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INCREASING THE PERFORMANCE OF TURBOCOMPRESSORS OF MOBILE ENERGY VEHICLES

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A complex of technical means and methods for researching the parameters of the operation of turbocompressors of internal combustion engines of mobile energy vehicles is substantiated. The regularities of changes in the parameters of the lubrication processes of the rotor bearings of the internal combustion engine turbocompressor during the operation of the hydraulic accumulator and the simultaneous braking of the rotor by the brake device built into the intake manifold of the engine have been established.

Key words: turbocharger, lubricant, rotor, friction, lubrication, reliability.

Problem. The use of turbochargers is one of the main ways to increase the unit power of internal combustion engines (ICEs), technical, economic and environmental properties during the operation of mobile power equipment (MEC) - tractors, self-propelled combines, cars, etc. However, the intense mode of operation of turbocompressors with stochastic loading indicators during the operation of the MES, the frequency of rotation of the rotor in the range of 40–170 thousand revolutions per minute and the temperature of exhaust gases of 650–700 °C requires ensuring effective lubrication of the bearings of the turbocompressor rotor. This is necessary to remove heat from the parts of the turbocompressor, to eliminate the wear of its rotor and bearings, which is not ensured by the standard serial scheme of the internal combustion engine lubrication system. A decrease in the supply and pressure of the lubricant to the turbocharger bearings during a sharp reduction in the revolutions of the engine crankshaft, its stop during overloads, as well as during start-up, especially in the cold season, are the main reasons for the deterioration of the performance of turbochargers, and a decrease in their reliability.

Analysis of research and publications. At the moment, the global engine industry has reached a significant level in terms of technology and design, so the increase in mechanical and indicator efficiency by the method of improving the combustion process, as well as the reduction of various losses, has practically been exhausted [1]. Therefore, the most effective way to increase engine power with practically unchanged mass and dimensional parameters and unchanged inertial loads is to increase the air charge density and cylinder filling factor. Increasing the mass charge of the cylinder with air allows you to proportionally increase the amount of fuel injected into the cylinders, which in turn leads to an increase in mechanical work (power) [2]. Tasks related to increasing the liter capacity of the engine, reducing the specific mass, and improving environmental factors are solved when forcing the power unit using a gas turbine supercharging system. The share of modern auto-tractor diesels equipped with turbochargers already exceeds 70% and is growing. To increase the durability of the engine, it is necessary to diagnose and, if necessary, restore the performance of the elements of the power unit. When carrying out maintenance of the car, it is recommended to carry out diagnostics of the turbocharger from the runout of the rotor shaft after stopping the engine, according to the size of the axial and radial clearances in the bearing assembly [10]. In order to determine the costs of ensuring the efficiency of the turbocharging system and other resource-determining elements of the engine during operation, statistical studies were conducted [3].

Research results. Conducted studies on the analysis of failures of turbocompressors of both domestic and imported production show that the main reason for turbocompressor failure is its high thermal stress [27]. During operation, the turbine part of the TKR is heated by exhaust gases, the

