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INFORMATION MODEL FOR FORECASTING OF TECHNICAL CONDITION AND DIAGNOSTICS OF PRODUCTS EXEMPLIFIED BY GAS INDUSTRY

Products of the gas equipment and pipeline systems (GE and PS) and other gas power equipment operating in the pipeline transportation systems (PTS), is usually characterized by an initial technical condition. This is due to the specific design, materials used, quality of manufacture or repair as well as costs of transportation and storage. Substantial influence on the functional state of these products exerts the wear of highly-accurate micrometric pair of pipe fittings, which takes place in the process of their exploitation and results in the loss of the sealing property. It should be mentioned that this process of change in geometry of the interfacing surface of pipe fittings takes place gradually and in most cases these defects, which are actual failure, are revealed at maintenance service or operating repair of GE and PS products. Among other things, such situation can be explained by many reasons, for example, with a great amount of the products of GE and PS that are made or repaired on the proper type enterprises. However, in this case, requirements which are produced to any, both new and repaired articles must be corresponded to a normative and technical document, and also scientifically-based recommendations.

Key words: *gas equipment, pipe fitting, defect, failure, technological heredity, forecast.*

I. Introduction

One of the main products of the GE and PS in the composition of the TPS is the pipeline fitting (PF), functional status of which has a significant impact on the reliability and durability indices of these systems. Wear of high precision pairs of the PF that occurs in the course of their operation results in the loss of sealing ability. This process of changing the geometry of the PF surfaces being conjugated and, consequently, increase in the gaps between them occurs gradually. Therefore, in most cases, these defects are the actual failures, which are detected only at the next repair. In this regard, the factors of durability, in particular, the values of the optimum operating service life of the PF TPS are determined, primarily, by the lifetime of the wearing precision pairs being conjugated.

II. Fundamental Notions

The performed research work has made it possible to establish the following failures of a new and repaired PF:

- the defects caused by the technological heredity of the production and repair of mating sealing elements;

- the defects that are inherited by materials being used;

- the defects not eliminated when conducting the input completeness and initial technical state.

Moreover, the defects, which can be eliminated, are identified:

- by running-in at idle and under load;

- by maintenance after running-in under load, as well as:

- failures prevented by conducting running-in, which increases the operating life of the PF.

The sequence of defects N(t) detection is shown in Fig. 1.

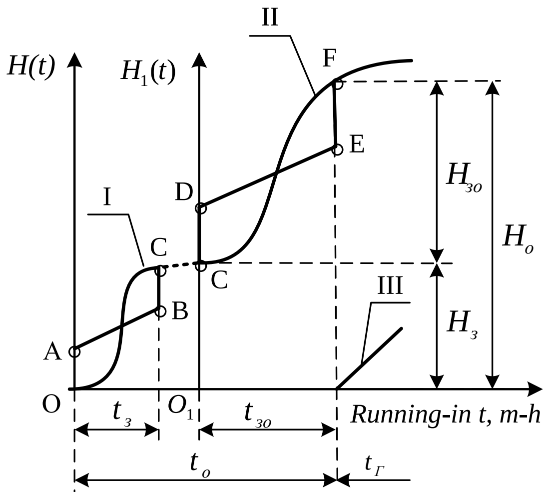

Fig. 1 – Scheme of the information model of forecasting of the technical condition of new and repaired GE and PS products at the stage of production in the running-in period: H_3 – is the total average number of possible failures of fitting without factory break-in (curve I); H_{30} – is the total average number of possible failures without operational testing (curve II); curve III is the number of failures in the consumer after the running-in.

Defects, that can be eliminated in the incoming quality control of completeness and initial state (OA and CD), represent defects in the fitting-in, assembling, testing, transportation and storage time. Typical defects of this group are as follows: violation of sealing ability; increased leakage of energy carrier; deformation or wear.

Defects, removable by treatment in running-in at idle and under load (AB and DE), are conditioned by the defects arising in the manufacturing process and assembling of the component parts of the GE and PS products. Typical defects of this group are the disadvantages of the thermal treatment, hidden sinks and cracks.

Defects, removable by maintenance after running-in under load (BC and EF), are associated with the verification and brining of the PF parameters to the level required by specifications through the adjusting operations, fitting -in of the product, elimination of energy carrier leakage, etc. [2,3].

