A FATIGUE TESTING METHOD OF WET CYLINDER LINER OF DIESEL ENGINES

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Abstract

It has been agreed to call the loads changing with time and acting in most varied constructional arrangements as well as the stresses accompanying them changeable or cyclic. Changeable stresses produce in the material a very complex entanglement of phenomena and changes depending on the value of those stresses and on the number of cycles. These are fatigue phenomena and changes. They develop successively till the element has been destroyed. This is called the element material fatigue. Thus changing loads and stresses are also called fatigue loads and stresses.

The purpose of the presented work was to develop a method of comparative investigations for wet replaceable sleeves in direct contact with coolant that have been submitted to technological treatment of sub-edge zone material strengthening. The source of loads is a cyclically occurring normal component of gas and mass forces in the cylinder. The frequency of changes is a derivative of the number of strokes in the engine run and of the rotational speed of the crankshaft. Fatigue loads can be the reason why cylinder liner cracks in the edge zone. The results of the fatigue testing of the technological process of strengthening the cylinder lines sub-edge zone on crack sensitivity shows differences in the behaviour of particular samples, depending on the parameters of strengthening. The fatigue testing method can be used to evaluate the technological process of cylinder liner.

Keywords*: combustion engine, diesel engine, cylinder liner, fatigue*

1. Introduction

To the described phenomena of fatigue loads and stresses are also submitted internal-combustion engine cylinder sleeves. The source of loads is a cyclically occurring normal component of gas and mass forces in the cylinder. The frequency of changes is a derivative of the number of strokes in the engine run and of the rotational speed of the crankshaft. Fatigue loads can be the reason why cylinder sleeves crack in the edge zone. Strengthening the material within the area of expected cracking can prevent cracking.

2. Aim of work

The purpose of the presented work was to develop a method of comparative investigations for wet replaceable sleeves in direct contact with coolant that have been submitted to technological treatment of sub-edge zone material strengthening.

Because of the recognitive character of the investigations, assumed was a variant of research on samples prepared from cylinder sleeves submitted to the technological process of different parameters. The reference level was to be constituted by the samples from a sleeve without a sub-edge protection.

3. Methodology of investigations

The accomplished technological treatment causes the increase of fatigue strength from 10% to 60% (values taken from literature, determined for comparative testing on round samples) [1, 2].

Geometry of the wall of the sleeve under investigation has been presented in Fig. 1. The sleeve wall thickness is changeable. Using samples of constant width (cut out from the sleeves) for the investigations might cause some "privilege" for the zones of the least thickness to initiate fatigue cracking during testing.

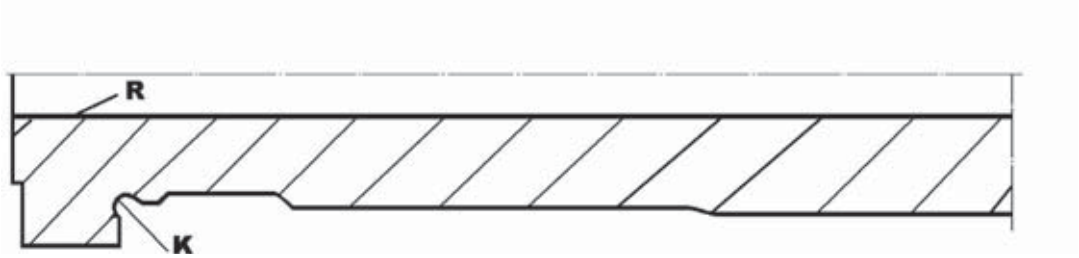

Fig.1. Wall geometry of the investigated cylinder sleeve: K – sub-edge notch zone, R – groove zone

Thus it seemed advisable to carry out a manipulation of preparing samples of changeable width but of a constant section area. By analogy to a circular section of the standard fatigue testing samples, it was proposed to prepare "square-in-section" samples of the width equal to the sleeve thickness in the neighbourhood of the notch bottom (denotation K – Fig. 1) and to increase the sleeve thickness in the groove zone (denotation R – Fig. 1).

