Vol-05 Issue 12, December - 2021 ISSN: 2456-9348
Impact Factor: 5.004

International Journal of Engineering Technology Research & Management

# A STUDY ON FAILURE OF EXCAVATOR HYDRAULIC PISTON PUMP

Hidayat Hidayat*1
Abdul Muis2
Abdul Halik3
Darma Aviva4
Minir5
*1,2,3,4Mechanical Engineering Department, Politeknik Negeri Samarinda, Indonesia

**ABSTRACT**
Hydraulic pump failures might be attributed to either hardware or an oil quality issue. The failures of excavator hydraulic pumps were explored in this study utilizing visual observations and component measurements. The pump was disassembled in accordance with the manual part book for the excavator hydraulic pump. By comparing the criteria for the reusable component to the abrasive wear on the pump slipper and swash plate, the abrasive wear on the pump slipper and swash plate was determined. The clearance between the piston and cylinder bore was tested and found to be more than the permitted limit as specified in the manual part book. Analyzing component failures properly can yield useful information about what caused the failure and how to prevent it in the future.

**Keyword:** Hydraulic, cylinder, Kalimantan, piston, Caterpillar.

## INTRODUCTION

Positive displacement pumps and non-positive displacement pumps are the two types of pumps. Hydraulic pumps are a type of positive displacement machine used in fluid applications to supply hydraulic fluid to devices such as heavy machinery, heavy vehicles, and tractors. Hydraulic power is used to move booms, arms, and buckets on large construction or mining equipment such as excavators. It is frequently possible for the primary equipment in small-scale mining to fail owing to hydraulic system failure. A hydraulic pump failure can be attributed to a variety of issues, including poor system design, the use of low-quality fluid, and inadequate contamination management.

Numerous researchers have been reported on the failure analysis and diagnostics of hydraulic pumps. A approach for diagnosing faults in intelligent hydraulic pumps that incorporates a non-linear unknown input observer was proposed [1]. The strategy was critical in enhancing the system's reliability. The alternative way is to use a vibration signal to diagnose a ball bearing in a hydraulic pump for maintenance [2]. A approach for analyzing the engineering-driven performance deterioration of hydraulic pumps that takes the nature of mechanical wear into account has been developed [3]. Another study examined the early detection of hydraulic pump failures, which are at the heart of hydraulic tube testers [4]. The results indicate that the proposed approach is capable of detecting the hydraulic pump signal. A study was conducted on the causes, reasons, and solution for the effects of exaggerated elastic deformation and fracture, such as the slipper and retainer, which result in the axial piston pump losing performance [5]. A study has been conducted [6] on the thermoelastic deformation mechanism of the slipper retainer as shown by its deformation and fracture. A method for analyzing the swash plate's wear behavior based on the elastohydrodynamic lubrication model was proposed [7]. A novel intelligent defect diagnostic scheme was proposed [8]. It is based on a variety of signal processing techniques. A study describes the development of a mathematical model of a hydraulic axial piston pump in order to replicate the dynamic behavior of the swash plate in PHM applications [9].

According to earlier research released by other researchers, there is no study on hydraulic pump failure on primary equipment such as an excavator. The goal of this research is to look at the breakdown of a hydraulic pump on large mining equipment, specifically an excavator. The hydraulic pump was disassembled in order to assess the quality of internal components such as the piston, retainer, and cylinder block. All components were examined visually or by measuring their dimensions using the manual part book as a guide.

iJETRM
International Journal of Engineering Technology Research & Management

**METHODOLOGY**

The hydraulic pump used in this study came from a Hitachi 1200-6 excavator. This excavator is a revolutionary hydraulic excavator that utilizes Hitachi's most recent technological advancements. The Hitachi 1200-6 excavator was designed and built for use in significant projects such as mines and civil engineering construction. The engine's specifications are listed below.

| | | |
|---|---|---|
| Merk | : | Hitcahi Zaxis 1200-6 |
| Serial Number | : | 10Z10536 |
| Model | : | CumminsQSK23 C |
| Cylinder | : | 6 Cylinder, inline |
| Fuel System | : | Direct Injection Type |
| Firing Order | : | 1-5-3-6-2-4 |
| Speed | : | 1800 rpm |
| Oil Engine | : | 18.5 gal |

Firstly, a failure study of the hydraulic pump was conducted by removing and reassembling components to see whether they were still useful or needed to be replaced. Secondly, the component was measured using the manual part's specification range measurement.

2.2 Observation (Visual and Measurement)

The hydraulic pump disassembly was carried out in accordance with the procedure outlined in the manual part book. Disassembly of the hydraulic pump component required the use of specialized tools.

Figure 1. Disassemble Hydraulic Pump Component

Figure 1 shows the disassemble hydraulic pump component. The component of the hydraulic pump was released by using some special tool kit. Then, the swash plate which is used as controller oil flow to the system, was removed from the top surface of the hydraulic pump. Then, the plunger was removed from the cylinder block located inside the hydraulic pump.

