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Deep learning based underwater metal object detection using input image data and corrosion protection of mild steel used in underwater study - A case study

Part B - Corrosion protection of mild steel used in underwater study

ABSTRACT

Buried metal objects in sea water may undergo corrosion because of the corrosive ions such as chloride ions present in seawater. However a paint coating may control the corrosion of the metal objects such as robots. Corrosion resistance of mild steel in 3.5 % sodium chloride solution before and after coating with Asian guard red paint has been evaluated by polarization study and AC impedance spectra. In presence of Asian guard red paint, the linear polarization resistance increases, corrosion current decreases, charge transfer resistance increases, double layer capacitance decreases and impedance value increases. That is corrosion resistance of mild steel objects in 3.5 % sodium chloride solution increases after coating with Asian guard red paint.

Keywords: *mild steel objects, robots, coating, Asian guard red paint, polarization study, AC impedance spectra, sea water, 3.5% sodium chloride.*

1. INTRODUCTION

This article is divided into two part. Part A deals with "Deep learning based Underwater Metal object detection using input Image data". Part B deals with "Corrosion protection of mild steel used in underwater study- A case study"

Metallic parts of machines of ships or aero planes may submerge in sea water. They may undergo corrosion when they come in contact with sea water which contains 3.5% sodium chloride. This is most commonly responsible for the corrosive nature of the sea water. The robots made of materials such as mild steel may also undergo corrosion when they come in contact with sea water, while is search. If a paint coating is given, it will control the corrosion of these proposed materials. Hence this work is undertaken. Mild steel is coated with Asian guard red paint. Corrosion resistance of mild in3.5% sodium chloride solution is measured before coating and after coating by electrochemical studies such as such as polarization study and AC impedance spectra [1-20]. The corrosion inhibition efficiency offered by red paint to mild steel in 3.5% sodium chloride is 99.98%.

2. RESULTS AND DISCUSSION

Corrosion resistance of mild in3.5% sodium chloride solution is measured before coating and after coating by electrochemical studies such as such as polarization study and AC impedance spectra.

Electrochemical studies

A CHI electrochemical work station with impedance model 660A was used for this purpose. A three-electrode cell assembly electrode was used in the present study (Scheme 1). Mild steel was used as working electrode; saturated calomel electrode was used as reference electrode and Platinum electrode was used as counter electrode. From the polarisation study corrosion parameters such as corrosion potential (E_{corr}) corrosion current (I_{corr}) and Tafel slope values (anodic = b_a and cathodic = b_c) and Linear polarisation resistance (LPR) were calculated.

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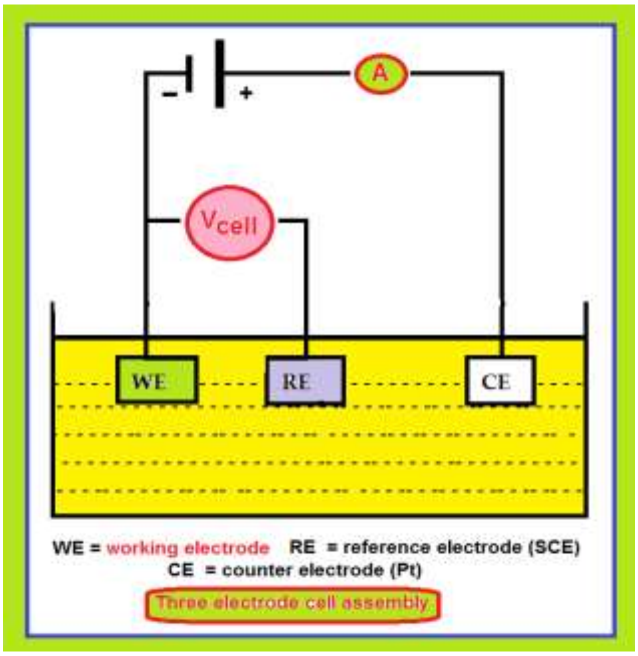

Scheme 1. Three electrode cell assembly

Shema 1. Sklop ćelije sa tri elektrode

AC impedance spectral studies were carried out on a CHI – Electrochemical workstation with impedance, Model 660A. A three – electrode cell assembly was used. The working electrode was mild steel, A saturated calomel electrode (SCE) was the reference electrode and platinum was the counter electrode. The real part (Z') and imaginary part (-Z'') of the cell impedence were measured in ohms at various frequencies. Values of the charge transfer resistance (Rt) and the double layer capacitance (C_{dl}) and impedance value were calculated from Nyguist plots and Bode plots.

