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Fatigue Life Assessment of a Drilling Riser Containing Corrosion Pits

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Abstract

The residual fatigue life of a corroded riser joint can be evaluated by means of a fatigue analysis based on S-N data. In this case nominal stresses are determined through a global riser analysis in which the drilling riser is modeled as a tensioned beam subjected to loads throughout its length and with boundary conditions at each end. The effect of the corrosion defects is taken into account multiplying the nominal stresses by stress concentration factors derived by local Finite Element analyses of the riser joints containing corrosion defects.

In this paper the fatigue life assessment of a drilling riser containing corrosion pits is presented. These pits are situated on the external surface of the riser joints. Five depths of corrosion pits are considered: 12.6%, 20.1%, 30.2%, 40.3% and 50.3% of the riser wall thickness. Stress concentration factors are calculated using solid Finite Element models and the fatigue analyses are performed considering the wave loads and the vortex induced vibrations. The results show the possibility of operational life extension of riser joints that would have to be replaced according to the usual acceptance criterion.

Introduction

In order to assure the integrity of a drilling riser, inspection is required at various times during its life span [1]. After each retrieval, the drilling riser joints should be inspected for fatigue cracks and wall thickness reduction due to corrosion (or wear).

According to the API RP 16Q [1], the acceptance criterion to be applied to wall thickness reduction should be agreed upon between operator and drilling contractor. The usual acceptance criterion dictates the substitution of the riser joints with wall thickness reduction above 12.5% of the nominal thickness. This criterion, called herein the maximum defect depth criterion, is excessively conservative because it applies to a corroded riser joint in operation the same wall thickness tolerance that is applied to a new pipe, manufactured in accordance with the API Specification 5L [2].

Areas of high wall thickness reduction form potential fatigue hotspots. In this context, the authors have been studying the fatigue of drilling risers with defects caused by corrosion in the base metal [3,4]. This paper presents the fatigue life assessment of a drilling riser containing corrosion pits. Stress concentration factors are calculated using solid Finite Element models and the fatigue analyses are performed considering the wave loads and the vortex induced vibrations.

Study Assumptions

The following assumptions were adopted:

- There is corrosion on the external surface of the riser joints;
- The internal surface of the riser joints, the connectors and the welds are free of corrosion;
- The internal surface of the riser joints is free of wear from the drill string rotation;
- The riser joints are free of dents and cracks;
- The drilling mud is not contaminated with corrosive gases such as carbon dioxide and hydrogen sulfide;
- The internal pressure is higher than the external pressure.