Figure 2. Cylinder Block

iJETRM
International Journal of Engineering Technology Research & Management

The cylinder block in which component of the hydraulic pump used as a house of the driven shaft is shown in figure 2. The cylinder block is also used to compress the oil by plunger and barrel so that the oil from the hydraulic pump has high pressure. Finally, removed all spring which located under the housing of plunger. All components inside the hydraulic pump were investigated by measurement or visual inspection. Measurement of component is the process of observing and recording the observations collected as part of this research. The component was measured to compare with the manual part book in order to define that the component is still reusable or not. As for the visual inspection, the condition of the component was observed by viewing or touching, considering the manual parts book.

## RESULTS AND DISCUSSION

The abrasion on the piston pump is depicted in Figure 3. Abrasive wear happens most frequently when a hard, rough surface glides across another. In this situation, abrasive wear occurs in this location as a result of contact between the slipper and the swash plate. The swashplate axial piston is a type of hydraulic pump that is frequently employed in heavy equipment. High pressure operation combined with obstruction between the valve plate and the cylinder block results in abrasive wear on the piston pump's slipper.

Figure 3. Abrasive wear on piston pump slipper

The cracking on the slipper retaining plate is depicted in Figure 4. Generally, the slipper retainer cracks as a result of the slipper becoming lodged in the cylinder block. The axial motion of the slipper retainer is related to the piston and cylinder block components.

Figure 4. Cracking on slipper retainer plate

The abrasive wear on the swash plate is seen in Figure 5. The rotator group of the hydraulic pump includes the swash plate as one of its components. The swash plate angle controls the displacement of an axial piston pump. Abrasive wear is the most prevalent cause of failure with swash plates. The piston's slipper glides across the swash plate's surface. Despite the fact that the piston's slipper is formed of the same steel as the swash plate, there is no carbide separation, and wear is caused by fluid contaminants.

iJETRM
International Journal of Engineering Technology Research & Management

Figure 5. Abrasive wear on a swash plate surface

It was determined how much space there was between the piston pump and the cylinder bore. According to the manual part book, the maximum clearance is 0.94 mm. Then it was discovered that the distance between the piston and the cylinder bore was greater than 1.07 mm. Table 1 shows the clearance measurement results within the cylinder bore. Pump performance improved as nominal clearances between the rate and stroking piston-cylinder pairs were increased. In this scenario, a further rise in clearance within the cylinder bore and piston pump has shown that the pump's performance has deteriorated significantly.

## CONCLUSION

Visual inspection and measurement of each part of the excavator hydraulic pump were used to explore the failure analysis. The visual check of the pump was done with the help of the dealer's manual part book. Oil pollution, blocked or restricted pump inlet, low oil level, and pump case over-pressurization are the most prevalent causes of hydraulic pump failure.

## REFERENCES

[1] M. A. Zhonghai, W. Shaoping, S. H. I. Jian, L. I. Tongyang, and W. Xingjian, “Fault diagnosis of an intelligent hydraulic pump based on a nonlinear unknown input observer,” Chinese J. Aeronaut., vol. 31, no. 2, pp. 385–394, 2018.
[2] T. Kim, Y. Jeon, and M. G. Lee, “A Study on Failure Diagnosis System for a Hydraulic Pump in Injection Molding Machinery Using Vibration Analysis,” J. Korean Soc. Manuf. Technol. Eng., vol. 22, no. 3, pp. 343–348, 2013.
[3] Z. Ma, S. Wang, H. Liao, and C. Zhang, “Engineering-driven performance degradation analysis of hydraulic piston pump based on the inverse Gaussian process,” Qual. Reliab. Eng. Int., vol. 35, no. 7, pp. 2278–2296, 2019.
[4] Z. Zhao, M. Jia, F. Wang, and S. Wang, “Intermittent chaos and sliding window symbol sequence statistics-based early fault diagnosis for hydraulic pump on hydraulic tube tester,” Mech. Syst. Signal Process., vol. 23, no. 5, pp. 1573–1585, 2009.
[5] G. Haidak, D. Wang, and E. L. E. Awong, “Modelling of deformation and failure of slipper-retainer assembly in axial piston machine,” Eng. Fail. Anal., vol. 111, p. 104490, 2020.
[6] G. Haidak, D. Wang, and E. Shiju, “Research on the thermo-elastic deformation and fracture mechanism of the slipper retainer in the axial piston pumps and motors,” Eng. Fail. Anal., vol. 100, pp. 259–272, 2019.
[7] J. Ma, J. Chen, J. Li, Q. Li, and C. Ren, “Wear analysis of swash plate/slipper pair of axis piston hydraulic pump,” Tribol. Int., vol. 90, pp. 467–472, 2015.
[8] Y. Lan et al., “Fault diagnosis on slipper abrasion of axial piston pump based on extreme learning machine,” Measurement, vol. 124, pp. 378–385, 2018.
[9] A. Bedotti, M. Pastori, F. Scolari, and P. Casoli, “Dynamic modelling of the swash plate of a hydraulic axial piston pump for condition monitoring applications,” Energy Procedia, vol. 148, pp. 266–273, 2018.