Analysis of polarization curves

Polarisation study has been used to detect the formation of protective film on the metal surface. When a protective film is formed on the metal surface, the linear polarisation resistance (LPR) increases and the corrosion current (I_{corr}) decreases.

The polarisation curves of mild steel immersed in various test solutions are shown in Figures 1 and 2. The corrosion parameters namely, corrosion potential (E_{corr}), Tafel slopes (b_c= cathodic; b_a= anodic) linear polarisation resistance (LPR) and the corrosion current (I_{corr}) values are given in Table 1.

When mild steel is immersed in 3.5%NaCl solution, the corrosion potential is -0.997 V vs SCE. The LPR value is 25 Ohmcm^2. The corrosion current value is 1.896×10^{-3} A/cm^2.

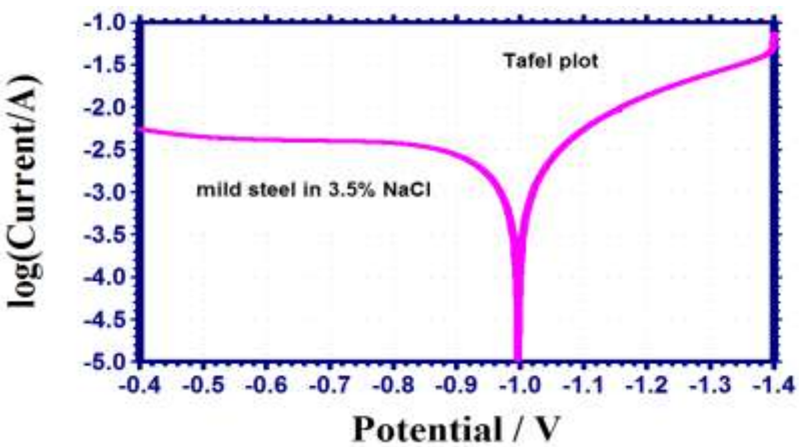

Figure 1. Tafel plot of mild steel immersed in 3.5 % sodium chloride solution

Slika 1. Tafel-ova kriva za meki čelik uronjen u 3.5 % rastvor natrijum hlorida

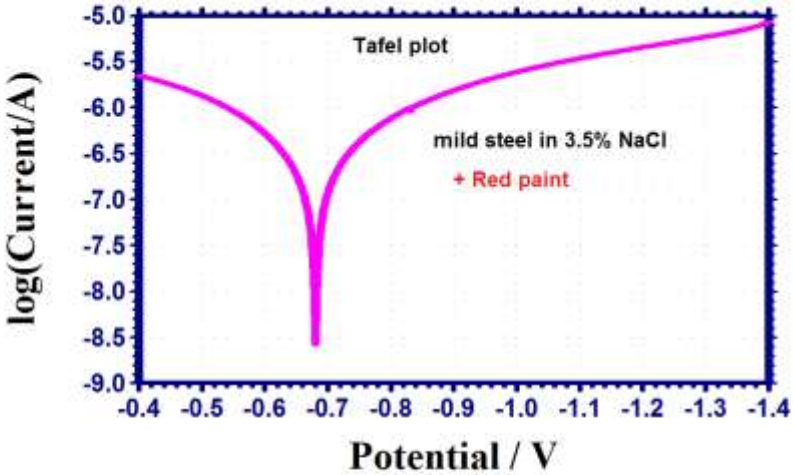

Figure 2. Tafel plot of mild steel immersed in 3.5 % sodium chloride solution after coated with red paint

Slika 2. Tafel-ova kriva za meki čelik uronjen u 3.5 % rastvor natrijum hlorida nakon premazivanja crvenom bojom

Table 1. Corrosion parameters of mild steel immersed in 3.5%NaCl in the absence and presence of protective coating (Asian guard red paint)

Tabela 1. Parametri korozije mekog čelika uronjenog u 3.5%NaCl u odsustvu i prisustvu zaštitnog premaza (azijska zaštitna crvena boja)

System	E_{corr} V vs SCE	b_c V/decade	b_a V/decade	LPR Ohmcm^2	I_{corr} A/cm^2
3.5%NaCl	-0.997	6.035	3.281	25	1.896×10^{-3}
3.5%NaCl+Asian guard red paint (AGRP)	-0.681	5.185	5.663	167159	2.398×10^{-7}

Influence of asian guard red paint (AGRP) on the corrosion resistance of mild steel immersed in 3.5%NaCl

Coating of Asian guard red paint (AGRP) coated mild steel shifts the corrosion potential to -0.681 V vs SCE. The corrosion potential is shifted to anodic side. This indicates that the anodic reaction is controlled predominantly. The LPR value increases from 25 to 167159 Ohmcm^2 (Figure 3), and the corrosion current decreases from 1.896x10^{-3} to 2.398×10^{-7}A/cm^2.

