Application Note

Pitting Corrosion Evaluation of Stainless Steel

Application Note: 2023/06

Pitting corrosion is an accelerated form of chemical attack where the corrosion rate is more significant in some areas than others. Stainless steels are generally very corrosion-resistant to perform satisfactorily in most environments. The limit of corrosion resistance of a given stainless steel depends on its constituent elements when exposed to a corrosive environment; however, Pitting corrosion can happen in stainless steel as localized attacks when exposed in certain conditions due to inclusions or a breakdown of the passive film, which occurs in only a few areas as opposed to the overall surface. This difference in relative areas accelerates the corrosion, causing the pits to penetrate deeper due to the autocatalytic process as dissolved oxygen can hardly diffuse into the pit, which leads to the formation of a small anodic area inside the pot and the relatively gigantic cathodic area outside since the passive film. [1,2]

In this note, the pitting corrosion in the presence of chloride is investigated. For this purpose, Potentiodynamic experiments are performed.

Experimental Procedure

Investigations were carried out with **VersaSTAT3** and **VersaStudio software** with the Corrosion Cell kit (K0047) in the aerated 3.5 % NaCl aqueous solution as the electrolyte at 30°C. A saturated calomel electrode (SCE, K0077) and a graphite rod were employed as the reference and counter electrodes, respectively.

Open circuit potential (OCP) was measured, and the latest reading of OCP was applied for the consequent Potentiodynamic by the Measure Open Circuit action (found in the Advanced Actions "Sequence Actions"), as shown in Figure 1.

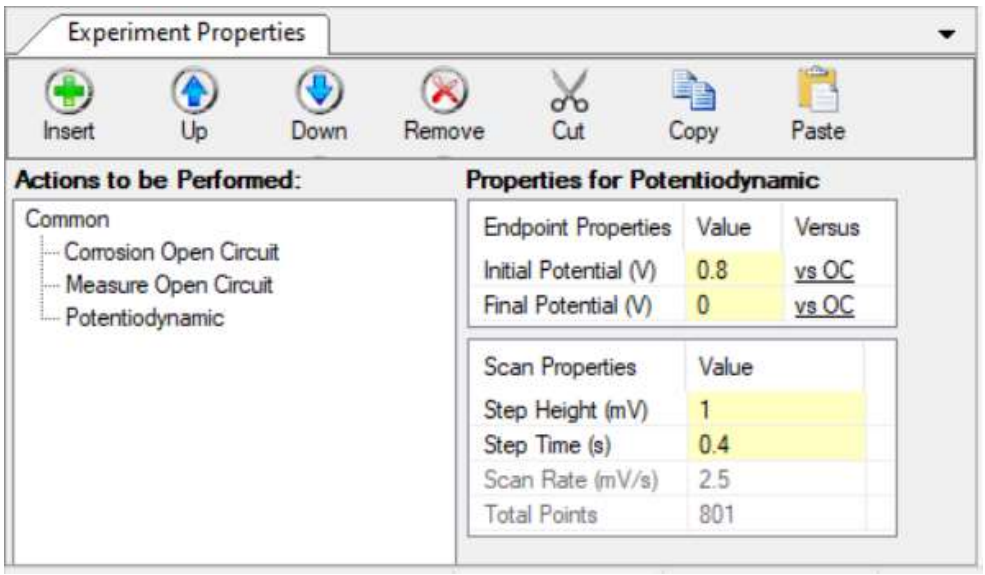

Figure 1. "Experiment Properties" settings for the Potentiodynamic measurement in VersaStudio.

It is easy to conclude the pitting potential (E_p) by tracking and hanging over the cursor on the data point (Figure 2A). Moreover, the corrosion potential (E_{corr}) and other related parameters, such as corrosion current (I_{corr}), cathodic (β_c) and anodic (β_a) Tafel constants, and corrosion rate with the "Tafel Fit" analysis tool can be determined from the Potentiodynamic profile (Figure 2B).

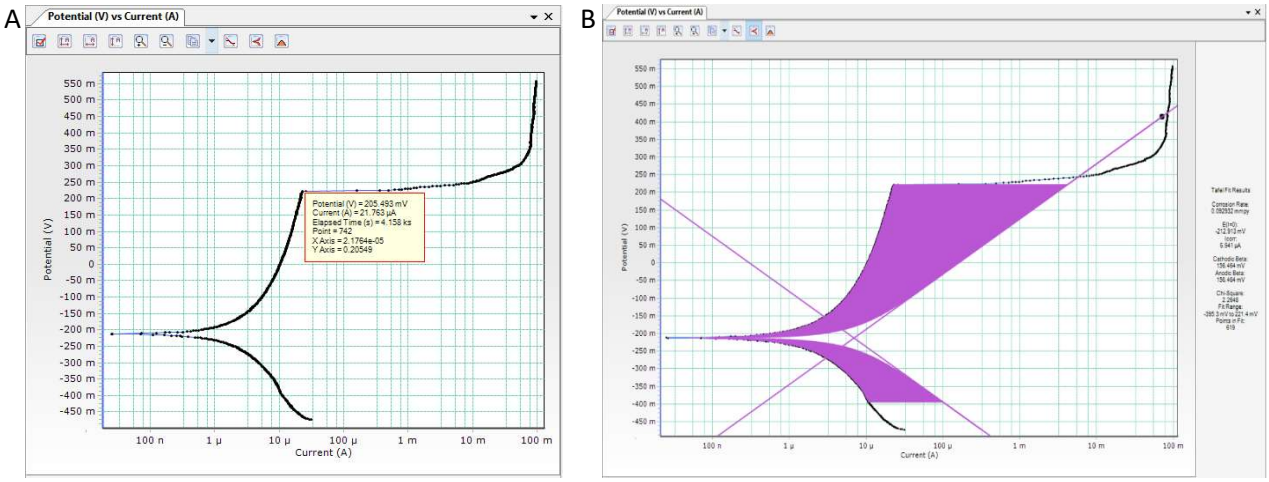

Figure 2. (A) the Potentiodynamic profile of the stainless steel sample and (B) its corresponding "Tafel Fit" results.

Table 1. Data resulting from the Potentiodynamic measurement.

E_{corr} (mV*)	I_{corr} (nA)	β_c (mV*)	β_a (mV*)	Corrosion Rate (mmpy)	E_p (mV*)
-212.91	25.13	156.46.	156.46	0.092932	208.56

* Potentials are reported in mV vs. SCE (Saturated KCl).

Conclusion

This note demonstrates some corrosion techniques (Corrosion Open Circuit, Measure Open Circuit, and Potentiodynamic) to evaluate the pitting corrosion in stainless steel. The "Tafel Fit" tool lets users obtain the corrosion rate and other typical corrosion parameters by selecting the related data points and clicking the "Tafel Fit" icon.

Depending on your specific sample and requirements for the application, we can provide you with various models of PAR and SOL instruments with different specifications that could also be used to perform the

above measurements. We will be happy to discuss your needs and recommend the most suitable instrument.

Reference

[1] Application Note CORR-4, Electrochemitry and Corrosion: Overview and Techniques, www.ameteksi.com/library/application-notes

[2] A. J. Bard, L. R. Faulkner, Electrochemical Methods, Fundamentals and applications, Wiley, New York (1980)

Summary – This note demonstrates some corrosion techniques (Corrosion Open Circuit, Measure Open Circuit, and Potentiodynamic) to evaluate the pitting corrosion in stainless steel. Depending on your specific sample and requirements for the application, we can provide you with various models of PAR and SOL instruments with different specifications that could also be used to perform the above measurements.

Please contact us for more information at **www.ameteksi.com**