A sample prepared this way has been shown in Fig. 2.

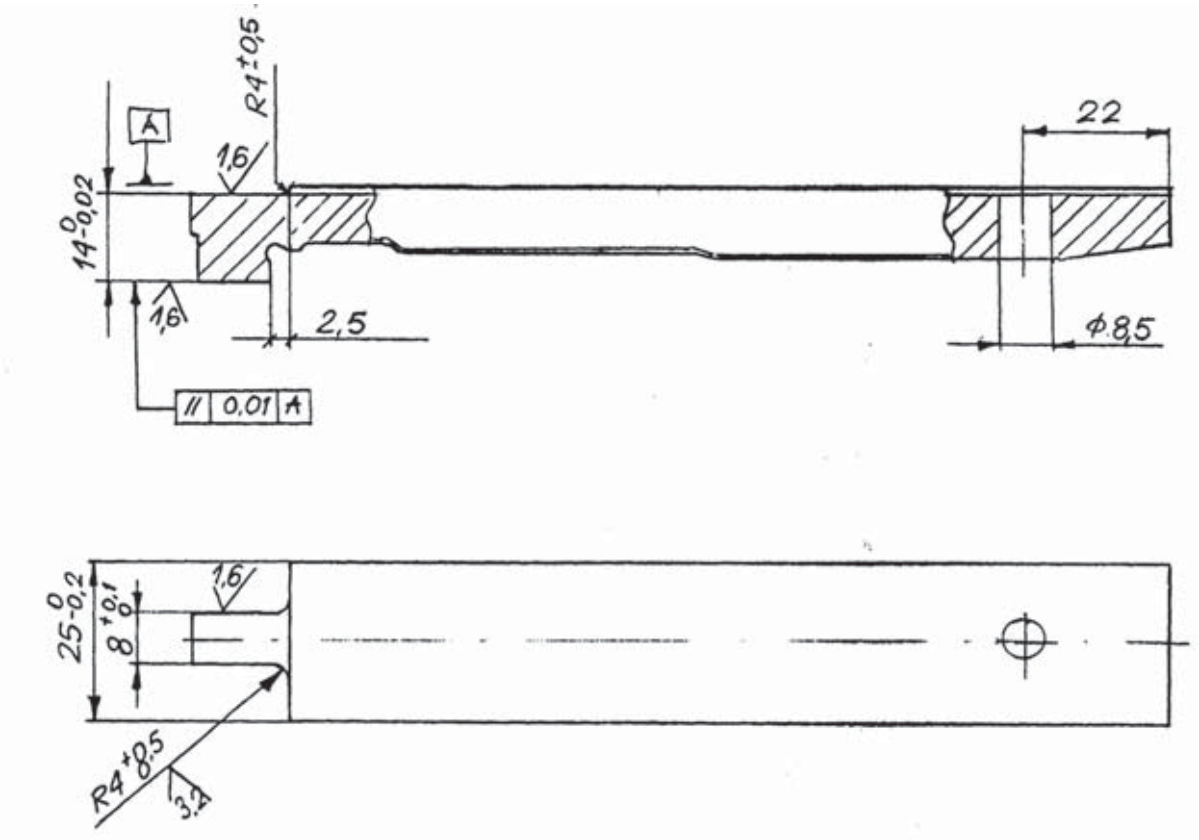

Fig.2. Geometry of sample for fatigue testing

The tested sample was fastened in a special grip applying a principle of "fixing the cylinder sleeve edge" and submitted to alternating loads. Frequency of loads (forcing) was matched with the combustion process parameters.

The investigations were carried out on a testing machine of the MTS 810 type. The suggested load frequency f=20 Hz (corresponding to the rotational speed of the crankshaft of a four-stroke engine n=2400 rot/min) determined the load amplitude a=0.86 mm, resulting from the machine pulsated characteristics.

