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Informativeness Increasing of Internal Combustion Engines Diagnosis Due to Technical Endoscope

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Abstract: The aim of this research is to eliminate the uncertainty in determining the technical condition of the detection object in particular a cylinder-piston group of internal combustion engine, through the use of technical endoscopes.

Key words: Vehicle, internal combustion engine, technical endoscope, informativeness, cylinder-piston

INTRODUCTION

Cylinder-piston group is one of the basic and most important parts of Internal Combustion Engines (ICE) from the technical condition of which the engine power, the fuel consumption and the content of harmful components in the exhaust gases depends largely. If there is a fault in the engine, for carrying of high-quality visual diagnostics partial disassembly of the unit is required which takes a lot of research then the same-to assemble (Denisov, 2016; Gritsenko, 2016a, b; Kucherov, 2016; Ismagilov, 2015). Usually design parameter changing can be detected by several different diagnostic parameters from which it is advisable to choose the most effective. For this property of informativeness is used (Ageev, 2016). Informativeness is a complex property that describes the removal of the uncertainty in determining of the technical condition of the diagnose object and to minimize the possibility of using the received diagnostic parameter to accept actually failed on technical parameters object of diagnosing for serviceable (Type 1 error) and vice versa (Type 2 error).

Downtime of transport, especially commercial, even for one day costs the owner too expensive so at the first sign of engine trouble it is invited to make a visual diagnosis with the help of a technical endoscope to determine the range of spare parts that must be ordered for the upcoming repair (Ageev, 2011, 2012).

The complexity of modern machines and mechanisms, performance of responsible functions makes the problem of hard to reach places diagnosis more and more actual. Currently, technical endoscopes of different designs are developed that allow to solve almost any diagnostic task. This excludes expensive operations of dismantling and reassembly. The possibility of a defect discovery depends on the quality and quantity of information transmitted by the endoscope. In many ways, the accuracy of defect detection is determined by the type of endoscope used. The use of endoscopes with the maximum possible diameter and minimum length, use where it is possible, rigid endoscopes leads to increase productivity of the operator, increase the probability of defect detection and reduce the probability of breakage of the endoscope. The optimum combination of the endoscope optical characteristics with the characteristics of the object under study and diagnosis of conditions as well affects an increasing of productivity and quality of diagnostics. This takes into account the field of view, magnification, resolution, aperture ratio, color reproduction of the endoscope, inspection conditions and minimum dimensions and shape of the defect. The endoscope is the main but not the only instrument for carrying out diagnostic tests. From the additional equipment illuminator is primarily required, whose light through a flexible optical fiber is fed into inaccessible area. The most commonly illuminators with capacity of 100 about 150 watt are applied. They provide the required amount of light are quite reliable and cheap. Endoscopes are available in different versions (flexible, rigid, slot, TV, video). Choice of a certain modification depends on the design of diagnosable objects and the existing conditions of the diagnosis.

Currently, technical endoscopes on service enterprises are not used because large garages and car dealerships engages a block replacement units. Overhaul of engines becomes the domain ofsmaller stations such as the garage. Dealership stations also do not really need view of the body hidden cavities because they engage in service for new cars.

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Currently on the market of car equipment two types of technical endoscopes are represented: optical instruments and devices which are based on digital camera. Optical devices provide high quality picture because with the probe in the combustion chamber of the engine (or any other area under study). Compact optics transmits much better image than a portable digital camera. The disadvantage of the optical endoscope is that he is not able to transfer the image on the monitor screen. Technical endoscopes which are based on digital camera give less quality of image. Furthermore an image or video can not only show a client in real time but also keep in the computer.

Purpose of the study: The aim of this research was the removal of the uncertainty in determining the technical condition of the diagnosing object in particular cylinder-piston group of internal combustion engine through the use of technical endoscope.

MATERIALS AND METHODS

In studies of the technical state of the internal combustion engines technical flexible endoscope ETG 8-1, 2-2 was used. This technical endoscope can be used for visual inspection of inaccessible areas, including closed, light-isolated having small inlet openings. For the object of industrial endoscopy diagnosis engine R5, mounted on the car volkswagen was adopted

RESULTS AND DISCUSSION

Figure 1 shows the images of the cylinder-piston group of R5 engine, mounted on Volkswagen vehicles after 120,000 km. Necessity of carrying out diagnostic of engines data in terms of "volkswagen centre of kursk" was caused by appearance of extraneous noise. With the help of endoscope were obtained the most comprehensive images of what is happening in the engine. They were examined visually piston cylinder wall, inlet and outlet seat valves.

