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Failure analysis of the brass tubes in a lubricating oil cooler

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ABSTRACT

Failure analysis was carried out on leaked brass tubes of a lubricating oil cooler. Direct evidences of dezincification and stress corrosion cracking (SCC) were observed by scanning electron microscope (SEM) and energy dispersive spectroscopic (EDS) analysis. It is found that there are many small pits distributed on the fracture surface and EDS analysis revealed the occurrence of dezincification in the small pits. SCC was observed on the cross-sectional plane of the fracture by SEM. Ammonia test has proved the existence of residual stress in the as-received tubes. It is determined that the brass tubes have been suffered from the co-action between dezincification and SCC.

1. Introduction

A lubricating oil cooler are usually used to cool the hydraulic liquid of a hydraulic power assistance system. The cooler is shell and U-shaped tube type heat exchanger with hydraulic liquid on the shell side and seawater on the tube side.

Leaks occurred at two U-shaped sections of cooling brass tubes in the lubricating oil cooler. The performed analyses allow us to indicate the failure cause of the cooling tubes. The failed tubes were examined visually and by scanning electron microscope (SEM) and X-ray mapping, respectively. The results of these analyses are presented in this study.

2. Visual observation and experimental procedure

One of the failed cooling brass tube is shown in Fig. 1, it is apparent that there is a transverse crack at the U-shaped section of cooling brass tube and no evident corrosion phenomenon can be found on the outside of tube.

In order to find out the corrosion extent along the thickness direction of the wall, the cracked tube was cut along the direction perpendicular to the crack and the metallographic section plane of the fracture was obtained. SEM observations were performed on the surface and the cross-sectional plane of the fracture to detect the failure mode. The results will be shown in Sections 3.2 and 3.4, respectively. EDS analysis was made to identify the elemental composition of different corrosion regions. Meanwhile, elemental X-ray mapping was made on the cross-sectional plane of the fracture to determine the distribution of the elements Cu and Zn. In addition, ammonia test was performed to find out whether or not there is residual stress leading to the SCC.

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