

## ANALYSIS OF CORROSION RESISTANCE AND PAINT SCHEMES IN STEEL SHEETS ASTM A242 AND CARBON STEEL SAE 1020

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**Abstract:** This Project intends to study the corrosion susceptibility of steel used in containers, ASTM A242 steel, and SAE 1020 carbon steel without coating and after applying four different types of paint coating. For the corrosion resistance analyses of the metal substrates and these paint, coatings will be employed electrochemical impedance Spectroscopy (EIS) Techniques, scanning electron Microscopy (SEM), Polarization Curves, Potentiodynamics, and Corrosion for mass loss. Automotive – Lacquer Nitrocellulose, a Naval, and an Epoxy Interseal 211 paintings will be applied by the method of airless system, ink released at high pressure by a narrow hole and by the dip-coating method. Moreover, the painting is already covered by the company Log-In Intermodal Logistics.

**Keywords:** Electrochemical Behavior, Container, Corrosion.

## GOALS

This project aims to research steel ASTM A242, used in containers, susceptibility to corrosion and evaluate its performance in four paint systems, in carbon steel SAE 1020 and ASTM A242, comparing them regarding their resistance, considering the climate conditions suffered by the containers.

## INTRODUCTION

There are many studies about corrosion and research for new methods to prevent the material from oxidation being justified by the high impact on society in three main elements: economic, environmental, and safety.

Costs related to corrosion are directly connected to maintenance but also costs related to safety. Besides that, research indicates these costs in different countries might range from 1 to 5% of GDP.

Significant naval structure oxidation is one of the biggest causes of Ambiental disasters, for instance, oil spills.

Therefore, it is essential to level up protection techniques to avoid this and many other negative impacts, pursuing a better cost-benefit ratio.

There are different kinds of corrosion due to mechanical or tension factors by land and seawater. In other words, according to the typology, there are different degrees of graveness and, therefore, different prevention methods to be applied.

The industry widely uses the methods for corrosion control and prevention: the use of special alloys material resistant to corrosion; applying liners as inert barriers; applying cathodic and anorthic protection methods; electrolyte adjustments or chemically corrosive; applying specific inhibitors for corrosion control, besides using anti-corrosive systems.

Many analysis techniques define the prevention and control method to compare the corrosion rates and types.

For precise results, a group of analyses will be used to evaluate the samples that will be the posterior bases for deciding the proper materials/liner used in each project.

Containers are used for different cargo transportation, from grains to chemical products, being carried through land and sea; besides, 95% of current transportation is currently done via containers. [7].

Therefore, this paper aims to analyze the steel used in containers, steel A242, susceptibility to corrosion and evaluate its performance in four paint systems, in carbon steel SAE 1020 and ASTM A242, comparing them regarding their resistance, considering the climate conditions suffered by the containers.

## MATERIAL AND METHODS

### RESEARCH MATERIAL

Research materials were acquired as metal sheets, totalizing thirty-four metal sheets.

Two container sheets, steel ASTM A242, paint provided by the company Log-In Logística Intermodal with 10cmX10cm and 3MM thickness dimensions, one being internally and externally coated and the other not covered. Furthermore, thirty-two SAE 1020 steel sheets with dimensions 3cmX2cm and 0,5 thickness will be used.

### **SAMPLES PREPARATION**

Samples will be prepared from container sheets, steel ASTM A242, and carbon steel.

Two container sheets will be cut in rectangular shapes approximately 2cm wide and 10 cm deep, while carbon steel will be cut about 3cm wide and 2 cm deep with a chainsaw. This tool belongs to the Universidade Estadual de São Paulo Campus Ilha Solteira's mechanical workshop.

Containers sheets provided by Log-In Logística Intermodal have a paint coating difference.

Both will be manually cleaned and sanded; however, an abrasive spray will be sandblasted on the sheets without paint coating, as the ones protected were already through this procedure by the company.

Fabio Domingos Pannoni's (2015) research state that abrasive sandblasting is one of the most efficient and used techniques for further system painting once the durability is prolonged. This method removes the superficial impurity and grants the surface roughness, allowing the coating to contact the subtract and better adhering the steel coating.

