Impact of hydrocarbon drilling mud on mud motor elastomers at different temperatures

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Abstract. The paper describes the experimental research of hydrocarbon drilling mud impact on engineering parameters of mud motor elastomer samples. It is believed to be urgent due to an increase in using mud motors in oil and gas well construction now, and the issue of intense exploitation is currently topical. The test results of elastomer IRP-1226 dependent on the temperature are shown in the paper. It is proved that the hydrocarbon drilling muds have a significant impact on wearing of mud motors elastomers under the condition of a temperature increase.

Introduction

Mud motors have been widely used in the process of oil and gas wells drilling since the middle of the 20th century. This was connected with the development of directional and horizontal drilling, renewal of production by sidetracking. Besides, mud motors are used for workover and well service [1].

Long-term operation of mud motors under various geological conditions has revealed low service life of elastomer (rubber component of stator). This is confirmed by a rate of mud motors accident encountered by contractors. On average mud motors breakdown cause 12 equipment downtime per a year, which increases drill time by that to 5-10 %. In Western Siberia, it increases the total cost of up to 3 million rubles per one well. According to the experience of various drilling intervals, the key factor of mud motors service life is a type of drilling mud. For instance, when hydrocarbon drilling mud is used, mud motors wearing increases by 250 – 350 % [2-3].

Mud Motors Manuals emphasize the impact of high temperature in bottom-hole zone on elastomer durability and it consequently decreases service life of a motor. Drilling mud comprising hydrocarbon-based reagents causes swelling of a rubber component (elastomer) of the stator and leads to premature motor’s breakdown. The differential pressure increasing the recommended working value of mud motor’s gear, decreases service life of the stator [4].

According to the information mentioned-above, it was decided to carry out experimental research of the impact of diesel fuel as one of the types of hydrocarbon drilling mud on durability of IRP-1226 rubber samples used as a material for rubber components of mud motors stator; and to identify the dependence of the size on temperature.

1. Materials and Methods

The impact of different mud types on rubber samples IRP-1226, which is oil-resistant rubber with improved wear-resistance and a temperature range from - 20 to +100^0 C, has been studied. Its nominal strength is equal to 9.8 MPa, failure elongation is 125% and Shore A hardness number is 65 – 95.

The samples were made in the form of cylinders with a diameter up to 43 mm and a thickness up to 11.5 mm. They were kept in plastic containers throughout the experiment with total immersion in the mud under atmospheric pressure. To verify the experimental results, 3-5 samples were analyzed for each type of the drilling mud. The first batch of samples was kept in the diesel fuel under temperature of 25^{0}C (room temperature), while the other three subsequent batches of samples were fully immersed in the muds in a cabinet dryer under temperature 50^{0}C, 75^{0}C and 90^{0}C, respectively. The time of the experiment was 20 days for each batch. This is due to the fact that the mud motor operation time is equal to 200 – 600 hours, with 240-300 hours on average [5-6].

It is necessary to note that the previous experiments made by researchers clearly showed elastomer instability in the drilling mud causing swelling or a decrease in the sizes [1,7 - 9].Therefore, the evaluation was made based on geometric dimensions of the rubber sample.

2. Results and discussion

According to the experimental data, the hypotheses about elastomers instability in regard to drilling muds causing swelling or the decrease in the sizes [10] were proved. Therefore, the experimental results were divided into two categories according to elastomers instability: 1 – a decrease in sizes (fig. 1 – 2); 2 – sample swelling (fig. 3 – 4).

At temperature 25^0 – 50^{0}C, a decrease in the size of the rubber sample was observed. Furthermore, the diameter of the sample reduced by 1.41 mm per 480 hours at temperature 25^{0}C, while at temperature 50^{0}C this parameter was 1.59 mm. At temperature 50^{0}C within the period of 0-48 hours, a decrease in the sample sizes is more intense than at room temperature. At the same time, throughout 100 – 480 hours at room temperature a decrease in a sample size is more intense than at temperature 50^{0}C. This is due to the high volatility of diesel fuel with the increase in temperature.

