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ELASTOMERS FOR DOWNHOLE SCREW PUMP

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One of the most promising means of lifting oil is the installation of a downhole screw pump with a drive that rotates the rod column by rotating the plunger. Screw pumps are capable of producing high viscosity oil, characterized by a high sand content. The use of screw pumps reduces capital and operating costs by 25-95% compared to other types of mechs. production. Efficiency increases by 40-80% and transportation costs are reduced, as the screw pumping system has a compact design and is easily mounted on the well.

The structural parts of screw pumps made of elastomers are fundamental factors in determining the service life and performance of the pump. Studies of changes in swelling and hardness of various series of elastomers within 96 hours revealed the most suitable commercial elastomer of a screw pump for the oil fields of Kumkol, Aryskum, Maybulak.

KEYWORDS: *elastomer, screw pumps, swelling of elastomers, hardness of elastomers, wear resistance.*

ҰҢҒЫМА БҰРАНДАЛЫ СОРҒЫҒА АРНАЛҒАН ЭЛАСТОМЕРЛЕР

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Мұнайды көтерудің ең перспективалы құралдарына поршеньді айналдыру арқылы штангалық бағанды айналдыратын жетегі бар ұңғыма бұрандалы сорғысын орнату жатады. Бұрандалы сорғылар құмның көп мөлшерімен сипатталатын тұтқырлығы жоғары мұнай өндіруге қабілетті. Бұрандалы сорғыларды қолдану басқа түрлерімен салыстырғанда күрделі және операциялық шығындарды 25-95% төмендетеді мех. олжа. Тиімділік 40-80% - ға артады және тасымалдау шығындары төмендейді, өйткені бұрандалы сорғы жүйесіактам құрылымға ие және ұңғымаға оңай орнатылады

Эластомерлерден жасалған бұрандалы сорғылардың құрылымдық бөліктері сорғының қызмет ету мерзімі мен өнімділігін анықтауда негізгі факторлар болып табылады. 96 *сағат ішінде эластомерлердің әртүрлі серияларының ісінуі мен қаттылығының өзгеруін зерттеу Құмкөл, Арысқұм, Майбұлақ кен орнының мұнайлары үшін ең қолайлы тауарлық бұрандалы сорғы эластомерін анықтады.*

ТҮЙІНДІ СӨЗДЕР: *эластомер, бұрандалы сорғылар, эластомерлердің ісінуі, эластомерлердің қаттылығы, тозуға төзімділік.*

ЭЛАСТОМЕРЫ ДЛЯ СКВАЖИННОГО ВИНТОВОГО НАСОСА

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К наиболее перспективным средствам подъема нефти относится установка скважинного винтового насоса с приводом, вращающим штанговую колонну посредством вращения плунжера. Винтовые насосы способны добывать высоковязкую нефть, отличающуюся высоким содержанием песка. Применение винтовых насосов снижает капитальные и операционные затраты на 25–95 % по сравнению с другими видами мех. добычи. Эффективность увеличивается на 40–80 % и транспортные расходы снижаются, так как винтовая насосная система имеет компактную конструкцию и легко монтируется на скважине.

Конструкционные детали винтовых насосов, выполненные из эластомеров, являются основополагающими факторами в определении срока службы и производительности насоса. Исследования изменения набухаемости и твердости различных серий эластомеров в течение 96 часов выявили наиболее подходящий товарный эластомер винтового насоса для нефтей месторождения Кумколь, Арыскум, Майбулак.

КЛЮЧЕВЫЕ СЛОВА: *эластомер, винтовые насосы, набухаемость эластомеров, твердость эластомеров, износостойкость.*

Introduction. Some structural elements of the pumps are made of elastomers, which significantly reduces the cost of pumps, increases their service life due to better resistance to abrasive wear [1-3]. Elastomers have a dynamic ability, they continuously correspond to the movement of the pump. The ability of the elastomer to withstand the action of injection and the impact of the pumped liquid directly affects the operating costs of pumping systems [4-5].

One of the most important conditions affecting the wear resistance of elastomers is the environment in which it is operated, namely oil and gas fluids. During operation in aggressive environments, changes in the physical and mechanical properties of parts made of various elastomers are observed, depending on the characteristics of the oils. A properly selected elastomer is a fundamental factor in determining the service life and performance of the pump. As practice shows, choosing the wrong elastomer can turn into a disaster for the equipment and the entire installation as a whole [6]. The results of precision and laboratory studies of elastomers available in the scientific literature show that the issues of the influence of operating conditions on their physico-chemical properties have not been sufficiently studied.

The purpose of the study is to identify the type of commercial and synthesized elastomer screw pump that is most suitable for the downhole conditions of the Kumkol, Aryskum, Maybulak deposits. To achieve this goal, studies of elastomers in the oils of the Kumkol, Aryskum, Maybulak deposits taken from various wells (sle.) were carried out.

