Impact assessment of various factors on operational efficiency of ESCP

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Abstract. The application analysis of two systems of maintenance of wells equipped with ESCP in the conditions of Western Siberia is presented in the article. The diagrams of coefficient dependence of technical readiness on time between repairs, failure factor are constructed on the basis of calculations. Recommendations for use of a maintenance and repair system (MRS) are made.

1. Introduction

Now the firm wells in the majority of oil companies developing oil fields in Western Siberia are operated with the application of ESCP. However features of these deep well pumps’ operation due to the lack of information measured directly in borehole conditions are not absolutely clear [1].

Results of measurements of various parameters of gas-liquid mix on pumps suction of a number of wells of the Priobskoye field executed by deep manometers thermometers are presented in this paper. Having analyzed measurements of deep manometers installed below the pump suction on 28 wells, the necessary calculations for the determination of values of key parameters characterizing operating conditions of ESCP were executed. The average values of density and gas content of the extracted liquid at the time of a stop of the pump are defined for various types of pumps and the characteristic curves of these parameters on the pump capacity (fig. 1, 2) are constructed.

![Figure 1. Dependence of the pump capacity on gas content at the stop time](image1)

![Figure 2. Dependence of pump capacity on the liquid density at the stop time](image2)
With reference to received schedules it is visible that than the pump capacity is higher at the smaller
density of liquid on the pump suction, and at a bigger value of gas content it breaks down. Therefore,
measurements of the specified well operation parameters on-stream will allow one to prolong the term
of the pump equipment operation and to increase MRP which on the Priobskoye field makes 94-100
days.

Carrying out the necessary measurements and estimating the density and gas content of liquid in
which the pump works, it is possible to make the decision about its conversion into the more optimal
mode in time. It will allow extending the ESCP service life, raising MRP to save considerably costs
related with stops and repair work [4,6].

2. Results and Discussion
Two systems of maintenance assuming carrying out planned repair work in the presence of crashes and
planned works are considered below. Basic data and results of calculation are given in table 1 where \( \tau_a, \tau_n \) is emergency and routine maintenance and repair time (MRS), \( C \) – coefficient of technical readiness,
\( \lambda(\tau_0) \) – the failure rate, \( \tau_0 \) – the optimum period of maintenance. In calculations it was supposed, \( \tau_a \) equal
to standard time of restoration in this oil company, \( \tau_a=\text{const} \). The technique is applicable only at \( \tau_a>\tau_n \).

| \( \tau_a \) | \( \tau_n \) | \( \tau_0 \) | \( \lambda(\tau_0) \) | \( C(\tau_0) \) | \( \tau_a \) | \( \tau_n \) | \( \tau_0 \) | \( \lambda(\tau_0) \) | \( C(\tau_0) \) |
| 3 | 15 | 134 | 0.0062 | 5 | 0.9305 | 3 | 15 | 41 | 0.00344 | 5 | 0.8772 |
| 5 | 15 | 229 | 0.0081 | 3 | 0.9247 | 5 | 15 | 52 | 0.00388 | 3 | 0.8456 |
| 7 | 15 | 377 | 0.0104 | 2.1429 | 0.9229 | 7 | 15 | 60 | 0.00416 | 2.1429 | 0.8233 |
| 9 | 15 | 676 | 0.0139 | 1.6667 | 0.9226 | 9 | 15 | 67 | 0.00440 | 1.6667 | 0.8041 |
| 11 | 15 | 1520 | 0.0209 | 1.3636 | 0.9226 | 11 | 15 | 73 | 0.00459 | 1.3636 | 0.7881 |

According to the presented table it is visible that as a result of calculation the figures were received
rather high for emergency and planned MRS \( (\tau_0 > 500 \text{ days}) \) which is not of practical interest and will
not be used further for carrying out the analysis also. According to other obtained data the characteristic
curves (fig. 3-5) are constructed.
Figure 3. The coefficient dependence of technical readiness on the optimum between-repairs period of carrying out MRS for ESCP

In fig. 3 it is presented that with the increase of the optimum period of carrying out planned MRS, the reduction of technical readiness coefficient is observed. For example, increase in $\tau_0$ from 134 to 229 days leads to the reduction of availability coefficient for ESCP for 6% when carrying out emergency and planned MRS [2].

The dependence of technical readiness coefficient on the failure rate of ESCP is given in fig. 4.

Figure 4. Dependence of coefficient of technical readiness on failure rate for ESCP

It is shown that with the increase in failure rate reduction of readiness coefficient is determined. This fact can be explained by the increase in the number of refusals about the increase in planned repairs’ time. This conclusion confirms fig. 5 where we presented that the coefficient of technical readiness increases with the increase in the ratio of standard time of emergency repair to planned maintenance. It is not difficult to notice that the increase in this ratio happens with the reduction of time of carrying out preventive repairs and the optimum periods of carrying out repairs. For example, the reduction of...
preventive repair time of 1.7 times leads to the increase in $C_r$ at emergency and planned MRS for 0.6%, planned – 0.3% in the conditions of field operations. Therefore, for the increase of the coefficient of technical readiness it is necessary to minimize time of carrying out preventive repairs.

![Graph](image)

**Figure 5.** Dependence of readiness coefficient on the ratio of standard time of emergency repair to planned for ESCP

Trends of schedules of fig. 3 and 4 have the similar character, both for emergency and planned, and for the planned system of service in various service conditions. A sharp drop of coefficient of technical readiness is observed in fig. 4 with the increase in the failure rate for the system assuming carrying out purely planned repair work. It is caused by frequent failures of ESCP and an increase in time of carrying out preventive repairs [3].

### 3. Conclusion

Analyzing the obtained data about the efficiency of application of two MRS systems for ESCP, it is possible to draw a conclusion that the application of the MRS emergency and planned system for these types of pumps is more favorable to achievement of the maximum coefficient of technical readiness. Application of the MRS carrying out planned repairs in the presence of crashes, is more preferably than the second system under otherwise equal conditions [5].

With the increase in the optimum period of carrying out repairs the readiness coefficient decreases, at the same time the application of the technique assuming carrying out the emergency repairs gives higher $C_r$.

### References

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