Metrohm Autolab

Application Area: Corrosion

Cyclic Potentiodynamic Polarization Measurements as per ASTM G61

Keywords

Corrosion, localized corrosion, cyclic potentiodynamic polarization, ASTM G61, alloys

Introduction

The ASTM standard G61 is used to determine the susceptibility to localize corrosion on various alloys of iron, nickel and cobalt, in a chlorine environment [1].

The potential at which the anodic current increases rapidly is an indication if an alloy is susceptible to localize corrosion. The higher the potential, at the same scan rate, the less prone the alloy will be to form localized corrosion.

The test consists of polarizing the system toward potentials more positive than the open circuit potentials (OCP), until the current reaches a determined value, then the scan is reversed, forming a hysteresis loop on the voltammogram. The higher the potential at which the hysteresis loop is closed, the less prone the alloy is to form localized corrosion.

Experimental Setup

For the experiment, a sample of stainless steel 430 was used as working electrode. As counter electrode, a platinum sheet electrode was employed. Finally, an Ag/AgCl 3 mol/L KCL reference electrode completed the cell.

An aqueous solution of NaCl 3.56% in weight was used as electrolyte.

A Metrohm Autolab PGSTAT302N was used, together with a Metrohm Autolab 1 L corrosion cell, shown in Figure 1.

Figure 1 – The Metrohm Autolab 1 L corrosion cell.

To remove the oxygen dissolved in the electrolyte, nitrogen gas was bubbled into the solution for one hour during the preparation, then a nitrogen blanket was kept above the solution during the measurement.

The OCP of the counter electrode was recorded. After one additional hour of bubbling nitrogen into the solution, the OCP of the sample was recorded, and the scan was started from 0 V vs. OCP. The scan rate used was 167 µV/s, with a step potential of 150 µV.

The value of the current cutoff when the scan is reversed is defined in the ASTM standard as 5 mA. The measurement stops when the potential reaches the corrosion potential (cutoff), or when the hysteresis is closed (manual stop by visual observation).

Results and Discussion

In Figure 2, the resulting voltammogram is shown.

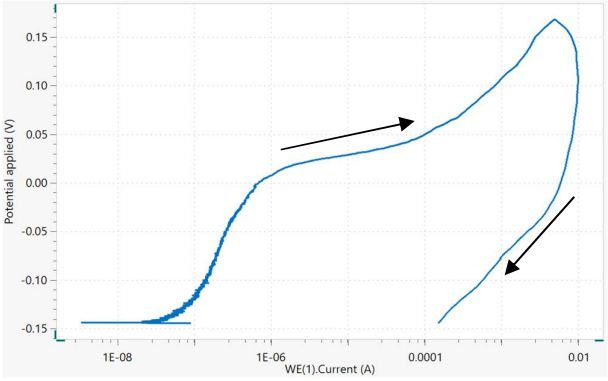

Figure 2 – The voltammogram for the ASTM G61 standard applied to a stainless steel 430 sample. The arrows show the scan direction.

Here, the current reached the 5 mA cutoff value, and the scan was reversed. The scan was terminated when the potential reached the corrosion potential (-0.145 V vs. Ag/AgCl 3 mol/L KCl).

In the case of the stainless steel 430 sample which was used, the presence of a high hysteresis suggests the occurrence of localized corrosion.

Conclusions

Testing the localized corrosion of iron, cobalt and nickel alloys in chlorine solution is regulated by the ASTM G61 standard. This application notes shows a measurement example in accordance with ASTM G61 by using a Metrohm Autolab PGSTAT302N and a Metrohm Autolab 1 L corrosion cell.

With the help of the NOVA software, the necessary cutoff on current can be defined.

In the case of the sample under investigation, the resulting voltammogram shows the presence of a hysteresis loop, which clearly indicates the susceptibility of localized corrosion.

References

[1] ASTM G61-86 (Reapproved 2009), Standard Test Method for Conducting Cyclic Potentiodynamic Polarization Measurements for Localized Corrosion Susceptibility of Iron, Nickel-, or Cobalt-Based Alloys, ASTM International, West Conshohocken, PA, 2016, www.astm.org.

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For more information

Additional information about this application note and the associated NOVA software procedure is available from your local **Metrohm distributor**. Additional instrument specification information can be found at **www.metrohm.com/en/products/electrochemistry**.