Materials and methods

Swelling and hardness

One of the most significant characteristics of the performance properties of elastomers is their swelling and hardness in a hydrocarbon medium over time. Elastomers of four industrial series used in the development of deposits were used for research: series 159 (acrylonitrile-butadiene copolymer), series 194 (nitrile rubber), series 199 (butadiene-nitrile elastomer), series 204 (butadiene- fluorocarbon copolymer) and elastomer synthesized on the basis of acrylonitrile and styrene (styrolacrylonitrile).

Styrolacrylonitrile combines several modified qualities of the components – acrylonitrile and styrene. In terms of physical properties, styrolacrylonitrile elastomer occupies an intermediate position between polystyrene and extrusion polyacrylonitrile. Compared with polystyrene, styrolacrylonitrile has increased impact resistance, surface hardness, weather resistance, resistance to aggressive media and dimensional stability. It is lighter than polyacrylonitrile and has higher bending strength, but worse light transmission. Styrolacrylonitrile is characterized by an increased softening temperature and a low coefficient of linear thermal expansion compared to other plastics.

Determination of hardness.

Determination of hardness by the Shore method with a Mitutoyo durometer. The determination is carried out on a scale of Shore A (Sh A) and Shore D (Sh D) according to the standard, DIN 53505. Shore hardness refers to the resistance of the material to the indentation of the tip of a certain shape under the influence of the spring pressure force (*Fig. 1*). The higher the number, the higher the hardness. The letter A defines softer values, the letter D defines harder values, and the areas intersect.

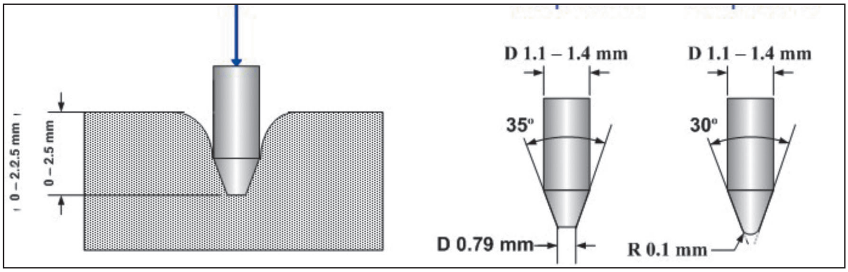

Figure 1 – **Determination of hardness by the Shore method with a durometer**

The method is characterized by a relatively large range of measurement results, but is convenient for its simplicity (including the design of the measuring device) and the efficiency of measurements, allowing them to be made, including on finished products, large-sized parts and curved surfaces of sufficiently large radii. Because of this, it has become widespread in production practice.

The depth of indentation into the material of a certain indenter is measured by force under specified conditions. The indentation hardness is inversely proportional to the depth of indentation and depends on the modulus of elasticity of the viscoelastic properties of the material. The results obtained are influenced by the shape of the indenter and the force applied to it, therefore there can be no direct relationship between the results obtained during tests with durometers of different types or other devices for measuring hardness [7].

Determination of elastomer swelling

Elastomers used in the screw pump come into contact with various organic substances with which interaction is possible. The elastomer surface is exposed to a variety of washes, oils, and solvents. The task of reliably assessing their effect on elastomers according to the swelling parameters obtained by various methods remains urgent. Various methods are used to determine the swelling parameters: weight, volume and optical methods. To determine the parameters of elastomer swelling under the influence of oils from various fields, a weight method was used, which is characterized by simplicity of execution and accuracy of the measured parameters [8].

Synthesis of copolymers

The synthesis of styrene - acrylonitrile copolymer (SAN) was carried out by radical polymerization in an ethylbenzene solution using benzoyl peroxide as an initiator at an initial monomer ratio of 50:50 (wt.h.) at a temperature of 150° C. [9, 10].

Results and Discussion

Tables 1-5 show the values of changes in the swelling and hardness of the studied elastomers in Kumkol, Aryskum, Maybulak oils for 96 hours.

Table 1 – **Results of changes in mass and hardness over time for the well 48 M-1 (g)**

Elastomers	Time, hour					Change in mass
	0	6	24	48	96	
series 199	2,7556	2,7943	2,7998	2,8001	2,8802	1,62%
series 159	2,8672	2,8782	2,8801	2,8857	2,8842	0,59%
series 194	2,6274	2,6509	2,652-	2,6558	2,6544	1,03%
series 204	3,9840	3,9849	3,9853	3,9857	3,9864	0,06%
SAN	2,9865	2,9869	2,9873	2,9879	2,9882	0,09%
Elastomers	**Time, hour**					**Hardness change**
	0	6	24	48	96	
series 199	71	71	71	71	70	-1,41%
series 159	79	78,8	78,5	78,5	78	-1,27%
series 194	61	60	60	60	60	-1,64%
series 204	78	78	78	78	78	0,00%
SAN	84	84	84	84	84	0,00%

Table 2 – **Results of changes in mass and hardness over time for well 302 Yu-2 (g)**

