Critical crevice diagrams for systems showing an active-passive transition

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Alloys that depend on oxide films or passive layers for corrosion resistance are susceptible to crevice corrosion. Examples are iron in a sodium acetate – acetic acid buffer and nickel, CF-8 and SS 304 in a sulphuric acid solution. These material-environment combinations show an active-passive transition in their polarisation behaviour and, hence, are susceptible to crevice corrosion. Indeed, a potential drop down the crevice might bring part of the crevice in the passive-active transition region, resulting in crevice corrosion.

Previously[1], a critical crevice diagram (Figure 1) was introduced to determine the onset of crevice corrosion of iron in a sodium acetate – acetic acid buffer solution under anodic protection conditions. Such a critical crevice diagram shows the critical characteristic dimension (CD) against the anodic polarisation potential at the mouth of the crevice (E_{mouth}). The characteristic dimension (CD) is defined as L^2/Φ_{EC}, where L is the crevice depth and Φ_{EC} is the electrochemical diameter defined as 4S/P (where S is the crevice's cross section and P is the electrochemically active perimeter). The critical crevice diagram shows that a higher CD (for a given E_{mouth}) or a lower E_{mouth} (for a given CD) brings one into the crevice corrosion regime.

Here, the critical crevice diagram is constructed for nickel (Figure 4 - at 24, 45 and 70 °C)[2], CF-8 (Figure 2 - 25 °C)[3] and SS304 (Figure 3 - 25 °C)[3] in a sulphuric acid solution. The diagram is constructed on the basis of the anodic polarisation behaviour and numerical simulation of the potential drop into the crevice. In order to perform the computations the polarisation curves are fitted with a function describing the active-to-passive transition.

References

1. Vankeerberghen, M., et al., *15th ICC Int'l Corrosion Congress*, Granada, Spain, September 2002.
2. M.I. Abdulsalam, *Corrosion* **58** 4 (2002) p 364.
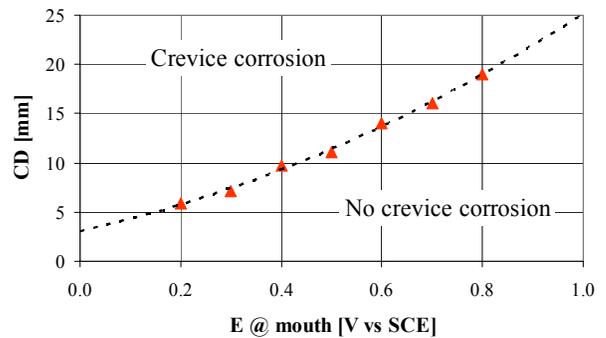3. W.D. France, Jr., N.D. Greene, Jr, *Corrosion* **24** 8 (1968) p 247.

Figure 1   Critical crevice diagram for iron in a 0.5M sodium acetate + 0.5M acetic acid buffer solution[1].
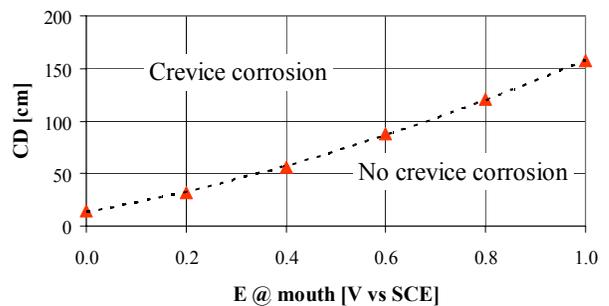

Figure 2 Critical crevice diagram for CF-8 in a 1N sulphuric acid solution based on data of reference 3.
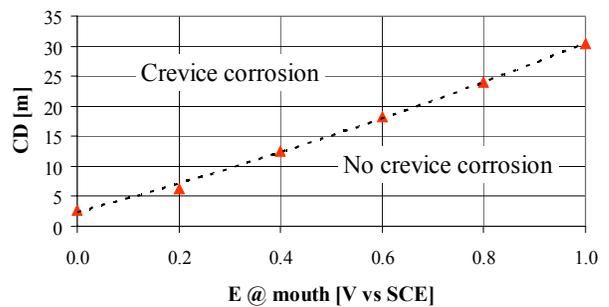

Figure 3 Critical crevice diagram for SS 304 in a 1N sulphuric acid solution based on data of reference 3.
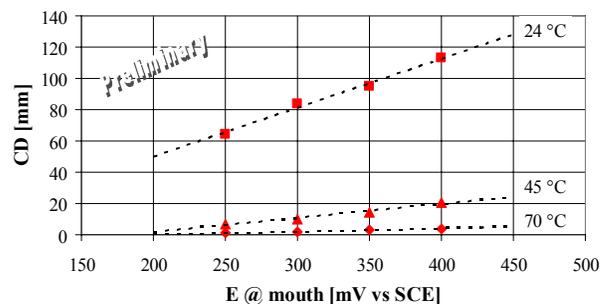

Figure 4 Critical crevice diagram for Ni in a 1N sulphuric acid solution based on data of reference 2.