During the experiment splitting of samples in diesel fuel was observed in all batches after 24 hours (fig.2). Mud gets insignificantly dark at temperature 50^{0}C, which confirms indirectly the possibility of drilling mud impact on elastomer wearing even without dynamic loading.

Intense change of the sample parameters in the form of swelling was observed at temperatures 75^0 and 90^{0}C. The following results were registered: at temperature 75^0 C diameter of the sample increased by 1.42 mm, while at temperature 90^{0}C swelling of the sample is 1.3 mm per 480 hours.

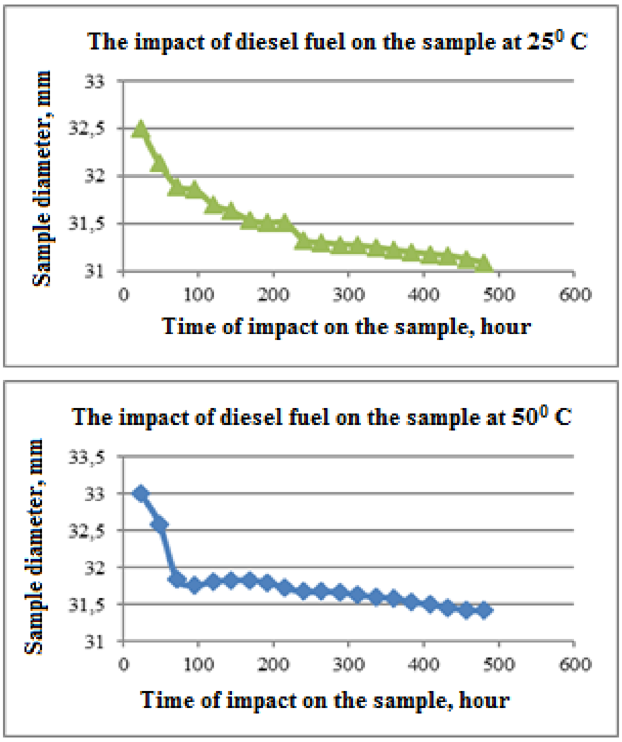

Figure 1. The impact of diesel fuel on the samples at 25^0 and 50 ^{0}C

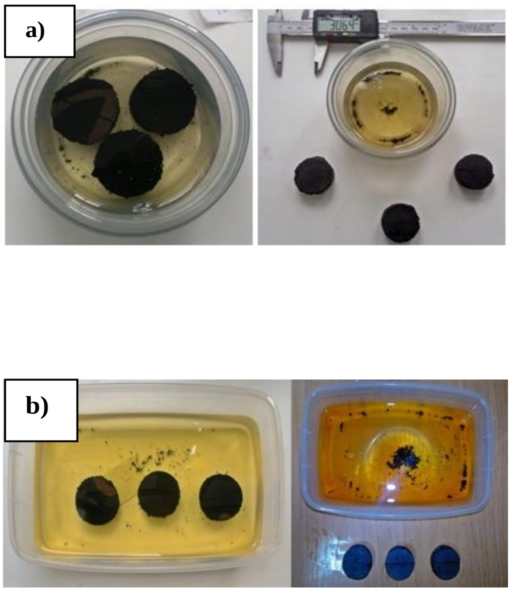

Figure 2. The samples and diesel fuel throughout 24 hours (left) and 480 hours (right), a) at 25 ^{0}C; b)at 50 ^{0}C

It should be noted that the degree of mud impact to the sample is determined not only by the temperature but also the duration of the experiment. At temperature 90^{0}C throughout 0-72 hours swelling of the sample is more intense than at temperature 75^{0}C. At the same time, throughout 144 – 148 hours more intense swelling is registered at temperature 75^{0}C.

