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Failure Analysis of the Aviation Piston Engine Lubricating Oil System

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Abstract: *With the continuous development and progress of science and technology, aviation has also begun to become an important field related to public life. Aviation is no longer only related to national defense, but also has entered public life. Once an aircraft has a problem, it will bring devastating damage, so it is necessary to eliminate the danger as much as possible and reduce the potential accident. The aviation piston engine oil system has an important impact on the safety of piston type aircraft. Studying the fault problems of this system is very necessary for troubleshooting and improving aviation safety. This article introduces the aviation piston engine oil system, explains its common faults and causes, and explores the troubleshooting countermeasures for the aviation piston engine oil system.*

Keywords: *Aviation; Piston Engine; Lubricating Oil System; Fault*

1. Introduction

Currently, there are various types of piston type aircraft, but their operating principles are basically the same. The piston engine oil system of aircraft is prone to failure, and once a failure occurs, the cause is difficult to find and repair. Therefore, it is necessary to study the fault problems and causes of the aviation piston engine oil system to provide some ideas and references for effective troubleshooting.

2. Overview of aviation piston engine oil system

The lubricating oil system is mainly used to provide lubricating oil for the mechanical tissues of aviation piston engines that require lubrication and cooling. It aims to reduce the friction generated during engine mechanical operation through lubrication and effectively reduce the problem of engine energy loss caused by friction [1]. In terms of the role of the lubricating oil system, it mainly includes the following points:

First, lubrication. The function of the lubricating oil system is to continuously provide lubricating oil with suitable viscosity for engine bearing shells, tappet bodies, gears, etc. during engine operation, thereby reducing wear issues caused by mechanical friction, which is crucial for extending the service life of the engine.

Second, the cooling effect. During long-term operation of the engine, it can cause the surrounding machinery to heat up due to friction. This local temperature rise can reduce the operating efficiency of the engine, while the continuous transmission of lubricating oil to corresponding cold parts can play a cooling role, in order to keep the engine bearings and gears in a normal temperature state, and ensure their normal operation [2].

Third, anti-corrosion effect. During the operation of an aviation piston engine, it is inevitable that it will come into contact with the surrounding air and water vapor, which can easily lead to continuous corrosion of the internal metal of the engine and shorten the service life of the engine. Using the lubricating oil system, it can form a protective film on the surface of the engine, so as to block the impact of air and water vapor on it, and achieve a certain anti-corrosion effect, which plays an important role in extending the service life of the engine.

Fourth, sealing. We should prevent the piston from leaking during movement, so as to prevent the working mixture and gas from entering the gearbox, resulting in a decrease in engine power and deterioration of the lubricating oil.

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Fifth, keeping the machinery clean. When the engine is operating, harmful substances such as carbon particles, oil fumes, worn metal chips, mechanical impurities, and dust generated due to incomplete combustion can enter the lubricating oil. Excessive amounts of these substances can affect lubrication. Therefore, lubricating oil should have the property of not allowing these impurities to deposit on the metal surface and float in the lubricating oil, and take it away by its own flow. This is equivalent to cleaning the machine parts.

Sixth, as the working fluid of the regulating system. In propeller aircraft, it is mainly used as a variable pitch working fluid.

3. Fault analysis of aviation piston engine lubricating oil system

The lubricating oil of the piston type engine is stored in the oil sump at the lower part of the engine gearbox. When the engine is running, the engine driven gear type lubricating oil pump pulls the filtered lubricating oil through the filter screen (coarse) out of the sump and pressurizes it. After being filtered by the main oil filter (paper filter element), it reaches the main oil passage cast on the gearbox. A radiator and a thermostatic bypass valve are also installed between the oil pump outlet and the main oil filter. When the oil temperature is relatively low, the thermostatic bypass valve opens, and some of the oil passes through the radiator to the main oil filter (the other directly to the main oil filter). When the oil temperature is too high, the thermostatic bypass valve closes, forcing the oil to pass through the radiator and then to the main oil filter. The lubricating oil that reaches the main oil passage lubricates the main bearings, tappet bodies, camshafts, and other components. The lubricating oil entering the main bearing enters the large end bearing of the connecting rod along the oil passage in the crankshaft. The lubricating oil flowing from both ends of the connecting rod journal is thrown to the cylinder wall, piston, tappet body end face, camshaft crest, and other friction surfaces by the rotary motion of the crank for lubrication. The lubricated lubricating oil returns to the oil collecting tank by gravity for the next cycle: the lubricating oil entering the tappet body passes through the plunger and push rod, and then reaches the valve rocker arm. After reaching the rocker arm, the lubricating oil is divided into two paths: one path lubricates the rocker arm shaft, and the other path lubricates the valve assembly through the oil hole at the front end of the rocker arm. The lubricated lubricating oil flows by gravity through the return pipe to the oil pool for the next cycle. The following is an analysis of the failure of the aviation piston engine lubricating oil system to explore the failure problems and solutions.

