Ensuring the wear resistance of the material of the bearing assembly of the turbocharger of the internal combustion engine

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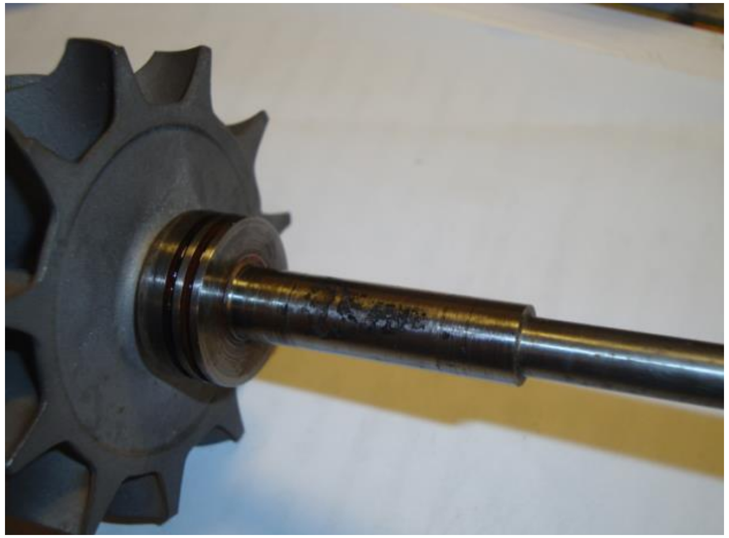
1. Introduction

The operability of the bearing assembly of the turbocharger of the internal combustion engine, which ensures its operation at different rotor speeds, determines the reliability of the turbocharger as a whole.

However, in real operation, there is an oil leak through the seals on the side of the turbine and compressor due to unbalancing of the rotor shaft, jamming of the rotor shaft in the plain bearings due to the penetration of oil burning products and foreign objects into the friction pairs, increased radial stroke of the rotor shaft and the possibility of touching the turbine or compressor blades on the housing due to wear of the plain bearings (bushings).

1. Introduction



The main types of wear of parts of the bearing assembly of the turbocharger

2. Purpose of the work

As a result of research, it was found that the number of failures increases with increasing wear and tear of equipment, which will eventually lead to an increase in the recovery period. In this regard, research aimed at ensuring the performance of systems and units, as well as tractors and agricultural machines in general, is relevant. The performance and reliability of the equipment directly depends on the conditions and intensity of loads on the tractor engines, which are characterize by frequent and abrupt changes of modes. Increased wear, reduced technical and economic indicators and engine power are associated with frequent starts and long stops of diesel engines, as well as short-term overloads, significant periods of acceleration and braking.

A feature of the turbocharger installed on car diesel engines is a compressor that pumps air into the cylinders of the engine, the rotation of which is carry out by the turbine. The turbine rotates from the exhaust of the engine itself, has a common shaft with a compressor and a sliding bearing.

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The turbocharger bearing operates under extremely negative conditions, as the exhaust temperature is 700 C, which has an impact on the turbine and bearing. Since the oil entering the turbocharger's bearing node is involved in the grease of the rubbing elements of the entire engine, soon enough loses its quality, ensuring the reliability of the turbocharger. Moreover, the turbocharger rotor develops a rotation speed from 15000 to 90000 min-1, while, structurally, there is no rigid kinematic connection with the oil pump, which leads to a long run-out of the rotor without the supply of lubricant. This circumstance leads to a sharp increase in the temperature in the bearing unit, coking of the oil and accelerated wear of the bearings.

One of the ways to solve the problem of improving the operational reliability of a diesel engine turbocharger is to improve the lubrication system of its bearing.

The **purpose** of the article is a comparative assessment of changes in the state of turbochargers with a standard lubrication system and when using individual lubrication systems of the bearing node.

3. Materials and methods

Assessment of the loss of the bearing resource and the failure of the KAMAZ turbocharger with the engine of the JAMS equipped with TKR-11 turbochargers was carried out under the regular lubricant mode and using an individual system of lubrication of the bearing node.

Change of the expense of the resource of the bearing and the operating time before the failure of the turbocharger depending on the mileage of the car were determined using the methodology for justifying the optimal type of dependence according to the criterion of the minimum residual dispersion.