temperature of which reaches 700 °C and higher [31], the main part of this heat is taken by the cast iron snail and turbine wheel impellers. Due to the high thermal conductivity of the materials of the auger and the bearing housing, heat is transferred to the bearing assembly. Heat removal from the TKR cast-iron auger is carried out into the environment by blowing air, the bearing unit is cooled by circulating lubricant. The determining factor affecting the reliability of the turbocharger, if we consider the temperature of the parts, is the thermal stress of the bearing unit. This factor is especially evident when the engine is stopped, when the cooling of the turbine auger by blown air and the bearing unit by circulating oil stops [4]. This is due to the transfer of a large part of the thermal energy from the heated turbine auger to the bearing unit. During the operation of turbochargers, their reliability directly depends on the amount of time working in emergency modes, such as insufficient crankshaft rotation frequency at maximum engine load and high exhaust gas temperature. In these operating modes, the flow of lubricant directed to the TKR does not provide adequate cooling of the TKR bearing. To increase the operational reliability of the TKR, in this case, the installation of a fuel supply corrector based on the pressure of the injected air is used in the speed regulators of the diesel injection pump. This change allows the diesel engine to operate in a restrictive mode. Correctors built into the regulators provide TKR protection when the diesel engine is operating in transient processes and in modes that are not set, with a decrease and increase in the load on
engine, with the exception of operation in emergency operating modes. The operation of the engine in the limiting mode excludes the emergency mode of operation of the TKR, as well as during the period of starting and stopping the engine and, accordingly, acceleration and stopping of the TKR rotor. When the engine stops in the TKR, the temperature of all its parts rises significantly due to the cessation of oil supply from the internal combustion engine lubrication system, which causes local overheating of individual parts of the TKR, their gouging and cracking. Solving this problem is possible after a thorough analysis of all processes and modes of operation of the TKR, factors affecting its trouble-free operation and adoption of new technological solutions for making changes to the design of the TKR. From the practice of operating engines with TKR, it is known that the main indicators of TKR reliability are indicators of the resource (wear resistance) of the bearing assembly. The most common type of TKR failure is jamming of the shaft (rotor) [13]. Conducting a comparative analysis of the determining factors that affect the operational reliability of the TKR, we came to the conclusion about the reasons that lead to the manifestation of the main failure of the TKR - jamming: 1. Exceeding the limit values of the parameters (dynamic and temperature) during the operation of the TKR in critical modes, which lead to the disruption of stable processes in friction pairs, which indicates the need to study the physics of the process. 2. The phenomenon of oil coking in the TKR oil channels. 3. The phenomenon of decentering (displacement) of the axes and holes of TKR parts in the field of the turbine. 4. Increased oil consumption due to TKR. 5. Deformation of the TKR body, which leads to a reduction in clearances. 6. Local overheating of TKR parts during diesel engine shutdown. 7. Intensive wear of the TKR bearing in the absence of lubrication after stopping the diesel engine. 8. Insufficient supply of lubricant (oil starvation) in TKR bearings. The turbocharger is cooled by the flow of lubricant circulating in its system, as well as by heat removal to the environment through the surface of the housing. The operational reliability of the turbocompressor directly depends on the temperature of the bearings. During normal operation of the internal combustion engine, the temperature of the lubricant rarely exceeds 100 °C. When the internal combustion engine stops, the flow of heat from the parts of the TKR turbine, which has a temperature of up to 700 °C, is transferred to the TKR bearing and lubricating oil as a result of heat exchange. In the absence of circulation and temperature exceeding 140–150 °C, coking of the remaining lubricating oil occurs, its deposition on the turbocompressor shaft, intensive wear of bearings and sealing rings, as well as possible distortion of the rotor shaft due to local overheating and engagement of the impellers.

Conclusions: The main reasons for the decrease in efficiency and reliability of turbochargers are high-speed (rotor rotation frequency in the range of 40–170 thousand min–1) and temperature

regimes, high variability of dynamic loads on engines. With the peripheral location of the TKR rotor bearings in the standard lubrication system of MES engines, the operational stochasticity of their loads determines the oil "starvation" of the bearings, an increase in the temperature of parts, coking of the lubrication channels, intensive wear and jamming of the turbo compressor rotor.

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СПЕЦИФІКА КОНСТРУКЦІЇ І РОБОТИ ТРАКТОРІВ БРЕНДУ «НЬЮ ХОЛЛАНД»

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Важко назвати автоконцерн CNH і в Америці, і в Європі. Оскільки її офіси та фабрики розташовані в США, Канаді та Євросоюзі, тобто це глобальне підприємство, яке вважається найбільшим у світі та представлене в багатьох країнах. Пострадянський простір, включно з Україною. Бо їм є що запропонувати аграріям – наприклад, чудову сільськогосподарську техніку. Трактори CNH Corporation під брендами Case IN і New Сьогодні Нідерланди мають більшу частку ринку для цього типу автомобілів. Загалом на дві згадані марки припадає близько 43% від загального обсягу нових тракторів, поставлених в Україну.

Рис 1. ***Трактор колісний та напівгусеничний New Holland***

Побачивши успіх не дуже потужного МТЗ (80-100 к.с.) на вітчизняних полях, концерн CNH вирішив вивести новий трактор на наш ринок. Голландії приблизно з такою ж потужністю (рис. 1) . Моделі TL 5040, TL 5050, TL 5060 також мають двигуни потужністю 80-100 к.с., і такі машини за виробничими параметрами підходять багатьом аграріям, в тому числі і Україні. Однак ціни на них вищі, ніж у Білорусі, що серйозно впливає на вибір аграріїв. Вузький і округлий капот, характерний для нових голландських тракторів , забезпечує хорошу маневреність навіть під час складних «танців» з фронтальним навантажувачем. Кабіни тракторів серії TL5000 оснащені скляними дверима та збільшеними вікнами (бокові та задні вікна, що відкриваються).Великі прозорі поверхні та тонкі колони демонструють круглу форму фронту роботи. Рівень шуму в салоні не перевищує 79 дБ [1] .