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Failure Investigation of a High Strength Low alloy Steel Threaded Connection in a High CO_2 Oil and Gas Field

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Abstract

Two connector failures occurred on two newly drilled wells using high strength API 5D Grade drill pipe joints as production risers in two deep water offshore wells. The first failure occurred after 64 days of well testing and producing while the second failure occurred after 111 days. Both wells had similar CO_2 partial pressure (pCO_2) with no H_2S expected or measured. The fracture surfaces were similar on both failures and both failed by brittle cracking. The failure investigation was performed using microscopic, surface analysis methods and mechanical tests (tensile, hardness, SSRT-slow strain rate test and CTOD-crack tip opening displacement). Process modelling (HYSIS software) have shown that water condensed in a large spectrum of temperature and pressure. Fractured connectors were examined macroscopically and with SEM (scanning electron microscope) to determine the location of crack initiation which led to the final brittle failure. The unusual brittle fracture in the threaded connections was attributed to a corrosive environment formed during several cycles of well shutdown allowing low pH condensed water due the high pressure and high CO_2 gas content to accumulate in the highly stressed area of the threads resulting in environmental cracking. This cracking was exacerbated by the presence of zinc in the thread dope and unusual, non-protective corrosion products.