Gas leak and fluid leakage are characteristic of the failures of the I[st] group of complexity. Without these failures removing further operation of the PF can result in more complex failures such as smearing of the sealing surfaces, energy carrier leakage, etc.

Violations of nodes serviceability, functionality of assembly units, such as safety valves, metering devices of energy carrier leakage, etc., the appearance of which can prevent further control and adjustment works, are typical for failures of the II group of complexity

Failures of the III group of complexity, such as a complete lack of the transported energy carrier overlap, the breakage of the spindle from the tube or bowl, the difficulties of slabs production or adjustment in the system, deformation of precision pairs, etc., the removal of which is laborious and expensive, become apparent, as a rule, after a long period of their operation of 1or 2 years. All these failures can be prevented by carrying out specific technical inspections. The mean time to onset of these failures can be shifted in the direction of lengthening time of the PF safe and reliable operation.

Analysis of the causes of failures according to LLC "Spectech-HAIR" has shown that some of them (the I group of complexity – 10%, the II group of complexity – 20%, the III group of complexity – 70%) occurring in various PF runs can be identified and resolved with the input control at the stages of factory and operational tests. A significant number of failures, that give the operator the greatest losses, can be prevented by the performance of running at idle and under load.

This is due to many reasons, for example, a high volume of products that are manufactured or repaired. Each PTS has a large number of products with a potential possibility of failure for various reasons, for example, when the need to combine operational processes different in physical nature and characteristics. Requirements that are brought to anyone – both new and renovated TPS product – must meet the regulatory and technical documentation, as well as evidence-based recommendations.

Reliability is important to ensure tightness in time (Fig. 2) for the conditions of the PF operation and, finally, the concept of the functional-technical condition of the proper operation is essential for the stage of the intended use of the PF.

Therefore, under operating conditions of the PF inaccuracy of the forecast is open to many hazards of violation of energy carrier delivery to the consumer or inability to foresee timing and volume of rehabilitation works to ensure the reliability of their operation. The initial values of the parameters determined in the first stage are fixed using direct measurements or calculations of the difference of input and output quantities of the transported energy carrier.

The advantage of the forecast is the ability to identify the time of occurrence of the failure, i.e. such an event when the considered parameter is outside of the tolerance field. Such parameters may be: violation of the geometry of the PF precision pairs; the increased level of internal stresses of the mating surfaces; the premature wear, etc. It is also possible to define initial parameters of the PF high-precision products with a view to their preservation throughout the period of operation.

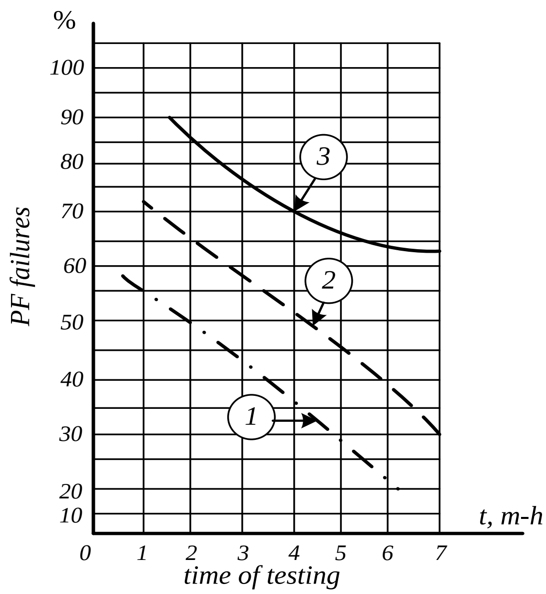

Fig. 2 – The number of detected defects when testing: 1 – the defects of the first group; 2 – defects of the second group; 3 – defects of the third group

The conducted research work gives grounds to assert that because of the number of cases of science-based, regular and economical methods of forecasting of the technical condition of the PF informal recommendations, facilitating diagnosis of the PTS products, are widely used in practice. If the predictions of the PF operational reliability at the stage of creation and production are currently unable to estimate with fairly high precision, then the predictions of technical condition in time require rather extensive investigation and clarification

