

CORROSION RESISTANCE OF NIOBIUM, TANTALUM AND TITANIUM IN SEA WATER AND SULFURIC ACID

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Niobium, Tantalum and Titanium reacts significantly with oxygen and nitrogen in temperatures above 300°C, forming a stable, adherent and passive oxide layer. These properties allows these alloys to be used in demanding situations where corrosion is the main concern, for equipment fabrication and machine parts. Tantalum (Ta) is found together with Niobium (Nb) in minerals such as columbite and tantalite [(Fe, Mn) (Ta, Nb)₂O₆] and is used in special alloys, electronic components and bone implants. The protective passive layer forms when the metal is exposed to air. Titanium (Ti) is used in high strength, corrosion resistant alloys for chemical, aerospace and naval industry and also in implants. The passive film that forms over the metal surface is very stable, what translates in a high electrode potential. This oxide layer protects the metal from further deterioration.

In this work the behavior of Niobium, Tantalum and Titanium concerning corrosion in natural sea water and sulfuric acid was investigated. Alloys samples were used as the work electrodes and were prepared using a ultrasonic cleaning bath with 3 different treatments of acetone, alcohol and distilled water during 10 minutes each. The experimental set up included a reference electrode of saturated calomel (ECS), a 6.25cm² platinum square plate as the counter electrode, all mounted inside a standard electrochemical cell. The two electrolytes used in the tests were a solution of sulfuric acid (0.5M), pH0.27 at a temperature of T = 22.7°C and natural sea water of Futuro Beach – Fortaleza, Ceará (AMNPFFC), PH = 7.78, at the same temperature. The potentiometer used was a VGSTAT 302 from Autolab. Data acquisition and curve analysis was performed using GPES and Origin 6.0 software respectively.

The obtained potentiodynamic polarization curves for Niobium (Nb), Tantalum (Ta) and Titanium (Ti) in both electrolytes are shown in Figure 1.

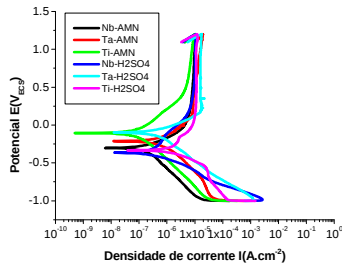


Figure 1 – Potentiodynamic polarization curves for Niobium (Nb), Tantalum (Ta) and Titanium (Ti) in both electrolytes, natural sea water (AMN) and sulfuric acid (H2SO4-0.5M).

Table 1 presents the parameters extracted from the

potentiodynamic polarization curves: corrosion potential (E_{corr}), corrosion current density (I_{corr}) and polarization resistance (R_p) for both electrolytes. Comparing the samples performance in sea water it is verified that corrosion starts first in the Nb, followed by Ta and Ti, the most resistant in sea water.

In the acid electrolyte corrosion starts in the Nb, followed by the Ti and Ta, with the corrosion current density being some what lower for the Ta when compared with Nb. The Ti corrosion current density on the other hand is the highest, meaning that the Ti is the most susceptible to corrosion of the three samples when in the acid electrolyte.

Table 1 - Parameters extracted from the potentiodynamic polarization curves for both electrolytes.

AMN				H ₂ SO ₄			
Material	E _{corr} (mV)	I _{corr} (nA.cm ⁻²)	R _p (KΩ.cm ²)	Material	E _{corr} (mV)	I _{corr} (nA.cm ⁻²)	R _p (KΩ.cm ²)
Nb	-304	5,98	518,70	Nb	-365	13,06	250,90
Ta	-213	11,96	183,90	Ta	-100	12,21	229,40
Ti	-106	0,49	1.203,00	Ti	-335	38,45	55,22

Conclusion

Titanium is the most corrosion resistant of the three samples in sea water and the least resistant in sulfuric acid. Niobium is the most corrosion resistant of the three samples in sulfuric acid and the Tantalum is the least resistant in sea water.

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