

# Resistance To Polarization

## ASTM G59 STANDARD TEST METHOD FOR CONDUCTING POTENTIODYNAMIC POLARIZATION RESISTANCE MEASUREMENTS

Measuring a Doxsteel Fastener’s resistance to polarization tells us how long it will take to react to its environment and corrode. The slower a fastener polarizes, the longer it will last, which makes this test one of the most important that we conduct.

By measuring targeted sections of the fastener to determine its resistance to polarization, we can determine its rate of corrosion per year of standard service. This is how we guarantee that our fasteners will not seize for five years, and why we estimate that they can last as long as 21 years.

SPECIMEN	(CM <sup>2</sup> )	E <sub>corr</sub> (mV) VS Ag/AgCl 5 min	E <sub>corr</sub> (mV) vs Ag/AgCl 55 min	(μA)	(Ω)	(Ω*cm <sup>2</sup> )	(mppy)	(mpy)
Doxsteel Coated Fasteners	110	-0.221	-0.199	1.528	17188	1890717	0.0001	0.00059
Cadmium Coated Fasteners	110	-0.709	-0.708	245	110	12063	0.0473	1.8606
Doxsteel Coated Wrenching Flat	2.5	-0.173	-0.148	0.081	355417	888542	0.00034	0.0137
Cadmium Coated Wrenching Flat	2.5	-0.687	-0.687	5.428	4841	9682	0.0577	2.2703
Doxsteel Coated Nut Thread	15.5	-0.286	-0.310	1.241	252325	392532	0.0009	0.0340
Cadmium Coated Nut Thread	15.5	-0.713	-0.710	13.583	2000	3100	0.0186	0.7331



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**TEST CERTIFICATE — EAR-CONTROLLED DATA**

Date: 6/30/2014  
P.O. No.:  
W/O No.: PRO002-06-20-37365-1

**POTENTIODYNAMIC POLARIZATION RESISTANCE TEST**

**Test Method: ASTM G59, G5, G102**

**INTRODUCTION**

Element Materials Technology was asked to conduct a potentiodynamic polarization resistance test in order to determine the corrosion resistance on three different sample sets. The corrosion rate was determined on the fasteners, the wrenching flats of the nuts, and the inside thread of the nuts according to ASTM G102 after conducting potentiodynamic polarization resistance measurements in a 3% w/v NaCl solution in accordance with ASTM G59. Testing was to provide a qualitative assessment of the coatings ability to withstand immersion in the test solution.

**SPECIMENS**

DOX-Steel® LLC provided all test specimens:

1. DOX-Steel® coated 5/8-11 x 4 ¼ fasteners and nuts

On all three tests, three specimens of each sample set where tested in order to provide a representative average of test results.

**EQUIPMENT**

1. Toshiba laptop computer, model A305D-SP6905R, s/n 19014393Q
2. Biologic Potentiostat / Galvanostat, model SP-150, series 350, with test box-4
3. EC-Lab Software, version 10.37
4. 3 test cells
5. Cole Parmer Ag/AgCl electrodes and titanium electrodes

Respectfully Submitted

Terry Wilt  
Manager, Product Qualification and Non-Metallics

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**TESTING**

**Solution**

1. NaCl 3% by weight, pH= 6.5 - 7.2, temp 25°C +/- 3° C, Atmospheric pressure, static conditions.

Sufficient solution was provided to conduct all tests in order to ensure consistent conditions between the tests

**Test Protocol**

All test specimens were rinsed with de-ionized water and dried before commencement of any testing. Solvents were not used to ensure that damage did not occur to the coatings, and care was taken to ensure that there was no mechanical damage to reveal the base material to the solution exposure.

Before the potentiodynamic polarization resistance measurements tests begun, the Biologic potentiostat system was tested to ensure calibration and proper functioning in accordance with test method ASTM G59 using the test box-4 device.

After securing the specimens (fastener, wrenching flat and thread interior of nut) to the test specific cell, the electrodes were connected to the 0.166 mV/s test cell, and the polarization resistance test was commenced with the corrosion potential recorded after 5 and 55-minute immersion. After 1 hour, a potential of  $\pm 20$  mV from the corrosion potential was applied at a sweep rate of 0.100 mV/s.

Values for polarization resistance, corrosion potential, and corrosion current, as well as polarization curves were produced using EC-Lab software.

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Specimen	Area (cm <sup>2</sup> )	E <sub>corr</sub> (mV) vs Ag/AgCl 5 min	E <sub>corr</sub> (mV) vs Ag/AgCl 55 min	I <sub>corr</sub> (μA)	Rp (Ω)	Rp (Ω*cm <sup>2</sup> )	Corrosion Rate	
							(mppy)	(mpy)
Fasteners	110	-0.221	-0.199	1.528	17,188	1,890,717	0.0001	0.0059
Wrenching Flat	2.5	-0.173	-0.148	0.081	355,417	888,542	0.00034	0.0137
Coated Nut Thread	15.5	-0.286	-0.310	1.241	25,325	392,532	0.0009	0.0340

*mppy: millimeters per year, mpy: milli-inches per year, Ecorr: Corrosion potential, Icorr: Corrosion Current, Rp: Polarization resistance*

**CONCLUSION**

The DOX-Steel® coated specimens gave high polarization resistance values, therefore DOX-Steel® coated fasteners have low corrosion rate values when tested under ASTM G59 and G5. Based on the results of these tests, 20 microns of DOX-Steel® coating would last more than 10 years.

