer, resistance to abrasive wear, provides good workability and high wear resistance. As a rule, a brittle layer containing an excess e-phase is not formed on the surface of the product. The layer also has corrosion resistance, which allows the method to be used instead of nitriding. The possibility of obtaining a high hardness of the subsurface layer is also important, which ensures that the thin reinforced layer is not forced through. Good efficiency of nitro cementation in triethanolamine medium when heated by high frequency currents was obtained for 38X2MYA steel. Sufficiently high results are also available when hardening 40 and 40X steels. Studies by B.M.Bodyanka et al. (Bodanka, 1986) show that such treatment of 40 and 40X steels is almost 3 times higher than wear resistance compared to surface hardening of HDPE.

Based on these considerations, nitrocementation in triethanolamine medium during induction heating by high frequency currents was chosen to strengthen the rod coupling of the deep-pumping unit. This method provides for steel 40 microhardness H100 746 with its high wear resistance in the extreme conditions considered above. Considering that this method of hardening can be fully automated and fits into the existing technological process of manufacturing rod couplings, its use can give a high effect (Akhmedov, 1977:4).

Table 7

The results of field testing of rod couplings strengthened by the proposed technology

Coupling weight, g		Weight loss, g	Relative weight loss, g
before the test	after the test		
630,300	628,300	2,0	0,32
640,160	638,500	1,6	0,25
629,200	624,100	5,1	0,81
638,000	623,500	14,5	2,28
638,100	627,200	10,9	1,71
639,200	638,500	0,7	0,11
633,700	626,700	6,0	0,95
640,300	639,500	0,8	0,12

Table 8

Results of field tests of control serial rod couplings

Coupling weight, g		Weight loss, g	Relative weight loss, g
before the test	after the test		
627,500	618,500	9,0	1,43
615,300	609,500	5,8	0,94
628,500	618,500	10,0	1,59
628,400	623,100	5,3	0,84
627,200	619,600	7,6	1,21
613,900	609,500	4,4	0,72
620,700	616,100	4,6	0,74
629,800	606,000	23,8	3,78
615,100	597,500	17,6	2,86
622,700	608,500	14,2	2,28

İt was decided to manufacture a batch of rod couplings of the deep-pumping unit from standard steel 40, hardened according to the selected nitrocementation technology, and conduct their comparative testing in field conditions. When mounted in a rod column, the hardened couplings alternated with serial ones that had undergone surface hardening of HDPE, and were lowered into the well 2419 NGDU "Kirovneft". The depth of the downhole is 579 m, the well is often repaired, including due to the breakage of the rod column.

After 33 days of operation, when the well was stopped for pump repairs, experimental and control serial couplings were extracted. Both groups of couplings were weighed after washing and drying. The absolute and relative weight loss (wear) of each coupling separately, each group of couplings and the average weight loss of one coupling for each group are determined. The results are shown in table 9.

Table 9

Group of rod pumps	Number of couplings in the group	Total weight of the group, g		Weight loss, g	Average mass loss of one coupling, g
		Before the test	After the test		
Reinforced with nitrocementation	8	5084,9	5047,3	41,6	5,2
serial	10	6229,1	6125,8	102,3	10,23

An analysis of the data in the tables shows that the group of rod couplings hardened by nitrocarburizing in a triethanolamine medium during induction heating of high-frequency couplings had wear almost 2 times less than the group of control serial couplings (5.2 and 10.23 g, respectively). Visual observation shows that the couplings hardened by nitrocarburizing were practically not subjected to corrosion, while serial couplings had noticeable signs of it (Kozlovsky, 1977:5). The surface condition of the coupling shows that catastrophically fast wear could be expected for serial couplings during further operation. Conducted studies give support to recommend the selected hardening technology for further extensive industrial testing and implementation in machine-building production.

Conclusion. Operating experience shows that correctly selected material which the coupling will be made, consideration should be given to the conditions in which it operates.

2. Average wear resistance of hardened belt couplings, compared with raw couplings, measured by weight loss increasing of 1 time, and increasing of the worn layer - 3 times.

3. The process of the rod coupling, which occurs under scuffing conditions significantly affected by the load, sliding speed, roughness of the contacting surfaces, friction pairs in terms of the formation of an anti-seize metal structure under these conditions.

4. The absolute and relative loss of mass (wear) of each coupling separately and the averaging of the loss of mass of one coupling and hardened by nitrocarburizing in triethanolamine medium during induction heating of high frequency is 2 times less.

5. Determined that studies give support to recommend the selected hardening technology for further extensive industrial testing and implementation in machine-building production.

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REFERENCES

Babaev S.G., Kerimova L.S. (2003). Improving the quality and reliability of oilfield equipment. Baku, Elm, 562 p. (in Rus).

Janakhmedov A.Kh. (1996). Petroleum tribology. Baku, Elm, 326 p. (in Rus).

Mustafayev S.D. Operation of wells by rod depth pumping. Baku, Science, 2010, 678 p (in Azerbaycan).

Mustafaev S.M. and others. (1990). Influence of the structure of the surface layer on wear resistance in various operating conditions // Collection of articles: Constructive and technological methods for improving the quality and reliability of oilfield equipment. AzINEFTEKHIM, p.17-19. (in Rus).

Quliyev A.A. etc. 2006) Issues of improving surface reinforcement processes. AATMX, N6 (46), Baku, (in Azerbaycan).

Bodanka B.M., Shipko A.A., Gurchenko P.S. (1986) Research and development of the technological process of high-speed nitrocarburizing of car parts // M and VOL. No. 8. (in Rus).

Raskatov V.M., Chuepkov V.S. and others (1980). Machine-building materials. Quick reference book - 3rd ed. M .: Mechanical Engineering, 511 p. (in Rus).

Antsiferov V.P., Bobrov G.V. et al. (1987). Powder metallurgy and dust-free coatings. M.: Metallurgy, 792 p. (in Rus).

Chernysh I.G., Nikitin Yu.A. Levental N.V. (1991). Study of the process of formation of thermally expanded graphite. Powder metallurgy. No. 6, 17-19 p. (in Rus).

Ochertyansky V.M., Perepelkin A.V. (1986). Properties of short-term sintered graphite iron. Powder metallurgy. No. 12, pp. 58-63. (in Rus).

Mamevov A.T., Guliyev A.A. (1989). Obtaining powders from iron shavings and features of making products from them. Powder metallurgy. No. 7, 4-9 p. (in Rus).

Akhmedov B.M., Karaev I.K. (1977). Research of the degree of failures of downhole pump rods during operation. Azerbaijan Oil Industry, N3,67-70s. (in Rus).

Volynsky V.N. and others. (1973). Increasing the contact endurance of 40KhS steel using low-temperature nitrocarburizing. Proceedings of universities. Mashinostroenie, p.121. (in Rus).

Kozlovsky I.S. (1977). Achievements in the field of steel heat treatment technology and prospects for its development. MiTOM, No. 10, pp. 68-71. (in Rus).

Jahanmir S., Peterson M.B. (1989) The Development and use of a Tribolode Recearch in proqress database.-U.S. Depyartment of Commerse, National of Standards and Technjljge, NISTIR.89-4112, June, pp.153-158.

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