APPLICATION OF THE SMALL PUNCH TEST TO EVALUATE HYDROGEN EMBRITTLEMENT IN STEELS AND NICKEL ALLOYS

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The use of techniques that evaluate the mechanical properties and structural integrity of equipments using small samples are of great importance for the industry. One of the most promising techniques is the Small Punch Test (ASTM E3205), which uses a disk of approximately 0.500 mm in thickness and 8 mm in diameter. In this test, the specimen is deformed using a WC/Co sphere until rupture. Through this methodology, it is possible to determine mechanical properties such as yield stress and tensile strength of the materials instead of using conventional specimens that require significantly larger dimensions. In this way, it is possible to remove small samples of components and equipments in operation, such as fasteners or pipes, and evaluate their structural integrity or determine properties of components that have lost traceability. Another possibility is to perform mechanical tests on components that would not be possible to remove traditional specimens from, such as, small components manufactured by additive manufacturing. The combination of this technique with an electrochemical cell in order to simulate the cathodic protection procedure applied to subsea components, can be used to evaluate and characterize the materials against the phenomenon of hydrogen embrittlement. Therefore, tests were performed on high-strength low-alloy steels and nickel alloys, applying a cathodic potential of -1100 mV [Ag|AgCl(3M)] to the samples in an aqueous solution of 3.5% wt of NaCl, simulating the environment of subsea fasteners. Different types of mechanical loading can be applied to the sample in order to better characterize the different susceptibility conditions: monotonic loading and by steps. By using small samples, the test duration is significantly shorter, when compared to other methods. The use of other specimen geometries, with the incorporation of a notch, brings the potential to determine the fracture toughness properties of the material. This development is in progress, but preliminary results indicate a great potential for determining this property, both in air and in hydrogen environment.