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Original Paper

Research on Fault Diagnosis Methods for Emulsion Pump

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Abstract

During the operation of emulsion pumps, it is inevitable that some mechanical failures may occur. The more serious and frequent components are crankshaft fracture and rolling bearing failure, which can affect the safety and reliability of the emulsion pump once they fail. Therefore, this article describes the symptoms of common faults in emulsion pumps, analyzes their causes, and proposes corresponding improvement measures. At the same time, combining modern diagnostic methods to diagnose faults such as crankshaft fracture and rolling bearing failure, in order to prevent unnecessary mechanical accidents from occurring. And according to the different usage environments and faults of its parts, appropriate diagnostic methods are adopted to prevent emulsion pump failures and improve production efficiency.

Keywords

Emulsion pump, Diagnostic testing

1. Background Analysis

The most basic purpose of a pump is to transport fluids or pressurize fluids as a mechanical device. It converts mechanical energy into pressure energy of a liquid, thereby increasing the energy of the liquid. The pump can not only transport water, oil, emulsifiers, mixed liquids, etc., but also transport media that mix liquid and gas.

In the classification of pumps, they can be roughly divided into three categories based on their working principles: other types of pumps, positive displacement pumps, and power pumps. In addition to categorizing various types according to the principles of work, other methods can also be used to classify and name them. For example, according to the driving method, pumps can be roughly divided into two types: electric water turbine pumps and wind turbine pumps. According to the transportation working medium, it is divided into three categories: mixed liquid pump, water pump, and oil pump. According to whether the pump has a shaft mechanical structure, it can be roughly divided into two types: linear pump and traditional pump (Zhu, 2022).

Emulsion pump is one of the many types of volumetric pumps. It is usually widely used on the working surface of coal mining, mainly to provide a large amount of emulsion for hydraulic supports, which are used to support the roof. The purpose is to provide a certain position and space for the entire coal mining engine during coal mining operations, thereby effectively preventing the collapse of the roof.

The normal operation of the emulsion pump depends on whether the safety maintenance operation is in place. And it has always been the main source of power in China's coal mining industry, capable of converting mechanical energy into hydraulic energy. So, emulsion pumps occupy a very large proportion in domestic and foreign mine operations. In coal mines, choosing to use emulsion pumps requires enduring harsh weather conditions and complex construction conditions. As the working hours gradually lengthen, the emulsion pump will continue to run.

2. Common Mechanical Fault Diagnosis Methods

2.1 Traditional Diagnostic Methods for Mechanical Faults

Due to the combination of the fault diagnosis theory and technology of mechanical parts in the new era with modern development, new signal detection and processing technologies, relevant scientists and researchers have roughly divided their diagnostic techniques into two categories. The first type is traditional diagnostic techniques.

1. The term "ear listening" is the most common diagnostic technique in traditional judgment. By distinguishing the sound, it is possible to roughly determine the working condition of bearing components and gear machine components, and even identify any internal leakage or other faults in the unloading valve.

2. "Hand touch": It mainly refers to the operator's ability to understand the strength and magnitude of vibration, whether there is pulsation, and the temperature through hand touch. For example, when we need to detect and judge the vibration of a water pump, we can observe the magnitude of the horizontal and vertical vibration amplitudes through human touch, in order to identify whether there are faults such as horizontal pressure pulsation caused by the sealing or damage of the water pump. When accurately detecting and judging the relationship between the temperature of a box and the temperature of other emulsions and other substances, it is to use a small nail on the back of a person's hand and fingertip as a probe, and then generate corresponding temperatures based on different senses.

3. "Eye": It refers to the simple inspection of whether the devices of each mechanical component are intact, whether there are deformation, cracks and other faults on the mechanical parts, whether the display of various mechanical instruments is normal, whether there is dripping caused by poor sealing, and whether there are corresponding changes in paint color caused by temperature changes before mechanical operation and startup.

4. "Nose" refers to the special odor that can be detected and smelled at any time through our sense of smell in the natural air dispersed indoors due to electrical equipment failures, such as the gasoline tar smell caused by the deterioration of indoor lubricating oil at too high a temperature.

2.2 Traditional Diagnostic Methods are Relatively Simple and Have Significant Limitations

1. Whether there is a malfunction in the internal parts of the pump body cannot be prevented in advance before it occurs.