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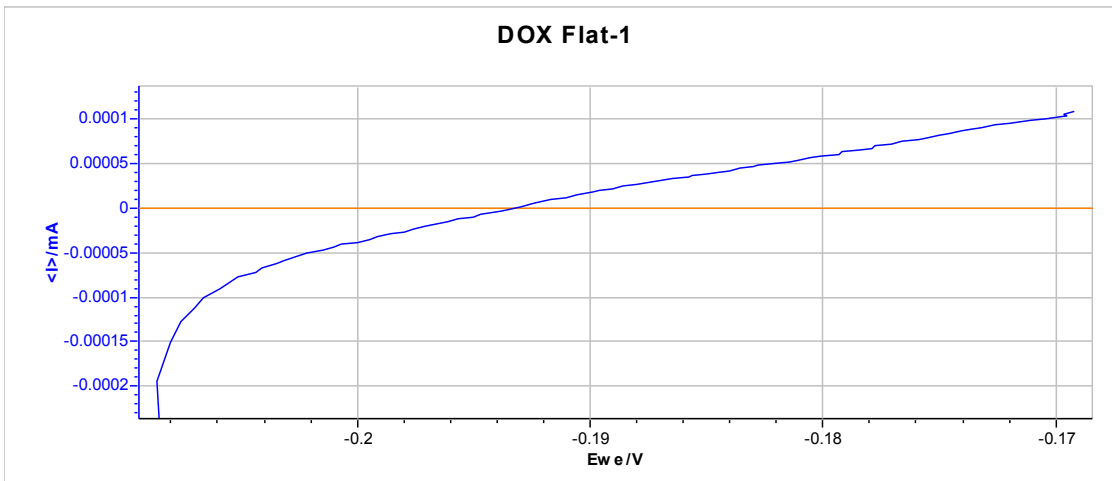
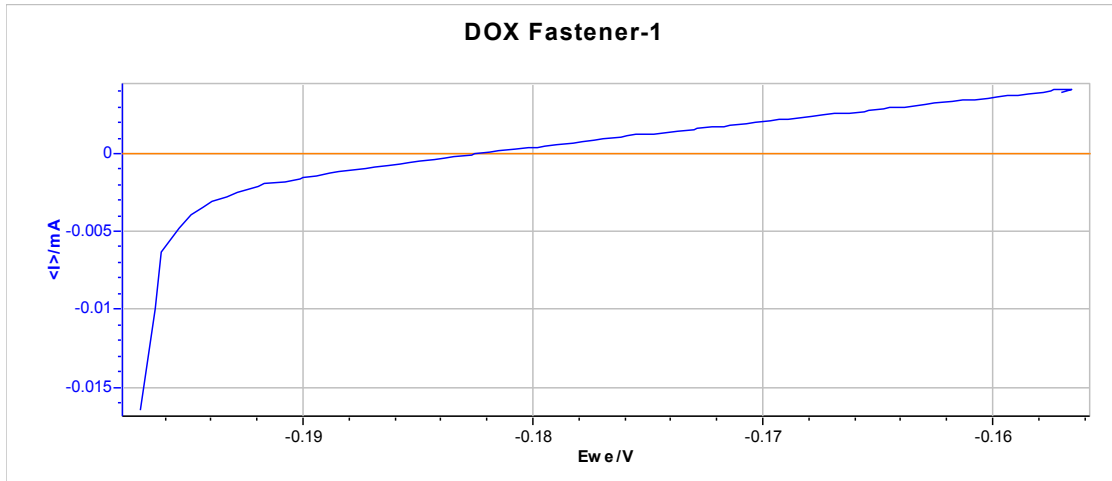
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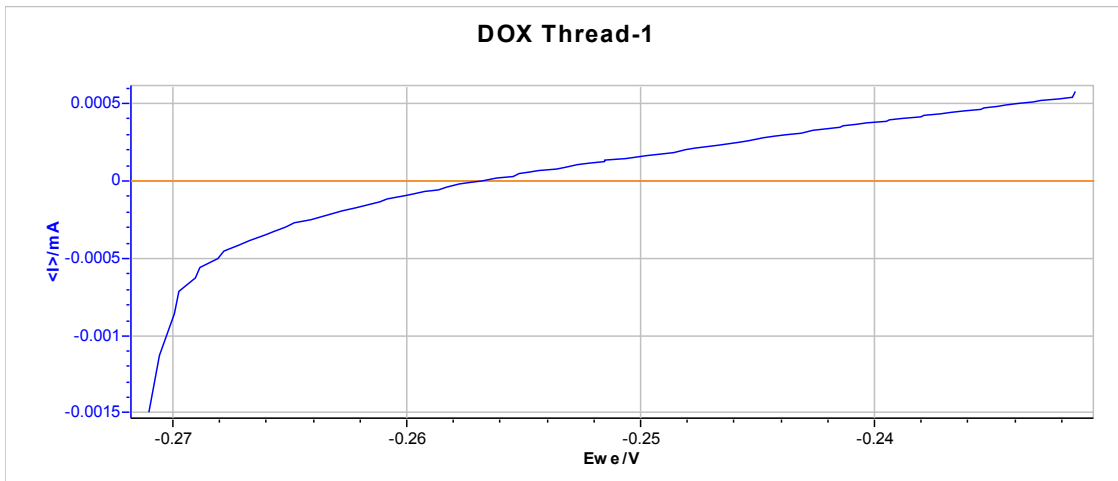
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