Tensile test evaluation of Duplex Stainless Steels 2205 under seawater conditions

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Duplex Stainless Steel undergoes tensile tests under seawater conditions and under various environmental conditions to test performance.

Abstract

One of the most popular engineering materials is Duplex Stainless Steel (DSS). It has a favourable combination of corrosion and mechanical properties and is popularly employed as a structural material in different fields of application where high mechanical strength is required and also in highly corrosive environments such as the oil and gas plant, nuclear reactors, process systems, offshore platforms and chemical plants. This article reports our findings on the evaluation of the tensile tests carried out on DSS 2205 under seawater conditions. Five Duplex Stainless Steels 2205 (DT4, DT5, DT7, DT8 and DT9) specimens were subjected to different environmental conditions such as seawater open circuit, air and also different conditions of hydrogen charging (0, 1, 15 and 24 hours) before the tensile investigations. This article shows how seawater reduces the performance of the DSS. These were confirmed by scanning electron microscopy (SEM) fractography.

Stainless steels are the major construction materials for corrosion-resistance in industrial equipment such as the process, power, petroleum and chemical industries. Stainless steels are alloys of iron containing at least 11% of chromium. It is a known fact that an amount of chromium can prevent the formation of rust in unpolluted atmosphere. Stainless steel corrosion resistance is provided by a very thin surface film called the 'passive film' which has self-healing characteristics in different environments (Sedriks, 1996; Binder and Brown, 1946).

More than 180 different alloys of stainless steels are known worldwide with chromium content up to 30% in some. Other elements are added to stainless steel to improve their properties and to make fabrication easier. Molybdenum, nickel and nitrogen are added for corrosion resistance; carbon, nitrogen, molybdenum, aluminium, copper and titanium are added for strength; selenium and sulphur for machinability; and nickel for toughness and formability (Adeniyi, 2011; Park and Kwon, 2002; Sedriks, 1996; Honeycombe and Bhadeshia, 1995).

Generally stainless steel is grouped into three groups according to their metallurgical structure (Sedriks, 1996):

1. Austenitic (face-centred cubic)
2. Ferritic (body-centred cubic)
3. Martensitic (body-centred tetragonal or cubic).

DSS is stainless steel that contains both austenite and ferrite in roughly equal amounts. The alloying elements commonly found in stainless steel are referred to as austenite stabilisers or delta ferrite stabilisers. The potency of each element is expressed in terms of equivalence to chromium (ferrite stabiliser) or nickel (austenite stabiliser) using a weight percentage basis (Sedriks, 1996; Pickering, 1979, 1978, 1976). The focus of this article is on Duplex Stainless Steel 2205. Five different DSS specimens were investigated in