### **APLYING PAINTING SYSTEMS**

The Automotive Lacquer Nitrocellulose, Naval, and Epoxy Interseal 211 will be applied by the airless system, which is paint released by high pressure through a narrow orifice and dip-coating method. Nevertheless, Epoxy Interseal 211 paint is provided in two packages; therefore, to apply it, it is necessary

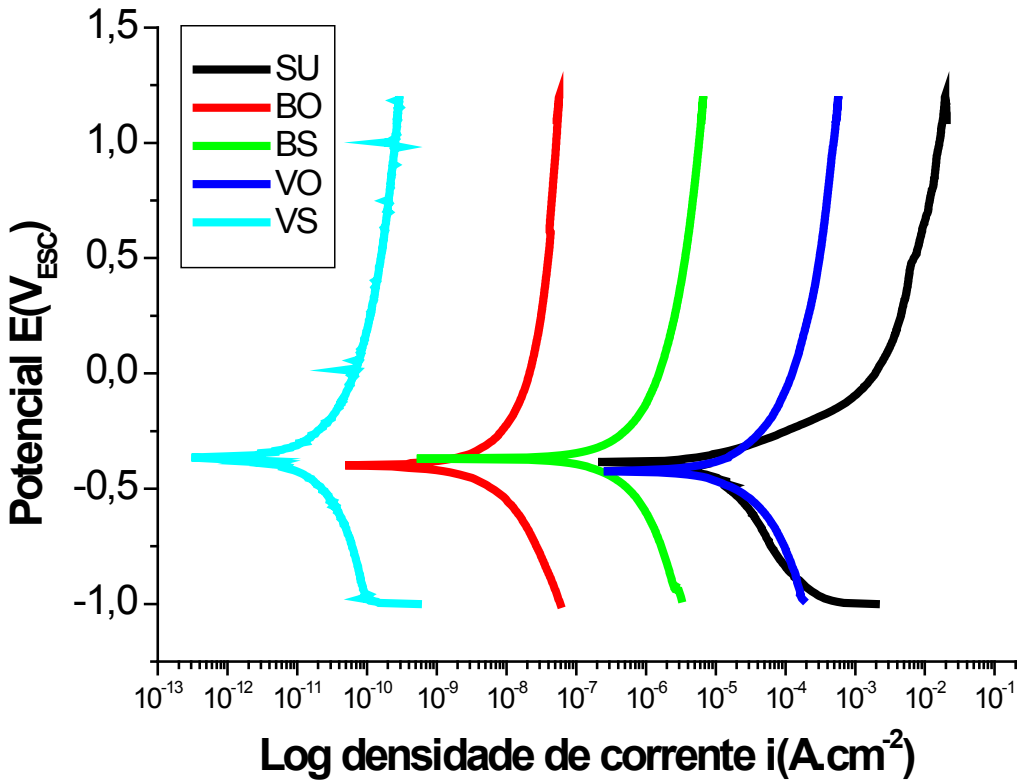
to mix them in a proportion of 6 parts of A to 1 part of B. Three paints will be applied to all sheets except those already coated by Log-In Logística Intermodal.

### **POTENTIODYNAMIC POLARIZATION CURVE**

To test the potentiodynamic polarization curve for solutions, it will be applied sulfuric acid with p,01 mol L-1e concentration: sulfuric acid, sodium hydroxide, seawater (sodium chloride) produced in the laboratory, and seawater collected in Santos, being the reference electrode used is saturated calomel. Subsequently, all test bodies will be submersed in each solution. The analysis method will be used from the collected data and computer statistics, turning data into the necessary curves by origin 6.0 software.

Different computer procedures are done considering the technological progress and the necessity of comparing the results. For the organic coating study, Denise Souza de Freitas and David Scantlebury (2006) used a statistics and image analysis methodology. Ferreira et al. (2008) approached the analysis using computer modeling evaluation methods and corrosion process simulation by computer modeling stainless steel.

## RESULTS AND DISCUSSION



Picture 1. Potentiodynamic polarization curves.

Material	$E_{CORR}$ (mV)	$I_{CORR}$ (A.cm <sup>-2</sup> )
SU	-385	$2,07 \times 10^{-7}$
BO	-399	$4,85 \times 10^{-11}$
BS	-370	$5,19 \times 10^{-10}$
VS	-365	$3,05 \times 10^{-13}$
VO	-424	$2,47 \times 10^{-7}$

Table 1. Electrochemical parameters.

Based on the graph and table analysis, we can evaluate the performance of painting systems relating to corrosion, observing the following parameters: corrosion current density and corrosion potential; we have got the decreasing performance results: Epoxy Interseal 211 paint (VS); internal coating paint provided by Log-In (BO); Nitrocellulose lacquer paint (BS); Naval paint (VO), external coating provided by the company; and, at last, subtract (SU).

## CONCLUSION

According to the results shown, we can assume that Epoxy Interseal paint 211 (VS) resisted better corrosion due to the corrosion current smaller density and more significant corrosion potential.

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