3.1. Lubricating oil pressure fault and its treatment

It is necessary to ensure that the lubricating oil in the aviation piston engine lubricating oil system smoothly reaches the surface of corresponding mechanical components of the engine and that the lubricating oil system maintains a certain pressure. However, during the operation of the aviation piston engine lubricating oil system, the pressure of the lubricating oil system often fails. For example, when the outside air temperature is low, the viscosity of the lubricating oil is high, resulting in high lubricating oil pressure. In this case, the oil passage is prone to blockage, which can lead to reduced mechanical lubrication effect. In severe cases, it can also cause mechanical wear and burning, leading to abnormal engine operation. If the lubricating oil pressure is low, it will cause the lubricating oil to not flow out normally, which can easily lead to poor lubrication effect on the mechanical surface, leading to serious mechanical wear.

This is a pressure failure problem in the lubricating oil system of an aviation piston engine. During processing, relevant personnel need to use the pressure sensor of the lubricating oil system to check if there is a high lubricating oil pressure. If there is a high lubricating oil pressure, they should investigate the adjustment of the lubricating oil pressure relief valve, the quality of the lubricating oil, and the blockage of the oil circuit one by one, accurately analyze the influencing factors of the high lubricating oil pressure, and carry out targeted maintenance measures. If it is detected that the lubricating oil pressure is too low, it is necessary to check the condition of the lubricating oil temperature sensor to see if there are problems with excessive lubricating oil temperature, oil pump problems, pressure gauge failures, etc. Finally, we can check the pressure regulation of the regulating and relief valve of the lubricating oil system to ensure that the pressure regulation is within a reasonable range and avoid unreasonable pressure regulation causing changes to the lubricating oil pressure.

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3.2. Oil system sensor failure

In order to monitor the operating status of the lubricating oil system, it is necessary to use temperature sensors, metal detectors, pressure sensors, etc. to monitor whether there are abnormalities in the operation of the lubricating oil system. If these sensors fail, relevant personnel may not be able to grasp the true operating status of the lubricating oil system in a timely manner, which may lead to the burning of engine components and severe wear, and also has an impact on the service life of the engine.

In dealing with sensor failures in the lubricating oil system of an aviation piston engine, it is important to clarify that the relevant sensors can effectively monitor the operating status of the lubricating oil system. If there is a problem with the sensor itself, it can lead to monitoring failure and inaccuracy, which is not conducive to timely detection of lubricating oil system problems. In a lubricating oil system, sensors are generally installed in the oil return circuit of the system, and their main role is to detect the working conditions of engine equipment and engine wear. If this detector fails during use, it may cause navigation personnel to be unable to grasp the lubricating oil outflow from the engine, which may lead to serious engine wear and tear that cannot be detected in a timely manner, seriously affecting the service life of the engine. Therefore, relevant maintenance personnel need to regularly inspect the operation of the sensors of the lubricating oil system to ensure that the sensors of the lubricating oil system remain in optimal working condition.

3.3. Excessive oil consumption

To ensure the orderly operation of the aviation piston engine lubricating oil system, if the lubricating oil cannot effectively bring local cooling effect after flowing into the corresponding mechanical position, it will cause the temperature of the lubricating oil and the mechanical temperature to rise at the same time, which will cause the engine to be unable to operate normally. At this time, the viscosity of the lubricating oil also continuously decreases, and the lubricating oil pressure continues to decrease, ultimately affecting the operation of the engine. If the temperature rises too fast, the consumption of lubricating oil is large, and it may also cause the engine to lock up and stop, resulting in unimaginable consequences.