It should be said that forecasting of the technical condition of the PTS products is important, in particular for the organization of their maintenance by date or by resource. For the PTS products, especially for high precision ones, it comes down to improving the parametric forecasting. It is important to regulate and evaluate those factors that can reduce the reliability and durability indicators of the product at all stages of the process of using this product. Studies have shown that different methods can be used to evaluate the accuracy of the forecast, the best of which is to compare the forecast results with the actual results of the PF technical condition. Subject to the operation of the PF inaccuracy of the forecast is open to many violations of delivery of energy carrier to the consumer or inability to foresee timing and volume of repair works for ensuring reliability of their operation. The initial values of the parameters determined at the first stage are captured using direct measurements or calculations of the difference of input and output quantities of the transported energy carrier [4, 5, 6].

If there are calculated relations, it is possible to trace the original form of mating surfaces, so that the effect of wear tells on the integrity of the PF product considerably less in the process of wearing. But at the same time possible adjusting of the nodes carried out in a certain period of time as well as phenomena associated with the nodes misalignment should be taken into account. Ultimately, it is possible to improve the PF performance using prediction.

In accordance with standard-technical documentation for gas production enterprises of Ukraine, taking into account the current situation in the gas power engineering, removal from service of the PTS products can be performed as needed. The study of the gas enterprises of the Kharkov region has shown that each gas regulating station (GRS) and gas distribution points (GDP) have different PF, and the service life of its operation in most cases are defined individually. A comprehensive inspection of the PTS products is performed at their planned repair. Wearing of the sealing surfaces on the discs and the housing is a characteristic fault for valves. In this case, due to loss of sealing, energy carrier leakage takes place through the closed valve; this leakage can only be debugged at a repair shop. When tightening the gland at an angle, or when trying to eliminate the leakage through the gland without re-packing it, cracks appear in a push axle box of the gland. To eliminate the fault it is necessary to shut off the valve immediately and replace the push axle box. In the PF, where the sealing part consists of precision metal couples, the wear of the rubbing surfaces takes place in the process of operation under the influence of technological heredity.

To prevent or minimize the loss of the transported energy carrier it is advisable to take into account all factors affecting the functional-technical condition of the PF and other PTS products. Theoretically, the most favorable period of operation of the PTS products, can be defined by the prediction of the functional technical state at certain stages of their operation.

Conclusions

1. Performed research work has made it possible to define failures of the new and repaired PF as failures of the I, II and III groups of complexity, with the operating time till appearance of these failures can be shifted in the direction of lengthening the time of safe and reliable operation of the PF.
2. With the help of the information model developed on the basis of statistical data the problems of parametric forecasting of operational reliability and prediction of the technical state of the GE and PS products aimed at timely preventive maintenance or repair can be solved.

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ИНФОРМАЦИОННАЯ МОДЕЛЬ ПРОГНОЗИРОВАНИЯ ТЕХНИЧЕСКОГО СОСТОЯНИЯ И ДИАГНОСТИКИ ИЗДЕЛИЙ НА ПРИМЕРЕ ГАЗОВОЙ ОТРАСЛИ

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Изделия газового оборудования и трубопроводных систем (ГО и ТС) и другое газовое энергетическое оборудование, функционирующее в составе транспортных трубопроводных систем (ТТС), как правило, характеризуется начальным техническим состоянием. Это обусловлено особенностями их конструкции, применяемыми материалами, качеством изготовления или ремонта, а также издержками транспортировки и хранения.

Ключевые слова – газовое оборудование, трубопроводная арматура, дефект, отказ, технологическая наследственность, прогноз.

ІНФОРМАЦІЙНА МОДЕЛЬ ПРОГНОЗУВАННЯ ТЕХНІЧНОГО СТАНУ І ДІАГНОСТИКИ ВИРОБІВ НА ПРИКЛАДІ ГАЗОВОЇ ГАЛУЗІ

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Вироби газового обладнання та трубопровідних систем (ГО і ТС) і інше газове енергетичне обладнання, яке функціонує в складі транспортних трубопровідних систем (ТТС), як правило, характеризується початковим технічним станом. Це обумовлено особливостями їх конструкції, застосовуваними матеріалами, якістю виготовлення або ремонту, а також витратами транспортування і зберігання.

Ключові слова - газове обладнання, трубопровідна арматура, дефект, відмова, технологічна спадковість, прогноз.