INVESTIGATION OF THE CORROSION BEHAVIOR OF SA-105 MATERIAL USING A DEVELOPED EXPERIMENTAL BOLTED JOINT TEST FIXTURE

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ABSTRACT

Corrosion is the second most common cause of hydrocarbon leaks on offshore platforms. In seawater and hydrocarbon services, bolted flange joints are prone to corrosion, particularly at the flange facing. Flanges connect various components like pipes, valves, pumps, etc., creating a piping system. The current research focuses on corrosion in bolted flanged gasketed joints and proposes a new method to quantify corrosion at the flange and gasket interface. Both crevice corrosion and galvanic corrosion are prevalent in bolted flanged gasketed connections, leading to pressurized fluid leakage, which can be hazardous to the environment and human safety. To address this issue, a novel test bench is introduced, which replicates the actual service conditions of bolted flanged joints. This test bench monitors the corrosion behavior of flanges on the contact surface between the flange and gasket subjected to service conditions such as temperature, gasket contact stress, fluid flow rate, pH and salinity. The corrosion behavior of flange materials is measured using a three-electrode cell, including a working electrode (flange material), counter electrode (stainless steel 316), and reference electrode (Ag/AgCl). Forged carbon steel ASTM A105 is used as a typical flange material for all electrochemical tests. The study employs two electrochemical tests, including electrochemical impedance spectroscopy (EIS) and linear polarization (LPR), to examine the corrosion rate of the flange materials used in conjunction with different types of gasket materials under distinct fluid flow rate, and gasket contact stress. Two levels of gasket contact stress (7 MPa and 35 MPa), fluid flow rate (no-flow, and flow conditions), and gasket material (graphite, and PTFE) are considered in this study. Electrochemical tests are performed using a 3.5wt% NaCl solution. The corroded surfaces of the specimens are examined using available techniques like confocal laser microscopy, scanning electron microscopy (SEM), energy-dispersive X-ray microscopy (EDS/EDX), and X-ray powder diffraction (XRD). The results indicate a higher corrosion rate of SA-105 when using the graphite gasket to seal the joint due to creation of a galvanic cell between the graphite gasket and SA-105 material that accelerates corrosion. Analyzing the EIS and LPR test results show that the corrosion product layer formed on the surface of the flanges controls the kinetics of the corrosion process. Surface analysis indicates that the flow condition (fluid flow rate = 0.1 L.min⁻¹) is more corrosive compared to the no-flow condition as it causes a higher corrosion rate and more pits on the surface of the flanges.