

NDT Developments to Access Flexible Pipes Annulus Integrity in a Presalt SCC CO₂ Scenario

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Petrobras is one of the leaders in offshore oil production. Brazil is the largest user of flexible pipes in the world. Most of the Petrobras' oil production is flown through these types of pipelines. The reservoirs in the pre-salt scenario have a large amount of CO₂ that comes with the oil streams and, together with other gases, permeates through the polymeric sealing layer until it meets the carbon steel metallic layers in the annulus. If there is water in this space, the conditions are created for CO₂ stress corrosion failure mechanism occurs, with consequent corrosion and cracking with the possibility of rupture of the metallic layers, loss of tightness and integrity. One of the most direct ways to guarantee the integrity of this degradation mechanism and allow the operational continuity of the flexible pipes network installed in this scenario with CO₂ and ultra deep waters is to know the condition of the annular space regarding the presence of water. Pipes with a dry annulus can be fully usable accordingly its design. On the other hand, pipes with a wet or flooded annulus are exposed to SCC CO₂ failure mechanism which can reduce service life in more than ten times. The lack of inspection technology solutions on the market for this purpose has motivated Petrobras to establish a structuring work to develop inspection tools and methodologies, including initiatives with companies in the market, internally in Petrobras and with universities. In an integrity management approach, without the annulus condition inspection tools, conservatively, all sections of each pipe are considered flooded. As an alternative, hydrostatic tests can be carried out to test the integrity of the metal reinforcement, but the gain is generally a few months or proceed with the replacement of the sections, which generally do not have a reserve available. Any of these alternatives, when technically viable, are temporary and produce extremely high costs, as they involve stopping production and mobilizing critical resources such as specialized vessels. The inspection solutions developed and presented in this work completely change this status, since the inspected pipes that present a dry annulus are free from the SCC CO₂ phenomenon and, therefore, can keep in operation accordingly to their design life. As a result of this work, Petrobras has qualified at least three tools from the market and two tools inside of its Research Center (CENPES). Most part of these tools are based on conventional and phased array UT. There is another development considering gamma transmission as physical principal. The most challenge for the tools from the market is to deal with the influence of higher pressures in UT signal behavior through the flexible pipe layers. Unprecedented data analysis approaches have emerged from experimental data analysis. The great deal from Petrobras internal tools come from the idea of coupling the end fitting region to access the annulus space of the pipe. Since the implementation of these technologies in 2020, the calculated benefits are in the order of US\$ 1 billion per year, considering saved oil production and operational cost reduction with vessel resources.