

SSC Resistance of 13% Cr and Super 13% Cr below pH 3.5 in Low H₂S Environment

Yves Gunaltun

Total secondee at PTTEP
Corrosion Expert, PTTEP/OPS
Bangkok, Thailand.

Suchada Punpruk

Corrosion Engineer, PTTEP/OPS/OMI,
Bangkok, Thailand

Siriporn Daopiset

Thai-French Innovation Institute
King Mongkut's University of Technology North Bangkok
Bangkok, Thailand

ABSTRACT

According to NACE MR0175/ISO 15156 standard, martensitic stainless steels can be used up to 0.1 bar of H₂S partial pressure provided that the pH is above 3.5. However, these alloys have been successfully used in Field A up to 0.0145 bar of H₂S at pH 3. It was decided to check the possibility of extending the domain of their use up to 0.035 bar H₂S partial pressure at pH 3 (Field B conditions) and then up to 0.05 bar H₂S partial pressure at pH 3 (Field C conditions).

First, SSC resistance of 13% Cr and Super 13% Cr were tested under the conditions of Field C in two different laboratories. 13% Cr and some of super 13% Cr failed but one alloy showed no crack, confirming the suitability of some Super 13% Cr for Field C.

Then, SSC resistance of 13% Cr was tested under Field B conditions with and without chloride. For the test without chloride, test samples are placed in both liquid phase (condensed water free of chloride) and gas phase under condensing conditions. No cracking was detected. However in the same conditions but with 500 ppm chloride, samples placed in the liquid phase cracked but no crack was detected on samples placed in the gas phase.

For material selection, shut in conditions are generally considered due to low temperature and high partial pressure of H₂S but there is no chloride. According to the test results the presence of chloride seems to be the main parameter at low pH values. Paper discusses the results of tests and the limits of using shut-in conditions for material selection.

KEY WORDS: Martensitic SS, 13% Cr, Super 13% Cr, sour service,

SSC, SCC, H₂S partial pressure, chloride.

INTRODUCTION

Field B is currently producing and wells were completed with L-80 grade 13% Cr. However, testing of new reservoirs indicated the presence of unexpectedly high H₂S levels. The study for Field B was related to the evaluation of the SSC risk in the existing wells. The field conditions are summarised in Table 1.

Field C is currently under development. The field conditions are summarised in Table 2. For this field, the possibility of using carbon or low alloy steels was investigated. For the carbon steel option, corrosion rates predicted by corrosion models "Lipucor" (Gunaltun, 2006) and "Corplus" (unpublished, refer to Nyborg, 2006) indicated unacceptably high corrosion rates. According to the prediction results, carbon steel tubing would fail after a few years of production. The use of corrosion resistant alloys (CRA) for tubing is considered as the most appropriate solution.

Selection of CRAs for metal loss corrosion is limited by the maximum operating temperature of each alloy and can be summarized as follows:

- 13% Cr : up to 150 degree C
- Super 13% Cr : up to 200 degree C
- Duplex stainless steel : up to 250 degree C

Below these temperatures, the metal loss corrosion rates of these steels are considered as negligible. Considering the temperature range, 13% Cr and Super 13% Cr or combination of both (bottom