4. Results of testing

It was 5 kinds of samples coming from five sleeves differing in the parameters of the operation of strengthening the sub-edge zone that were submitted to the testing. The results of the testing in the form of the average number of cycles that the samples resisted before they were destroyed have been set up in Fig. 3.

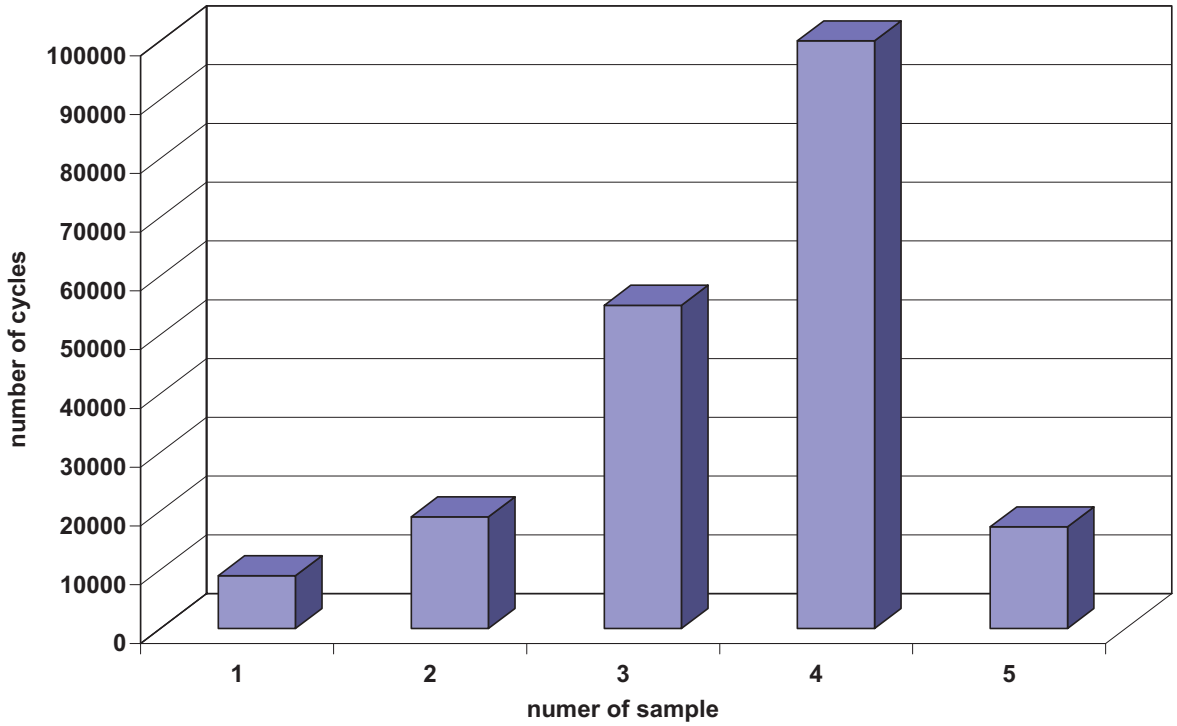

Fig.3. Average number of cycles to fatigue destruction of sample

5. Conclusions and remarks

- The results of the fatigue testing of the technological process of strengthening the cylinder sleeve sub-edge zone on crack sensitivity shows differences in the behaviour of particular samples, depending on the parameters of strengthening.
- The character of the changes in the amount of cycles in a fatigue test till the sample has been destroyed points to the occurrence of a local extreme.
- The fatigue testing method proposed here can be used to evaluate the technological process of cylinder sleeves.

References

[1] Kocanda, S., Kocanda, A., *Niskocyklowa wytrzymałość zmęczeniowa metali,* Warszawa, PWN, 1989.
[2] Kocanda, S., Szala, J., Podstawy obliczeń zmęczeniowych: Warszawa, PWN, 1991.