2. When judging the temperature of the box and the temperature of the emulsion, it is necessary to feel the temperature with your hands, which has a certain degree of danger.

3. Moreover, for traditional diagnostic methods, novices born in the thatched cottage generally cannot achieve effective diagnosis due to lack of relevant practical experience. So in the diagnostic methods of mechanical parts, we need a new type of diagnostic method to meet the needs of modern mechanical industry development.

3. Modern Diagnostic Methods for Mechanical Faults

3.1 Vibration Signal Diagnosis Method

The vibration signal diagnosis method has a wide range of applications because it can detect faults more accurately and earlier. It is to install vibration sensors at appropriate locations where parts need to be monitored or diagnosed, making it convenient to collect vibration signals of parts and analyze and process them to determine whether relevant parts have malfunctioned.

There are two main methods for diagnosing vibration signals of parts. One is a simple diagnostic method, and the other is an accurate diagnostic method.

Simple diagnosis mainly involves pre determining the presence or absence of faults, while accurate diagnosis mainly determines the type and cause of faults based on the results of simple diagnostic methods. Simple diagnostic methods include amplitude value judgment, shape factor judgment, peak factor judgment, and kurtosis coefficient judgment. The most commonly used amplitude value judgment method. Mainly comparing the actual measured amplitude value with the judgment reference value. The waveform coefficient determination method refers to the ratio of peak to average value. If the ratio is a bit high, it means that the bearing is slightly corroded. If the proportion is too small, it indicates that it is a bit worn out.

3.2 Acoustic Emission Diagnostic Method

Acoustic emission diagnosis mainly refers to the deformation and failure of object defects or abnormal parts caused by stress concentration caused by external forces, and these strains can be released in the form of elastic waves. For example, as the rolling bearing rotates, the damaged part of its cage will experience friction and collision with the rolling elements and the inner and outer raceway surfaces, resulting in sound radiation. It has the following advantages:

1. The frequency spectrum features are relatively clear and the spectrum is relatively wide. And in the high-frequency range, the characteristics usually exceed several tens of kilohertz, so it plays an important role in anti-interference.

2. Under the same load, if small cracks occur and it is necessary to predict the fault as early as possible, the vibration is not very obvious. The use of acoustic emission monitoring method can accurately and

sensitively reflect the real-time situation of parts. So when using acoustic emission to monitor the operation of bearings, it has an advantage over vibration.

The acoustic emission method has some drawbacks: when the electrical signal output from its sensor is used to check the changes in internal defects of the part structure, it is more complex and often requires rich knowledge of other testing methods (Yao, Zhou, & Yang, 2003).

3.3 Local Temperature Diagnosis Method

The local temperature diagnosis method is to monitor the temperature of the parts to determine if they are operating abnormally. If the relevant parts are damaged, their temperature will continue to change. The local temperature diagnosis method was actually adopted early on because there were no other good diagnostic techniques available at that time. Moreover, its diagnostic method is relatively simple and practical, so it also plays a certain role in the diagnosis of mechanical parts.

The main drawback of local temperature detection methods is that they are not suitable for early detection of parts. Because when there is a significant change in the temperature state of the parts, the relevant mechanical parts may have been damaged. The temperature monitoring of parts is relatively easy to measure, but the error is relatively artificial, so we started using auxiliary detection. For example, a temperature indicator. In order to prevent irreparable damage to some critical equipment, scientific researchers have introduced parameters measured by part temperature into relevant control systems, thereby increasing their automatic protection function and sound and light alarm function.

4. Conclusion

Although emulsion pumps are not commonly used in daily life applications, they are indispensable in the mining industry and deep well operations. It is an energy conversion device that can convert mechanical energy into hydraulic energy, thereby delivering high-pressure emulsion to the hydraulic support or single hydraulic pillar of the comprehensive coal mining working face, achieving the support of the roof and achieving a safe working environment. During the operation of the emulsion pump, the related mechanical parts are also severely damaged and replaced, which not only affects work efficiency and output, but also causes personal safety issues for workers. So the research in this article starts from the direction that damage to the crankshaft parts of the emulsion pump can lead to serious consequences, and frequent damage to the rolling bearings can lead to reduced efficiency. By using modern advanced mechanical component diagnosis methods to monitor the operation process of its parts in real time, it can achieve the goal of improving the work efficiency of the machinery and ensuring output while ensuring a safe working environment for operators.

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