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Failure analysis of a diesel engine

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Abstract

This paper presents the failure analysis of a diesel engine with 16 cylinders in V and 592 liters of displacement that was used for electric power generation, which failed at 27,000 hours of service. The study was performed by visual inspection and macroscopic examination of fractured elements, from which it was determined that the origin of the failure was the fracture by fatigue of one of the four B3 cylinder crown bolts whose fracture propitiated the failure of the other three bolts, so that the crown fell into the cylinder combustion chamber blocking the displacement of the piston, generating the buckling and fracture of the piston rod. The chemical composition, Brinell hardness and microstructural analysis of the crown bolts determined that the fatigue of the B3 cylinder crown bolt was due to an excessive tightening torque during its installation process which generated high stresses that, together with a lower fatigue strength caused by a slightly lower hardness in the failed bolt, produced the crown bolt fracture.

Keywords: failure analysis; diesel engine; fracture mechanics.

1. Introduction

A diesel engine of 16 cylinders in V and 592 liters of displacement that was used for generation of electrical power failed to the 27,000 hours of service; according to the maintenance history, the services of the 1,500, 3,000 and 7,000 hours were made according to the manufacturer's recommendations. The engine failed shortly before the overhaul service it would receive by completing the 30,000 service hours.

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Nomenclature

σ_m	Ultimate stress in the rod
a	Crack size
FFS	Fitness for service
K_I	Stress intensity factor in mode I
K_{IC}	Fracture toughness
UTS	Ultimate tensile strength

2. Materials and methods

2.1 Visual inspection

The failure was located in one of the engine cylinders and caused the breakage of a large number of parts of that area, such as pistons, connecting rods, bolts and even the connecting rod broke the wall of the monoblock. Upon careful examination of the fractured fragments, it was observed that in the component called crown of the cylinder, it had the four fixing bolts fractured. By looking closely at the fracture surfaces of the bolts, three were found to be fractured by over-loading, ie, they broke suddenly and in one event, whereas a bolt presented an invoice identified as fatigue.

2.2 Fractographic examination.

The four bolts of the crown of the failed cylinder were taken to the laboratory for detailed study. In addition, two non-failed bolts of another cylinder were taken. Figure 2 shows the fractures of the cylinder bolts. The bolts 1, 2 and 4 have a rough fracture, with the fracture plane inclined respect to the longitudinal axis of the bolt and have plastic strain at the edge. These fractures are of the ductile type and are identified as stress-strain fractures. In contrast, bolt 3 exhibits a smooth and shiny fracture, with an abrupt transition to a fibrous and opaque fracture, in addition to presenting beach markings, which confirm that it is a fatigue fracture.

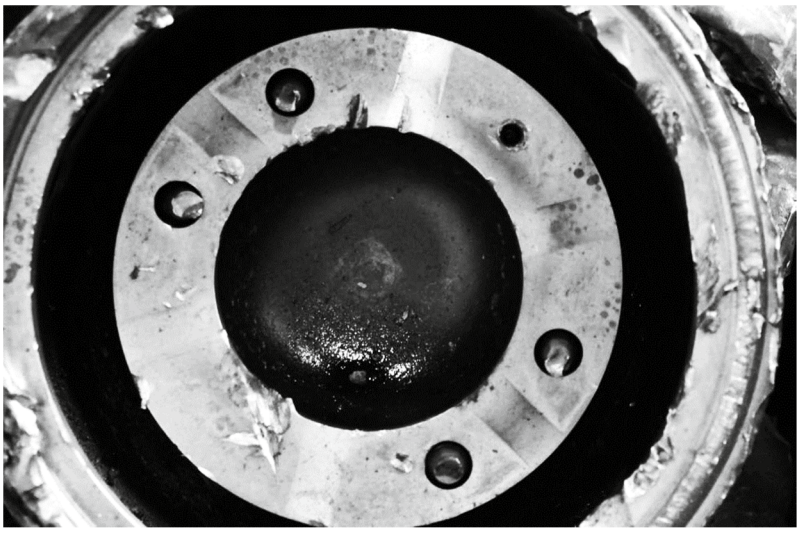

Fig. 1. View of the crown of the cylinder where the four fractured crown bolts are observed, the bolt indicated by the arrow shows a fatigue fracture, while the remaining three have an overload fracture.