To address the problem of excessive fuel consumption in the aviation piston engine lubricating oil system, considering that the consequences of this problem may be relatively serious, it is necessary to understand the reasons for high fuel consumption. Currently, during the operation of the aviation piston engine lubricating oil system, the reasons for high oil consumption in the lubricating oil system include: unreasonable use level of lubricating oil, piston ring wear and improper installation, valve guide sleeve wear, and the lubricating oil filler cap not being properly covered, which are all factors that cause high oil consumption in the lubricating oil system. Therefore, during the maintenance of the lubricating oil system, relevant personnel need to pay attention to the inspection of engine mechanical wear, timely inspection of the lubricating oil filler cap and control of these factors that may lead to increased fuel consumption can effectively prevent the occurrence of high fuel consumption issues.

3.4. Internal wear of the lubricating oil system

During the operation of the aviation piston engine lubricating oil system, certain wear problems inevitably occur, and these problems accumulate over time and may continue to increase, leading to severe internal mechanical wear of the engine and lubricating oil system. This wear can affect the operating efficiency of the engine. From the perspective of internal wear of the lubricating oil system, the main reason is that impurities accumulate in the lubricating oil, resulting in clogged oil passages in the lubricating oil system. This can exacerbate engine wear and shorten the service life of the engine.

For the treatment of severe internal wear in the lubricating oil system of aviation piston engines, during the maintenance of the lubricating oil system, relevant personnel should do a good job in cleaning the lubricating oil system, and add corresponding grades of lubricating oil according to the lubricating oil system standards to prevent the use of substandard lubricating oil. Secondly, it is necessary to reasonably use metal detectors, which can effectively prevent debris from entering the lubricating oil system. It is also necessary to regularly inspect and replace the lubricating oil filter, which can effectively understand the wear degree of the engine machinery.

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4. Safeguarding measures for fault handling of aviation piston oil system

4.1. Developing maintenance system for lubricating oil system

We should provide necessary system specifications and systematic work guidance for relevant maintenance work through the development of the lubricating oil system management system. Judging from the current causes of some lubricating oil system failures, they are largely related to unreasonable use methods and unscientific maintenance methods. Therefore, there is an urgent need to establish a complete lubricating oil system management system. To ensure the perfection of the system, it is necessary to do a good job in the construction and improvement of its own rules and regulations. Only with scientific rules and regulations constraints and guidance can the lubricating oil system maintain the optimal operating state and reduce the occurrence rate of lubricating oil system failures. Regarding the management system for loading and unloading machinery and the working environment, equipment management and daily maintenance system, equipment acceptance technical standards, and other regulations and systems, it is required that each unit establish and improve the equipment management system together with the equipment competent department, publicize and implement various rules and regulations for the use, maintenance of equipment and facilities, inspect and guide the operating staff to implement the equipment safety operation regulations, in order to promptly prevent and correct illegal operations command against regulations, improve the technical equipment level of the lubricating oil system, and maximize the system effectiveness.

4.2. Strengthening training to improve fault handling ability

In order to further improve the professional level of field oil system maintenance personnel, it is necessary to actively organize them to carry out business training on troubleshooting of aviation piston engine oil system. Through a comprehensive training system, relevant staff can learn and grasp the maintenance and management knowledge of the lubricating oil system in a timely manner, so that key management personnel can learn and master the basic content, methods, and requirements of troubleshooting and maintenance of the lubricating oil system, understand the main problems in maintenance management, and strengthen the management and assessment of the lubricating oil system in response to the problems. Through training and communication, we can effectively enhance the business integration and emotional communication of maintenance personnel, improve the maintenance and handling ability of airport maintenance personnel for aviation piston engine oil system failures, and improve business skills, so as to promote the maintenance level of aviation piston engine oil system at airports to a new level.

5. Conclusion

This article introduces some common faults and troubleshooting methods of aviation piston engine oil system, which can provide some ideas and references for troubleshooting aviation piston engine oil system.

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