IS LABORATORY TESTING OF SCC SUSCEPTIBILITY FIT FOR PURPOSE?

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There has been remarkable progress in the development of international standards for evaluating the susceptibility of metals and alloys to stress corrosion cracking, with more than 30 ISO and ASTM standards and various industry-specific testing standards produced over the last 40 years or so. Despite this, the occasional failure does occur, and this poses concern in the deployment of novel alloys and additive manufactured metals, for which there is limited or no prior service experience in hostile environments. How can one be confident that laboratory testing will be sufficiently discriminating in ensuring the integrity of associated structures and components over the projected lifetime? In that respect, it is emphasised that qualifying materials for service application is not in the scope of testing standards. The selection of test method, the detailed specification of variables in the test standard, and the use of the test data generated are the responsibility of an informed end-user.

Some failures can be attributed to poor fabrication or to uncontrolled excursions in stress/strain, environment, and temperature (see ISO 21601) that are not always captured in the adopted test method. An example will given of a pressure vessel failure where the stainless steel vessel fractured because of an increased temperature following breakdown of a cooling system. The grade of stainless steel selected was appropriate to the operating temperature but could not accommodate the excursion. This was not a failure of a test method but limitations in system analysis, identification of potential failure mechanisms, and risk assessment.

There are many variables that can affect the outcome of a laboratory stress corrosion cracking test in adopting existing standards. Nevertheless, surface preparation, dynamic strain rate, and environmental simulation are perhaps the most concerning in terms of opportunity for greatest variability or misplaced confidence in the relevance of the methodology adopted. Examples for each will be described to highlight the issues.

Progress is being made towards developing test methods for additive manufactured metals and alloys, in which the range of factors that may impact on the testing methodology or susceptibility are highlighted. An example will be given of the impact of specimen preparation and microstructural orientation on cracking susceptibility.

Finally, in closing, the need for test method development and testing specification will be commented on as a framework for discussion on qualifying advanced materials as fit-for service.