Elastomers	**Time, hour**					**Change in mass**
	0	6	24	48	96	
series 199	2,7946	2,8018	2,8051	2,8073	2,8082	0,49%
series 159	2,9250	2,9325	2,9348	2,9382	2,9387	0,47%
series 194	2,6256	2,6350	2,6398	2,6403	2,6416	0,61%
series 204	3,9694	3,9729	3,9731	3,9737	3,9743	0,12%
SAN	2,9116	2,9125	2,9147	2,9150	2,9163	0,16%
Elastomers	**Time, hour**					**Hardness change**
	0	6	24	48	96	
series 199	71	71	71	71	71	0,00%
series 159	79	79	78	78	78	-1,27%
series 194	61	61	60	60	60	-1,64%
series 204	78	78	78	78	78	0,00%
SAN	84	84	84	84	84	0,00%

Table 3 – **Results of changes in mass and hardness over time for well 100 Yu-3 (g)**

Elastomers	**Time, hour**					**Change in mass**
	0	6	24	48	96	
series 199	2,7566	2,7671	2,7686	2,7702	2,7709	0,52%
series 159	2,9306	2,9408	2,9447	2,9469	2,9448	0,48%
series 194	2,6403	2,6511	2,6537	2,6557	2,6560	0,59%
series 204	3,9792	3,9832	3,9835	3,9856	3,9842	0,13%
SAN	2,8690	2,8699	2,8715	2,8733	2,8747	0,20%
Elastomers	**Time, hour**					**Hardness change**
	0	6	24	48	96	
series 199	71	71	71	71	71	0,00%
series 159	79	79	78	78	78	-1,27%
series 194	61	60	60	60	60	-1,64%
series 204	78	78	78	77	77	-1,28%
SAN	84	84	83,5	83	83	-0,85%

Table 4 – **Results of changes in mass and hardness over time for well 309 Yu-1 (g)**

Elastomers	**Time, hour**					**Change in mass**
	0	6	24	48	96	
series 199	2,7899	2,8005	2,8036	2,8065	2,8081	0,65%
series 159	2,8582	2,8696	2,8725	2,8769	2,8778	0,69%
series 194	2,6278	2,6394	2,6425	2,6469	2,6482	0,78%
series 204	3,9471	3,9506	3,9515	3,9533	3,9536	0,16%
SAN	3,9471	3,9506	3,9515	3,9533	3,9536	0,16%
Elastomers	Time, hour					**Hardness change**
	0	6	24	48	96	
series 199	71	71	71	71	70	-1,41%
series 159	79	78	78	78	78	-1,27%
series 194	61	60	60	60	60	-1,64%
series 204	78	78	78	77,5	77	-1,28%
SAN	84	84	83	83	83	-0,96%

Table 5 – **Results of changes in mass and hardness over time for a 240 M-2 (g) well**

Elastomers	Time, hour					Change in mass
	0	6	24	48	96	
series 199	2,7637	2,7638	2,7699	2,7703	2,7704	0,24%
series 159	2,9329	2,9413	2,9435	2,9462	2,9465	0,46%
series 194	2,6363	2,6365	2,6401	2,6424	2,6429	0,25%
series 204	3,9795	3,9928	3,9929	3,9930	3,9937	0,36%
SAN	2,8752	2,8763	2,8794	2,8801	2,8823	0,25%
Elastomers	**Time, hour**					**Hardness change**
	0	6	24	48	96	
series 199	71	71	71	71	70	-1,41%
series 159	79	78	78	78	78	-1,27%
series 194	61	60	60	60	60	-1,64%
series 204	78	78	78	78	78	0,00%
SAN	84	84	84	84	84	0,00%

The obtained values showed that the largest relative change in the mass of the elastomer in oil is observed for the series 199 - (1.62- 0.24) %, while the largest decrease in stator density is observed for the elastomer series 194 – (-1.64%).

The best indicators were observed for the elastomer of the 159 series, so the relative change in the mass of the elastomer in oil did not exceed 0.69%, and the hardness decreased by a maximum of (-1.27%). And in some cases, the hardness of the elastomer did not change even after 96 hours.

The synthesized styrene – acrylonitrile (SAN) copolymer showed a stable minimum change in the mass of the elastomer (from 0.09% to 0.25%) and minimal changes in the hardness of the elastomer in all oils of the presented fields after 96 hours of exposure period.

Obviously, this is due to the fact that the acrylonitrile contained in the material increases its viscosity and resistance to chemicals, neither dilute acids nor fats and oils can damage this material.

Conclusion

In conclusion, screw pumps with stators made of elastomer series 159 and a new elastomer of styrene – acrylonitrile copolymer can be recommended for use in the Kumkol, Aryskum, Maybulak deposits.

At the same time, it should be noted that a direct correlation between the expressed dependence of changes in the swelling of the elastomer and changes in the hardness of the elastomer over time was not revealed for all the oil fields considered.

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