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Multidegradation processes in Direct Riser Tensioning (DRT) systems for O&G

Today many exploration wells are located at water depths of between 1500 and 3000 m, meaning equally long riser pipes have to be used. A drilling riser is fixed to the seabed, connecting the well to the drilling vessel acting as an extension of the drilling well from the seabed to the drilling vessel's drillfloor. Direct riser tensioning (DRT) systems, consist of 6 large hydraulic cylinders (with a stroke length of 16 m) providing tensioning of the drilling riser while compensating for the drilling vessel heave movements. Direct Riser Tensioner (DRT) cylinders are complex tribological systems, which include the use of seals, guide bands, hydraulic fluids/lubricants and materials in relative movement. These components fail due to the combined effect of multidegradation processes (friction, wear, corrosion and mechanical stresses). The origins of these degradation mechanisms lie at the atomic level and cause enormous economical loses (down time can lead to lost revenues of more than USD 550,000 per day), safety consequences and potential environment impact.

The main purpose of this master project is to understand the multi-degradation phenomena in oil and gas offshore steels. In this research work, it is planned to scientifically study interaction and synergy of wear, corrosion and fatigue as 3 major degradation mechanisms in one system exposed to harsh offshore conditions. This project focuses more on the mechanisms and processes leading to multi-degradation and failure rather than influence of one parameter on enhancing the degradation. Following objectives are to be reached through this master work:

- Better understanding of tribocorrosion phenomena, shed light on how it takes place and how conditions in offshore environment play a part in the process or deviate the phenomena from tribology exclusively or corrosion solely.
- Adding up fatigue to the tribocorrosion phenomena and understanding the new system with respect to contribution of each degradation mechanism solely and also interactions and synergies.

Different stainless steels that are used in offshore (316L and Super-duplex) are to be tested in the multi-degradation test rig developed by NOV in cooperation with the Tribology research group at NTNU. The Lab Scale Multi-Degradation (LSMD) test rig will be the main equipment to reproduce complex conditions that offshore components are exposed to. On one hand different environment related variables such as temperature, electrolyte, loads and potential, on the other hand different sample related variables such as microstructure, grain size, surface finishing etc. will be changed and the effects will be studied.

Samples tested in multi-degradation environment will be characterized and studied thoroughly. Optical microscopes, SEM, EBSD, XPS, FIB, EDX etc. will be used to measure