Increasing percentage of uptime of pipeline transport system at production association LLC KINEF

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Abstract. The system of the preventive maintenance (PM), accepted at production association LLC KINEF, taking into account safe operation and health assessment, is analyzed. Statistical data of results of diagnostics are processed; options of the increase of the integrated reliability indicator of the system of pipeline transport are offered. The trend lines of a condition change of the pipeline in time and the approximate curves of diagnostic data of nondestructive inspection technique with creation of the long-term forecast of its technical condition was constructed. The option of correction of the accepted PM system with the analysis of quantitative change of an indicator of reliability was developed, by which application of the percentage of uptime will increase from 0.909 to 0.957.

1. Introduction

It is possible to call pipeline transport as the most demanded type of transport for movement of liquid and gaseous products. The main advantages of pipeline transport are low producing costs of transportation and high productivity. Taking into account the high productivity and requirements to safety, increasing the reliability of pipeline transport [1] is one of the most urgent tasks for today.

The purpose of the research is to increase the reliability of the pipeline transport system at the production association LLC KINEF by updating properties and integrated reliability indicators, as well as change of the system of preventative maintenance due to optimization of technical diagnostics of the pipeline.

To increase the reliability of the pipeline transport system and to achieve the goal, the solution of two main objectives is required:

1. To assess the reliability of the system of pipeline transport at production association LLC KINEF [2]

2. To increase reliability indexes, including percentage of uptime of the equipment.[3]

The solution of an above-mentioned problem will reduce idle times of oil-refining equipment, which in its turn will increase the operating efficiency of the factory and will lead to growth of net profit of the enterprise.

The increase of reliability and efficiency indicators of pipeline transport diagnosis was studied in works [4,5,6,7].

2. Materials and methods

The system of the preventive maintenance (PM) is a complex of organizational and technical actions on service, supervision, operation and repair of processing equipment, directed to the prevention of
premature wear of component parts, knots and mechanisms and to maintaining them in the operable state.

The essence of the PM consists in the fact that after the equipment has been run for a certain period of time, preventive inspections and different types of planned maintenance are carried out, the frequency and duration of which depend on the design and repair features of the equipment and on the conditions of its operation.

At LLC KINEF, PM is to be done once per 2 or 4 years. The time between PM depends on characteristics of the transported fluid, so for hostile environment (alkali, acid, etc.) the interrepair time makes 2 years, and for non-intrusive environments — 4 years. Measurements by thickness gauging are carried out according to the PM schedule in the form of test diagnostics, by the results of which the necessity of conducting repair works is determined.

For correction of the system of the PM accepted at production association LLC KINEF, and optimization of technical diagnostics of the pipeline, the LG-24/7 machine intended for hydrofining diesel and kerosene fractions is considered. In particular, the pipeline transporting crude hydrogen-containing gas is considered. For this system of pipelines, trend lines and their approximation taking into account a final condition have been constructed.

The applied system of the PM at petroleum processing plant LLC KINEF is based on definition of a condition of the pipeline with application of the nondestructive inspection technique (NI) [8]. One of the applied methods is the ultrasonic thickness measurement by A1209 devices. At the same time for use of the A1209 device carry out test diagnostics (with a stop of work of technological equipment). Diagnostics by this device is carried out single-point that doesn't allow to reveal defects on all length of the pipeline.[9]

In addition to the aforementioned NI technique, it is offered to enter the nondestructive inspection technique based on magnetic memory of metal [10]. This technique allows one to carry out thickness measurement without stopping technological equipment along the whole length of the pipeline. This allows one, in its turn, to partially pass on from test diagnostics to function test of the pipeline using the IKN-7M-16 device.[11]

Correction of the PM system allows one to decrease the percentage of uptime. The quantitative analysis of the integrated reliability indicator and the percentage of uptime for the LG-24/7 equipment has been made. The reliability indices were considered for three characteristic periods:

1. For the whole period of the operating time of equipment up to its modernization (from 2008 to 2033) — without updating (basic) PM.
2. For the whole period of the operating time of equipment before its modernization (from 2008 to 2033) — with updating (accepted) PM.
3. For the remained operating period from 2017 (taking into account the period of putting the equipment into operation in 2008) to 2033 with updating PM (modernized).

For each of the specified periods, the utilization coefficient $K_{pu}$ is calculated:

$$K_{pu} = 1 - \frac{T_{IT}}{T_{OT}} \cdot \frac{1}{T}$$  \hspace{1cm} (1)

where: $T_{IT}$ – time of repair (ineffective time) of the equipment for the specified period; $T_{OT}$ – operating time of the equipment for the specified period, $T_{IT} = T - T_{IT}$; $T$ - the general time including operating time and ineffective time.

The received results of calculation of percentage of uptime are shown in table 1.

3. Results and discussion

The built trend lines in the section of pipeline No. 2, transporting crude hydrogen-containing gas, are presented in fig. 1. Approximation of trend lines has revealed two boundary points: with the worst ($T_{min}$) and the best ($T_{max}$) technological projection of the condition of pipe walls up to the limit of reject value.
Figure 1. Predicted trend line of pipe wall thickness variation

By this trend line, it is visible that the condition of pipe walls, corresponding to the rejection limit, will come in the period of 2049 - 2070, which in many aspects exceeds the overhaul period of the PM, accepted at the production association. There is a similar technological projection on other trend lines, obtained by analyzing the section lines of the pipeline. According to the accepted PM, the equipment in the period from 2008 to 2016 was stopped for test diagnostics, and repairs were made two times, i.e. once per 4 years. Despite the received results of trend lines, which showed that the theoretical service life of the pipeline with the worst trend line ($T_{\text{min}}$) will make up 41 years (from 2008 to 2049). At that, in research the average service life of the equipment – 25 years (according to the project documentation) was accepted, i.e. from 2008 to 2033. After it, remanufacturing of the equipment is conducted.

Having analyzed the resulted trend lines, taking into account the partial transition from test to functional diagnostics, it is necessary to correct the system of the preventive maintenance, adopted at production association LLC KINEF. For this purpose, it is proposed to increase the interrepair time from 4 to 8 years. The updated PM schedule, in which there are no stoppages in 2012, 2020 and in 2028, is presented in fig. 2.
For the assessment of the result of PM correction and optimization of the diagnostic system, quantitative change of the reliability indicator has been analyzed. As a result of this analysis, it becomes vivid that after updating, the downtime of the equipment decreases, and, consequently, the utilization coefficient grows (table 1), i.e. the integrated reliability indicator increases ($K_{TU}$).

**Conclusion**

Owing to transition from testing to functional diagnostics and the updating of the PM system, the downtime of the equipment decreased, which in its turn, increased the utilization coefficient. If the offered system of PM had been put into operation from 2008 (it is a year of putting the LG-24/7 equipment into operation), the utilization coefficient would have grown from 0.909 to 0.957.

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