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Analysis of the failure of an offshore compressor crankshaft

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ABSTRACT

During the inspection of a North Sea oil and gas platform a crack was identified on the crankshaft of a compressor.

Subsequently, the component was decommissioned and a failure examination undertaken to determine the mechanism of failure. The crankshaft was analysed using a range of inspection, measurement and fractographic techniques.

Magnetic particle inspection (MPI) indicated that the crack extended for the majority of the shaft's length, rotating through approximately 225 degrees of the shaft's circumference. Laser scanning verified the dimensions and concentricity of the crankshaft were in accordance with the manufacturer's specifications. On sectioning the crack and forcing it open, complex fracture features were revealed. Optical and scanning electron microscopy were used to examine these features as well as the surface of the crankshaft.

The investigation determined that the mechanism of failure of the crankshaft was probably corrosion fatigue, initiating from localised corrosive attack on the crankshaft's surface.

1. Introduction

Failures in the oil and gas sector can have a range of implications, impacting both business and safety. Consequently, it is important that failures are investigated with a view to preventing reoccurrence. Therefore, when an oil leak was detected on a compressor crankshaft, located on an offshore oil and gas platform, an inspection was performed. When inspected, a crack was observed on the surface of the crankshaft. The crankshaft had been in service, from new, for approximately 8 months. A failure examination and material analysis were carried out on the crankshaft to determine the mechanism of failure.

2. Visual examination

Fig. 1a and b shows a section of the crankshaft and hub in the as-received condition. The section of crankshaft consisted of a saw cut shaft section with a nominal diameter of 180 mm connected, via a crank web, to a longer shaft section with a machined end of nominal diameter 170 mm. A crack was evident in the longer shaft section.

The longer shaft section contained a keyway and a lubrication port. The keyway was 240 mm in length, with a depth of 17 mm and a width of 45 mm. The visual appearance of the crack, from the surface of the crankshaft, suggested that it may have propagated from the keyway spiralling along the section of shaft, in one direction, for 200 mm rotating through roughly 225 degrees of the shaft's circumference.

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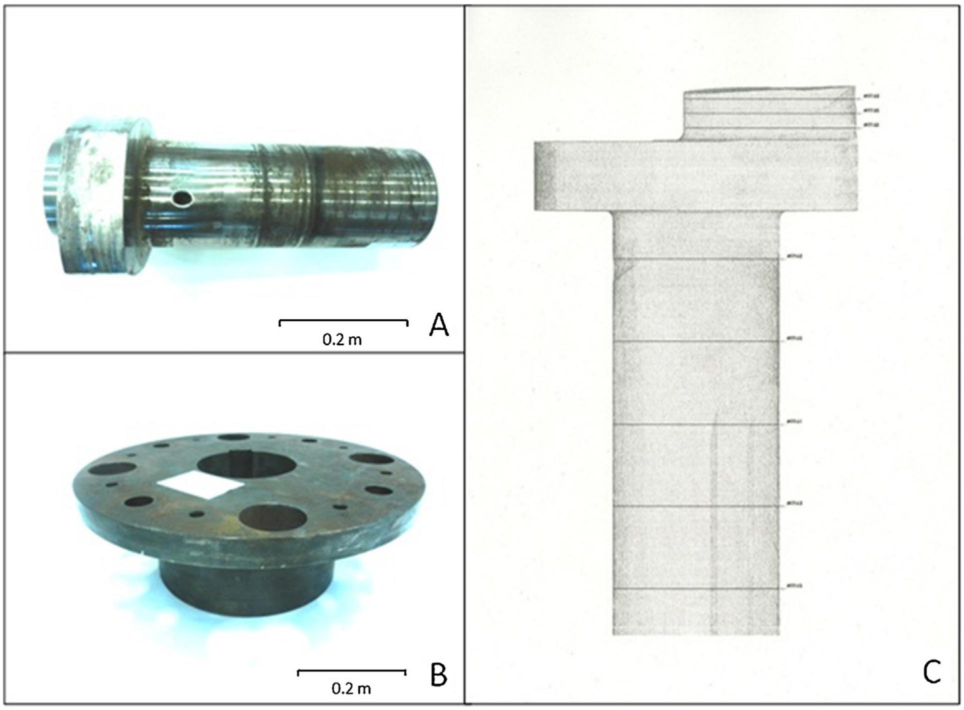

Fig. 1. (A) Section of crankshaft as received, (B) hub as received and (C) laser scan of the crankshaft showing the diameter measurements.

Deformation marks, including scoring and galling, were observed across the majority of the shaft's surface. An 18 mm wide circumferential band of plastic deformation, consistent with galling, was observed 290 mm from the shaft's machined end.

2.1. Laser scanning

The crankshaft and internal bore of the hub were scanned using a Romer Absolute Arm 7525SI. Laser scanning was undertaken to verify that the shaft and hub were concentric, and to determine if an out of balance force played a role in the shaft's failure. It was found that the shaft was concentric to within 0.04 mm along its length, i.e. there was no taper, Fig. 1c. The internal bore of the hub had a slight ovality of 0.058 mm.

2.2. Non-destructive inspection

Magnetic particle inspection (MPI) was used to determine the extent of cracking and to identify the location of the crack tips on the surface of the crankshaft, Fig. 2a. It could be inferred from MPI that the crack extended for the majority of the shaft's length, rotating through approximately 225 degrees of the shaft's circumference. The crack tips, at the surface of the

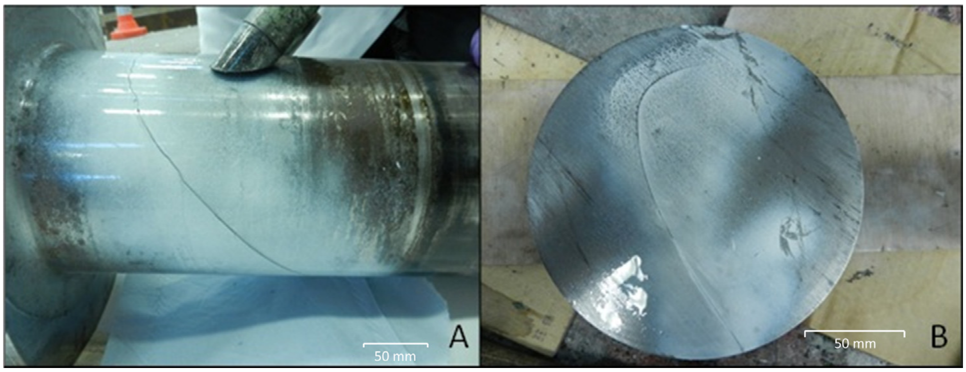

Fig. 2. (A) MPI of crankshaft surface showing extent of cracking and (B) section through crankshaft, showing extent of cracking.