16 KAMAZ cars were selected for experimental research, including for 3 cars prototypes of individual lubrication systems for turbocharger bearing units were made. The frequency of monitoring was chosen to be equivalent to the frequency of the second maintenance (TS-2). So, for KAMAZ with the YAMZ-286 engine equipped with TKR-11 turbochargers, the frequency of monitoring was 16,000 km.

Type of oil pump drive on the car engine

3. Materials and methods

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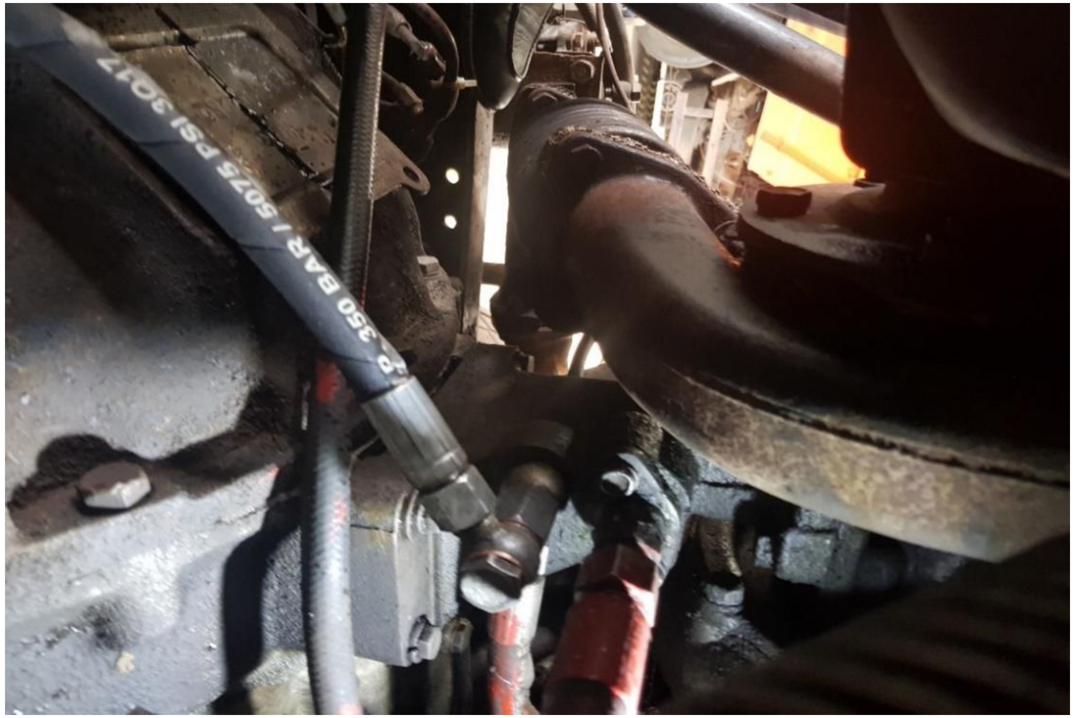
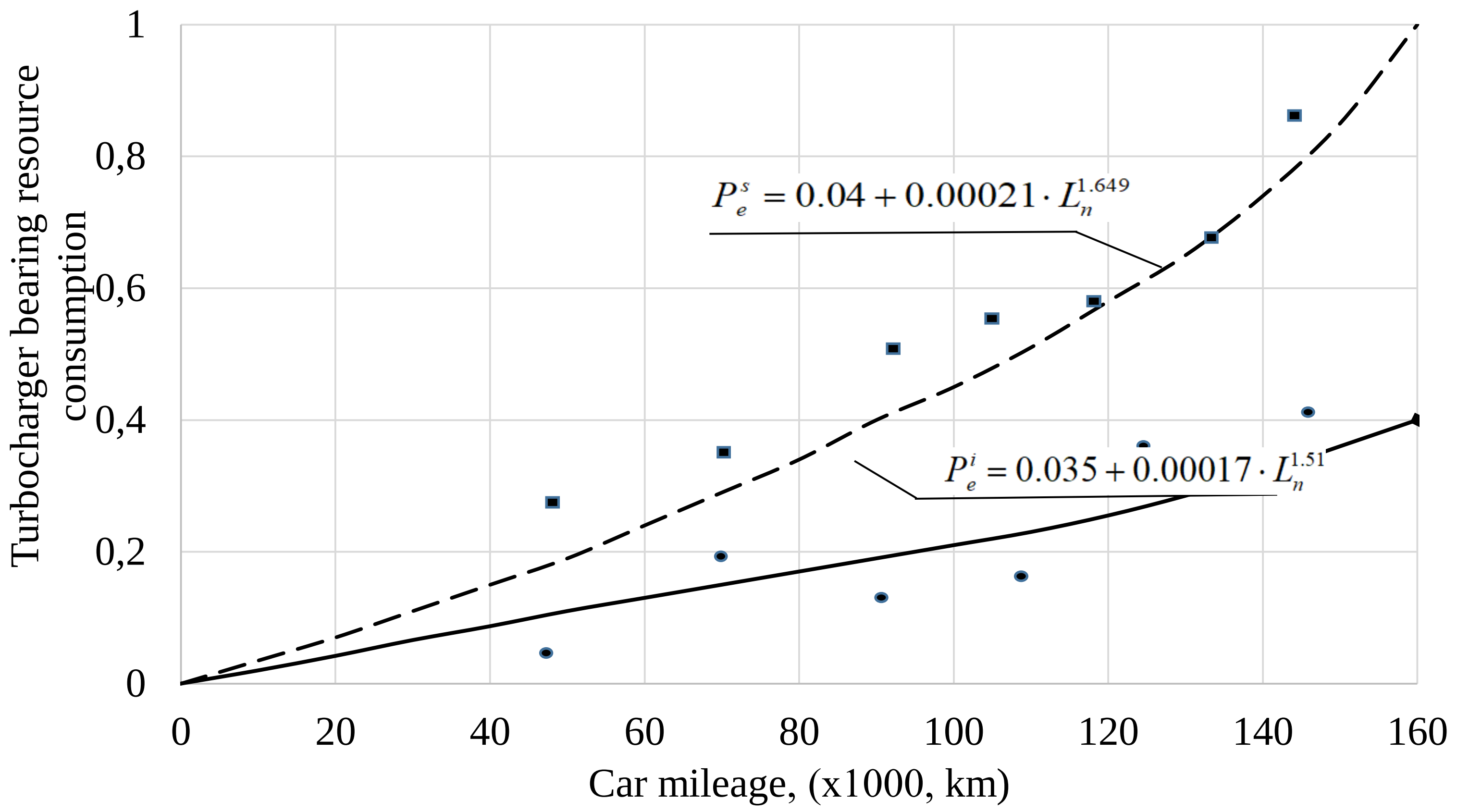