Following the results of diagnosis using a technical endoscope it has been found that the cause of increased noise in the R5 motor is delamination of coating engine cylinders from the base of monoblock and the need for repair of the engine by boring beneath the repair sleeve. For a description of the car engine technical condition the apparatus markov random processes was used. In line with that the car engine performance in the future depends only on its actual technical condition to

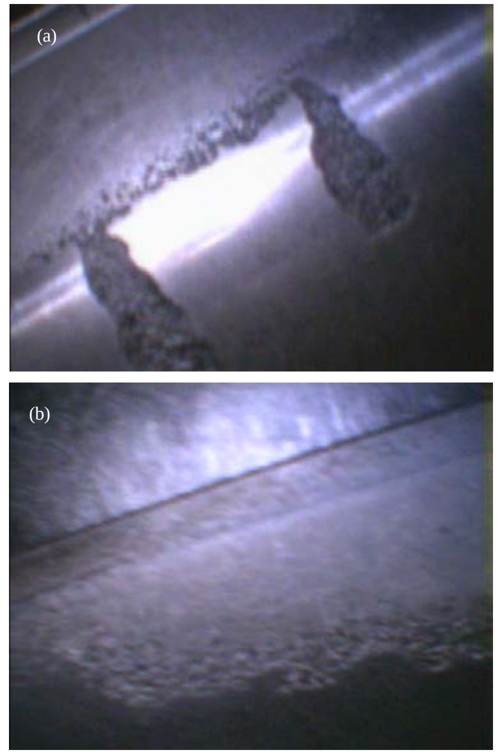

Fig. 1: Image of the cylinder wall of the R5 engine, obtained with the help of a technical endoscope

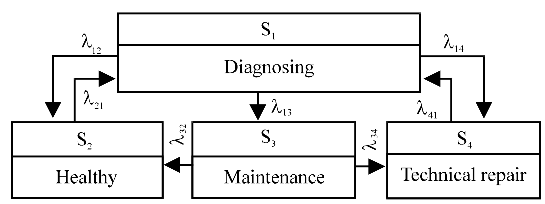

Fig. 2: Marked graphs of car engine conditions for a Markov process with continuous time

which the engine can come in different ways. Using the technical endoscope allows to define possible states of a car engine S_1-S_4, i.e., it is a Markov random process with discrete state which is manifested in the fact that the system abruptly goes from one state to another: SK→SK+1 (Fig. 2). On the graph at the arrows indicated transition probability. For a Markov process with discrete state and continuous time probabilities densities λ of system transitions during the time Δt from the state S_i to the state S_j were considered:

$$\lambda_{ij} = \lim_{\Delta t \to 0} \frac{P_{ij}(\Delta t)}{\Delta t} \quad (1)$$

Where:

P_{ij} = The probability

Δt = The car's engine will move from the state S_i to the state S_j

For small Δt $P_{ij}(\Delta t) \approx e_{ij} \Delta t$. Having data on the densities of transition probabilities eij, the probabilities of all states of the motor vehicle at different times were calculated, i.e., the probability of the first state $P_1(t)$ the second $P_2(i)$ were determined and etc. These probabilities are determined from the system of differential equations of A.N. Kolmogorov. The system of equations for the marked graph of the states:

$$\frac{dP_1}{dt} = -(\lambda_{12} + \lambda_{13} + \lambda_{14})\, P_1 + \lambda_{21} P_2 + \lambda_{41} P_4 \qquad (2)$$

$$\frac{dP_2}{dt} = \lambda_{12}\, P_1 + \lambda_{32} P_3 - \lambda_{21} P_2 \qquad (3)$$

$$\frac{dP_3}{dt} = \lambda_{13}\, P_1 (\lambda_{32} + \lambda_{34}) P_3 \qquad (4)$$

$$\frac{dP_4}{dt} = \lambda_{14}\, P_1 + \lambda_{34} P_3 - \lambda_{41}\, P_4 \qquad (5)$$

In the equation indices t are omitted for brevity, ie Instead of $P_1(t)$ P_1 is recorded and so on. Limit states (at $t \to \infty$) when P_i = const were determined from the above system of equations, whose left sides were equal to zero and the conditions under which $P_1+P_2+P_3+P_4 = 1$.

CONCLUSION

Thus, the use of industrial endoscopy makes it possible to determine the final probabilities that characterize the mean residence time of a car engine in appropriate conditions S_1, S_2, S_3 and S_4. Using the technical endoscope is a unique opportunities for visual diagnosis not only the engine but also for gearboxes, axles and chassis. Technical endoscopes should be in the arsenal of any diagnostics post at the service station.

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