Pre-salt Challenger: Corrosion Laboratory Tests in Very High Pressures.

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Abstract.

One of the most important discoveries concerning the oil and gas world reserves was made in the Brazilian offshore deep waters. The so called "Brazilian Pre-Salt province" comprises reservoirs below a salt layer of variable thickness that can reach up to 2,000 m. Among the technological challenges that are being faced to put these huge reserves into production, an important one is the material selection for the corrosive environments found in this scenario. High pressures, coupled with variable $CO_2 - H_2S$ gas contents, leads to the development of test laboratories that can foresee the materials behavior in such conditions. The Non-Destructive, Corrosion and Welding laboratory (LNDC at COPPE/UFRJ), is facing this challenge and has developed some tests to deal with these new experimental conditions. In this paper, a briefing of these facilities and main test results concerning corrosion aspects will be presented.

Scope

Materials behavior in presence of CO_2 and H_2S dissolved in chloride water solutions at high pressure, for example 600 bars, have unknown electrochemical interface that needs to be tested in laboratory. The tendency in these cases is to use the so-called corrosion resistance alloys (CRA) that are mainly iron-chromium-nickel-nitrogen alloys. However, these alloys have a very complex metallurgical nature and many phases can be present in its structure. In particular, during the welding process, due to the heat input, undesirable phases can be formed. The behavior of these multiphase steels in high pressure must be tested. Moreover, questions like "what is the actual condition to assure the cathodic protections for a steel working at 700 bars?" and "does the hydrogen permeation and consequently the hydrogen embrittlement occur at the same way in 1 bar and at 700 bars?" must be answered. In summary, does all laboratory data obtained for atmospheric and relatively high pressure can be extrapolated for very high pressure as deled in the pre-salt conditions? The LNDC is working in two parallel ways to answer these quastions:

- 1- Developing/adapting corrosion tests for high pressure and, from a practical point of view, obtaining data to be used in real life situations.
- 2- Using the apparatus developed in the previous point to perform more academic work, in general thesis, to better understand the material behavior in such submitted in such special conditions.

In the present paper the following subject will be discussed:

- Results concerning carbon steel in function of the CO₂ and H₂S concentration in different total pressure.
- Results concerning the monitoring of a corrosion system processing different quality of oil.
- Results concerning CO2 corrosion of a martensitic steel obtained in a loop working at 200 bars
- Development of a system able to work in corrosion fatigue until 600 bars.
- A Devanathan permeation cell to work up to a total pressure of 400 bars.

Examples of some results:



Loop used to study the electrochemical behavior of a martensitic steel in high pressure.



Impedance diagrams obtained in CO_2 medium in 100bars and 150° C. using the loop shown in fig 1



Laboratory studies using an autoclave (A) and a multitask cell for electrochemical measurements (B)



Impedance Results obtained in the field (Refinery) and in laboratory.