DEEPWATER

HYDROGEN EMBRITTLEMENT STUDY ON AN INCONEL GASKET IN A CLAMP CONNECTOR

Deepwater laboratory testing to determine if CP current was reaching internal gasket, possibly leading to embrittlement.

Deepwater Corrosion Services Inc. (DCSI) was contracted by OneSubsea (OSS) to conduct laboratory testing including potential monitoring of an OCS clamp connector subject to cathodic protection (CP). It was unknown if the CP current reached the 725-alloy (UNS N07725) gasket inside the clamp connector. Furthermore, the effects caused by the CP on the gasket material were also unknown; as indicated by Cameron & Schlumberger personnel, one of the main concerns was that the polarization of the Inconel gasket could generate hydrogen, leading to potential hydrogen embrittlement when the CP level is excessive.

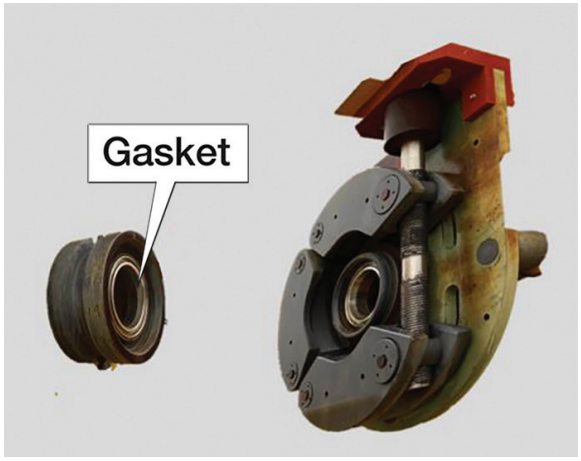
The DMG is made of Inconel 725-alloy (UNS N07725) with high resistance to temperature, pressure, and corrosion; despite these characteristics, Inconel 725-alloy couplers cracked in service conditions in 2015. The failure was attributed to hydrogen embrittlement, and the conditions were re-created by simulating service conditions with a CP level of -1200 mV vs Ag/AgCl (seawater). Since no electrochemical tests were carried out, it was imperative to carry out potential and current monitoring of the clamp in service conditions to determine the effect of the CP in the gasket.

The scope of the work was to determine the presence and extent of cathodic protection polarization inside the OCS clamp connector, specifically the alloy 725 gasket inside the subsea connection assembly. In order to achieve the target, Deepwater Corrosion Services carried out laboratory testing to measure the electrochemical potential in a total of nine locations inside and outside the clamp. Some of the locations required machining of the connector for introduction of Luggin capillaries, allowing the introduction of micro reference electrodes for potential measurements at well defined, highly localized test points. Three levels of external CP polarization were achieved by using an impressed-current cathodic protection (ICCP) system using an in-house Transformer Rectifier (T/R), anode and grounding system. Additional SACP testing was carried out using an aluminum sacrificial anode.

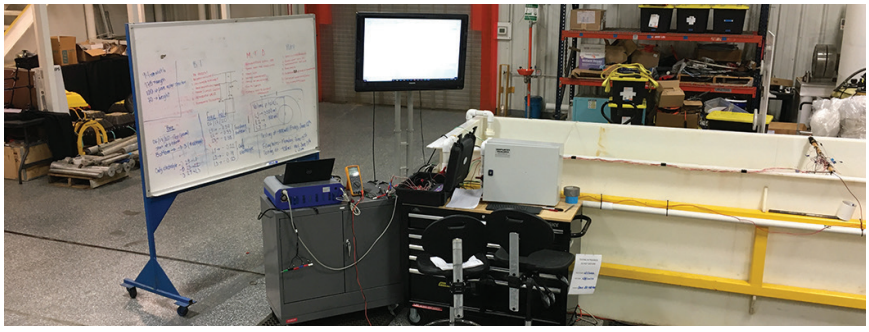
It was assumed that the CP had caused the hydrogen embrittlement occurring on the Inconel gaskets; however, after extensive testing, there was no proof that the CP reached the failed gasket. Note: The results from this work were obtained under laboratory conditions and not in the field under service conditions.

More info at www.stoprust.com

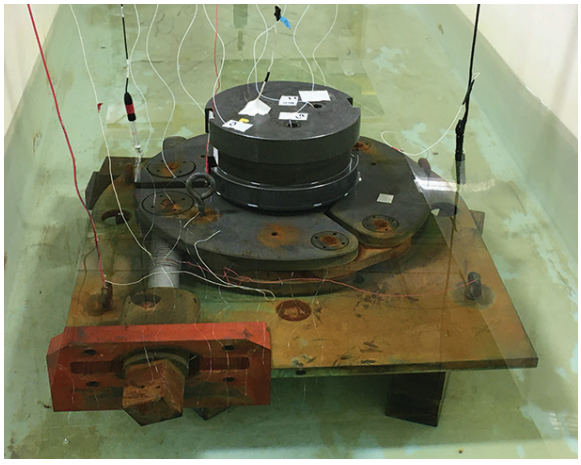
CLAMP CONNECTOR'S CATHODIC CONUNDRUM
Searching for the cause and effect of CP on a subsea 725-alloy gasket.



WHERE THE PROBLEM IS
The inboard connector (left) and outboard hub and clamp assembly (right).



UNDERGOING SOME TESTS
A view of the data logger used to determine the amount of CP, if any, that was reaching the Inconel gasket.



GETTING TO THE BOTTOM OF IT
Multiple tests were run in one of Deepwater's test tanks.