Type of connection of the supply hose

3. Results of the study

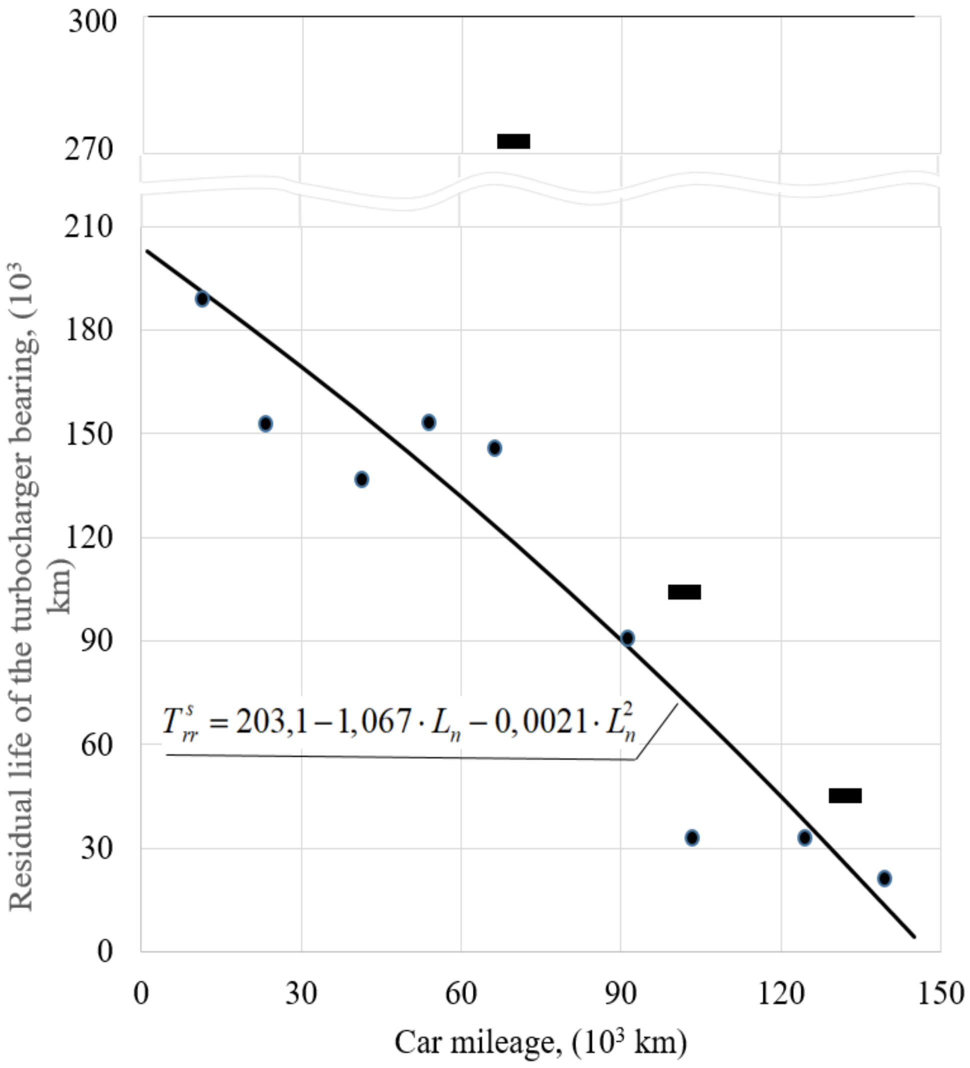
Figure shows graphs of changes in the expense of the car's turbocharger bearing resource, depending on its mileage at the regular grease mode of the bearing node and when using an individual lubricant system. From where you can see, with the standard model of lubrication of the bearing turbocharger, its resource is spent intensively and at a mileage of 160000 km is exhausted. Using an individual turbocharger bearing node system, only 40% of the resource is consumed for the same mileage.



3. Results of the study

It can see that under the normal mode of smearing the total mileage of the car before the turbocharger failure reduced from 75000 km to 23000 km per mileage of the car equal to 160000 km. This implies the appearance of at least one turbocharger failure for each 40000 km of mileage. When using an individual turbocharger lubricant system, there were no failures during the pilot studies. To explain the results, consider the graph (Figure) of the dependence of the change in the residual resource of the turbocharger bearing node and the mileage of the car.

Residual resource for 160000 km of the car's mileage decreases from 210000 to 22000 km. This is due to the fact that despite the periodic oil change in the engine during maintenance, small (commensurate with the gap in the bearing unit) and solid abrasive particles fall into the bearing unit of the turbocharger, which leads to an increase in the intensity of wear.



Formulas: definitions of tightness of communication, resource consumption and operating time for failure

$$m_R = \pm \frac{1 - R^2}{\sqrt{n}}$$

$R \geq 3m_R$.

$$P_e^s = 0.04 + 0.00021 \cdot L_n^{1.649}$$

$$T_f^s = 14982,6 \cdot L_n^{-1,278}$$

$$T_{rr}^s = 203,1 - 1,067 \cdot L_n - 0,0021 \cdot L_n^2$$

The relative simplicity of the applied methods and formulas allows us to obtain a fairly accurate forecast.

6. Conclusions

It was revealed that under the standard lubrication mode of the turbocharger bearing, its resource is consumed twice as intensively as when using an individual lubrication system of the turbocharger bearing unit.

With the standard lubrication mode, the operating time to failure of the turbocharger will be reduce three times per 160000 km of the car's mileage, when using an individual lubrication system of the turbocharger, during the same period there were no failures.

With the normal lubrication mode of the turbocharger bearing, the residual life for 160000 km of the car's mileage decreases by 90%, which is explained by the presence of small (commensurate with the gap in the bearing unit) and solid abrasive particles in the lubricant, which lead to an increase in the intensity of wear despite the periodic, during maintenance, oil change in the engine. When using an individual turbocharger lubrication system for the same mileage, the residual life was reduce by 40%.

Thank you!

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