When studying the temperature range of 75^0 – 90^{0}C, an increase in sample size was obvious even within the first days of the experiment. This is opposite to the experimental data registered in the temperature range of 25^0 – 50^{0}C. Splitting of samples was less intense but it mainly occurred at temperature 75^0 C (fig.4). The color of diesel fuel rapidly darkened (within 24 hours), and at temperature 90^{0}C it became close to black.

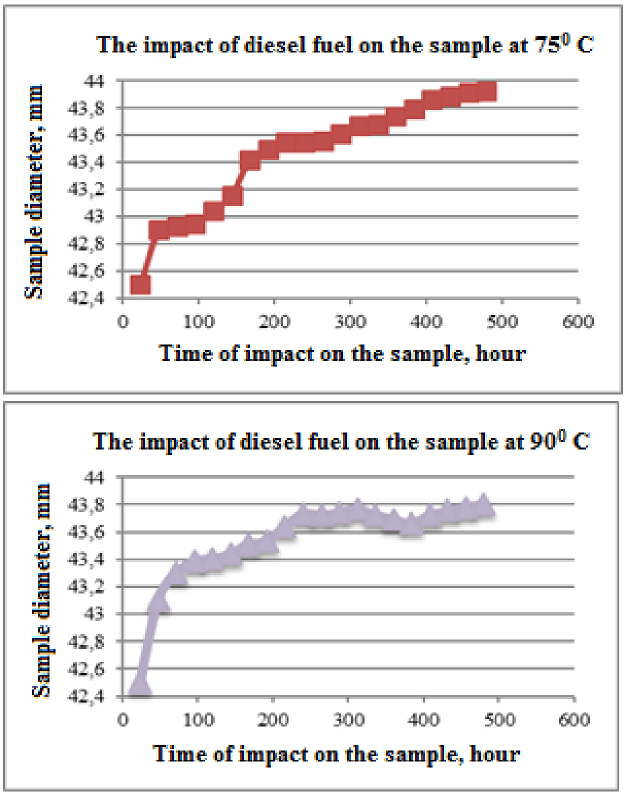

Figure 3. The impact of diesel fuel on the samples at 75^0 and 90^{0}C

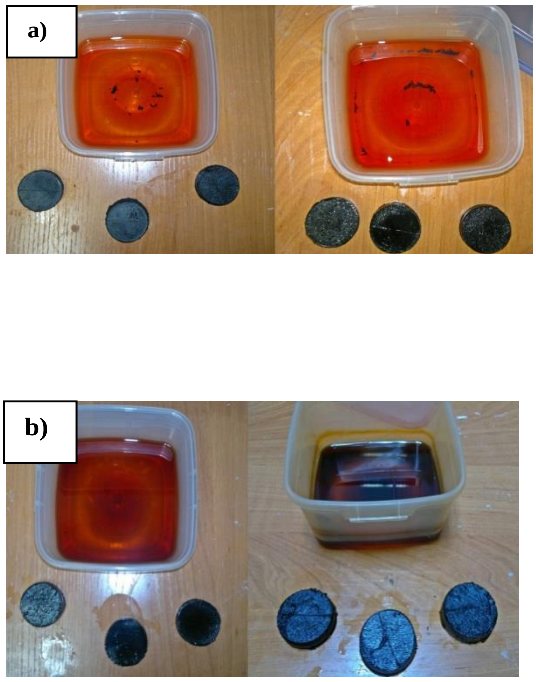

Figure 4. Figure 2. The samples and diesel fuel throughout 24 hours (left) and 480 hours (right), a) at 75 ^{0}C; b)at 90 ^{0}C

Conclusions

Evaluating the results of the research, it can be noted that the impact of diesel fuel as a type of drilling mud on elastomers' parameters is confirmed. In all studied temperature ranges intense deformation and splitting of the samples were observed. In further research it is necessary to pay particular attention to the temperature range of 75^0 – 90^{0}C, since according to the experimental data; it is within this range, where more intense elastomers deformation is registered.

Acknowledgement

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