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CRACK ANALYSIS OF CRANKSHAFT FOR DIESEL ENGINE

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Preliminary Note – Prethodno priopćenje

The cause of crankshaft fracture crack of a certain vehicle has been analyzed through macroscopic analysis, microstructure analysis, mechanical properties test and dimension inspection. The analysis results show that: the fatigue strength of the crankshaft is reduced due to spheroidization recession, low strength and shallow nitriding layer of the fillets.

Keywords: engine; crankshaft; crack; microstructure; mechanical properties

INTRODUCTION

The crankshaft is an important part of the engine and the key part of engine power transmission. It can be said that the quality of the crankshaft determines the service life of the engine. So it plays an important role in improving crankshaft processing technology and improving crankshaft performance to study the crankshaft fracture crack. There are three broken crankshafts made of qt900-3 in an engine company. The strengthening process of crankshaft is ion nitriding. The fracture diagram of one crankshaft is shown in Figure 1.

In this paper, the causes of fracture of the crankshaft are found out through a series of analysis and inspection, including macroscopic analysis, microstructure analysis, mechanical property test and dimension inspection. It can be determined that the cause of crankshaft fracture crack is the combined effect of spheroidization recession, low strength and shallow nitriding layer of the fillets.

MACROSCOPIC ANALYSIS

The three crankshafts were broken all at the one and three cranks of the crankshafts. By observing the fracture crack areas of the crankshafts, the crack sources of the three crankshafts are all at the connecting rod fillets. The fracture surface of the first two crankshafts are rough, with a small amount of radial fatigue cracks, showing brittle cleavage fracture. The fracture surface of the third crankshaft is relatively fine, with obvious fatigue striation, and the surface of the fracture sources is severely worn, which is a typical fatigue fracture. Therefore, of crack source by using wire cutting. Both of these two cracks are fatigue fracture. The macroscopic fracture diagram of crankshaft is shown in Figure 2.

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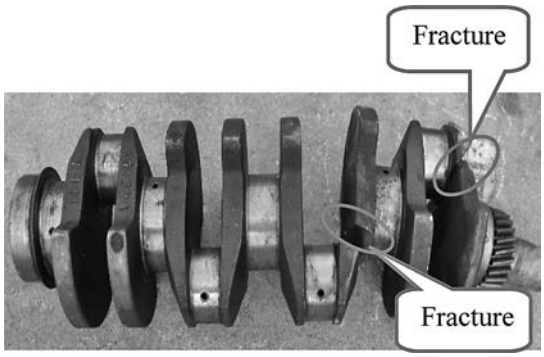

Figure 1 The fracture diagram of crankshaft

MICROCOSMIC ANALYSIS

The specimen was cut at the position. Then, detected the vertical plane of crack source according to "GB/T 9441-2009 metallographic examination of ductile iron." The detecting device was Olympus GX71 metallographic microscope.

The results showed that the graphite spheroidization level near the fracture of the crankshaft was level 5. The diameter of graphite ball was 5 grades. The diameter content was 95 %. There is no cementite phosphorus eutectic at the fracture crack location. The nitriding infiltration layer of the fillets was 0,1 and the nitriding infiltration layer of the journal was 0,2 as shown in Figures 3, 4,5,6 and Table 1.

From the microstructural picture and detection value, Spheroidization of the crankshaft is not uniform, the graphite ball is larger, the nitriding infiltration layer of the rounded corner is shallow, lower than the technical requirements.

MECHANICAL PROPERTY TEST

The tensile test and impact test were carried out on the crankshaft. According to the test results of mechani-

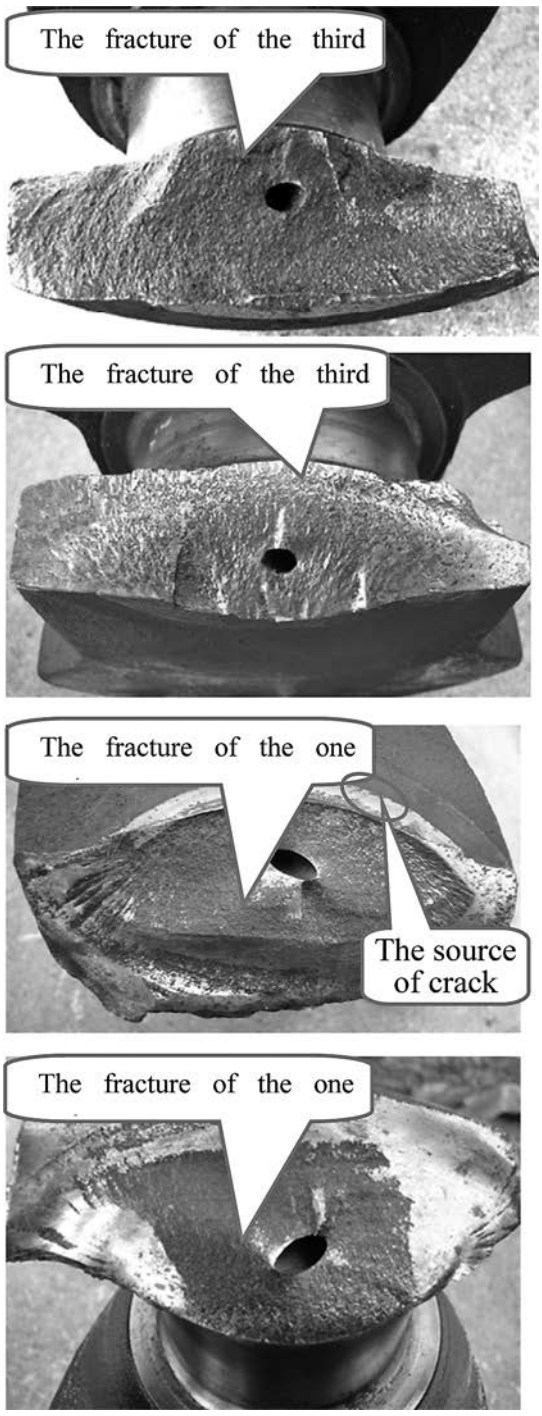

Figure 2 The macroscopic fracture diagram of crankshaft

cal properties in Table 2, the tensile strength of the crankshaft is low and does not meet the technical requirements, which is attributed to spheroidization recession. Other toughness and hardness meet the technical requirements.

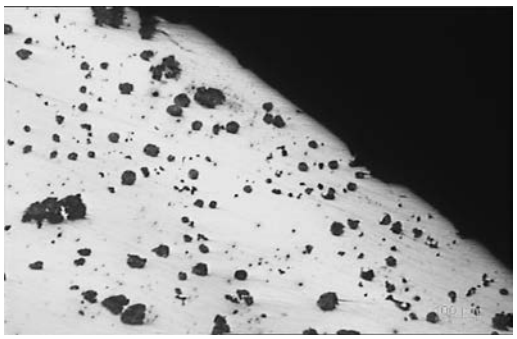

Figure 3 Graphite morphology on the surface of the fracture site.

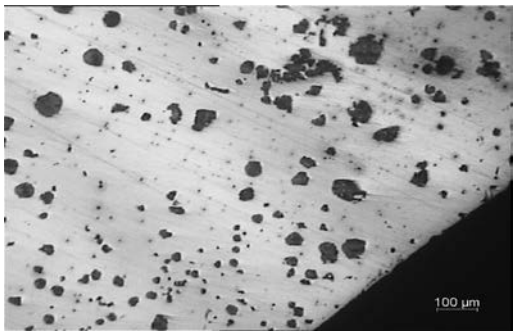

Figure 4 Graphite morphology on the surface of the fillet

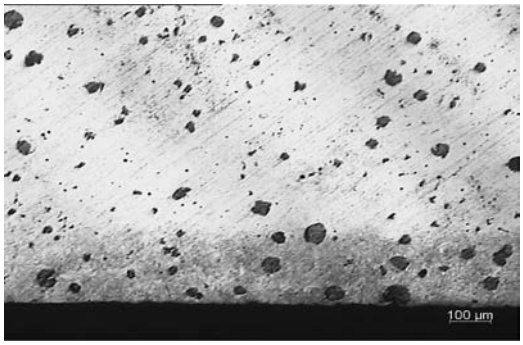

Figure 5 The nitriding layer of the journal

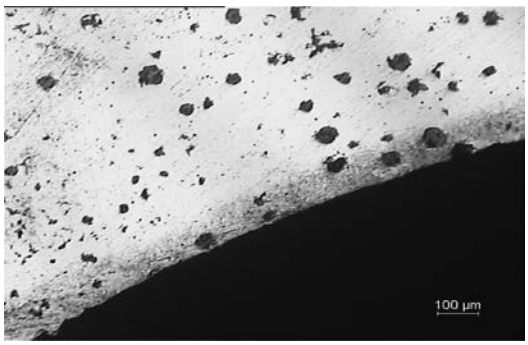

Figure 6 The nitriding layer of the fillet

Table 1 **Detection results of microstructure**

Item	The level of Spheroidizationlevel	The size of graphitelevel	Pearlite/%	Cementite /%
Detection result	5	5	95%	0
Technical Specifications	1–2	6–8	>85%	≤2
Item	Phosphorus eutectic/ %	The nitriding infiltration layer of the rounded corner/ mm	The nitriding infiltration layer of the journal/mm	
Detection result	0	0,10	0,20	
Technical Specifications	≤2	≥0,15		

Table 2 **Detection results of mechanical property**

	Tensile strength /MPa	Elongation/%	To attack/ J/cm^2	Hardness /HB
Detection value	869	3,2	33	288
Technical requirement	≥882	>3	>19,6	270–321

DIMENSIONAL INSPECTION

According to the size requirements of the drawings, dimensions of the crankshaft satisfied with the technical requirement.

CONCLUSIONS

Through the above cutting sample analysis, it is found that: Spheroidization of the crankshaft is decayed, Strength of the crankshaft is low, and the nitriding layer on the fillets of the crankshaft is shallow. Due to the combined effect of the three factors, the fatigue strength of the crankshaft decreases, which to a large extent leads to the fatigue fracture of the crankshaft during installation and use.

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Note: The responsible translator for English is Yanming Li, School of Applied Technology, University of Science and Technology Liaoning, Anshan, China