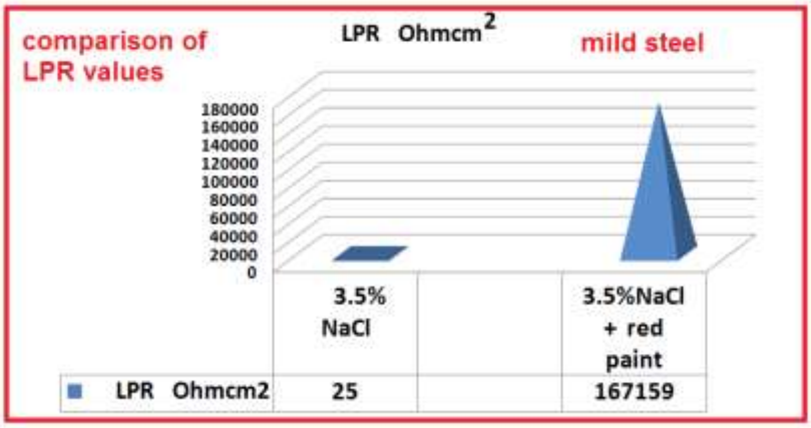

Figure 3. Comparison of LPR values

Slika 3. Poređenje LPR vrednosti

This tremendous decrease in corrosion current value suggests that a protective film is formed on the metal surface and probably the protective film consists of Fe^{2+}complex formed between Fe $^{2+}$ and the ingredients of the Asian guard red paint (AGRP). A better understanding is that the paint does not allow the water molecule to reach the metal surface. Hence corrosion is controlled to great extent. The inhibition efficiency calculated from LPR values is 99.99%. The corrosion potential shifts to the noble side, thus confirming the protective nature of the red paint (Figure 4).

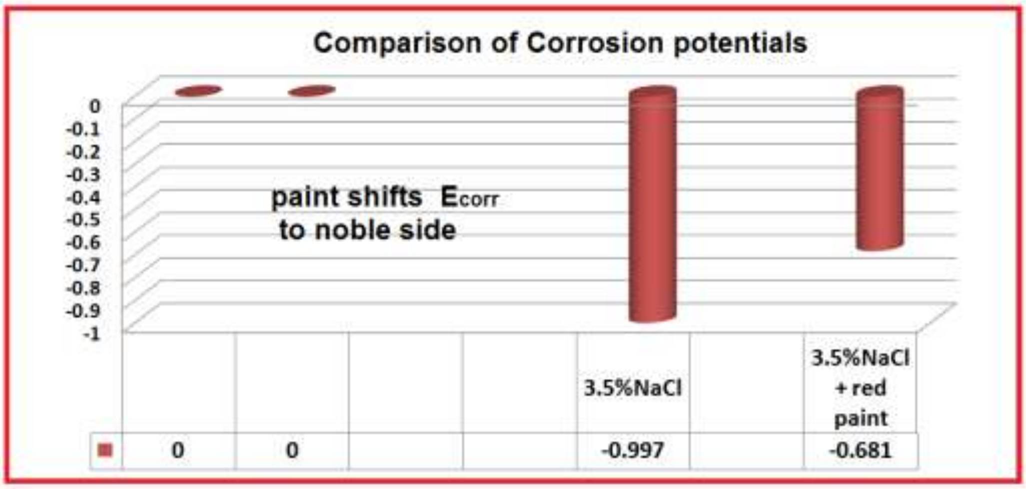

Figure 4. Comparison of corrosion potentials

Slika 4. Poređenje korozionih potencijala

Implication

When a mild steel robot or machinery coated with Asian guard red paint (AGRP) is immersed 3.5%NaCl, the corrosion resistance of the increases. This is due to the fact, the coating of the film prevents the corrosion of mild steel 3.5% NaCl. Hence, it is recommended that the mild steel used in under water technology may be coated with the Asian guard red paint (AGRP). The inhibition efficiency calculated from LPR values is 99.99%.

Analysis of AC Impedance spectra

The AC Impedance spectra of mild steel immersed in various solutions are shown in Figures 5 a and b (Nyquist) and Figures 6 and 7 (Bode plots).

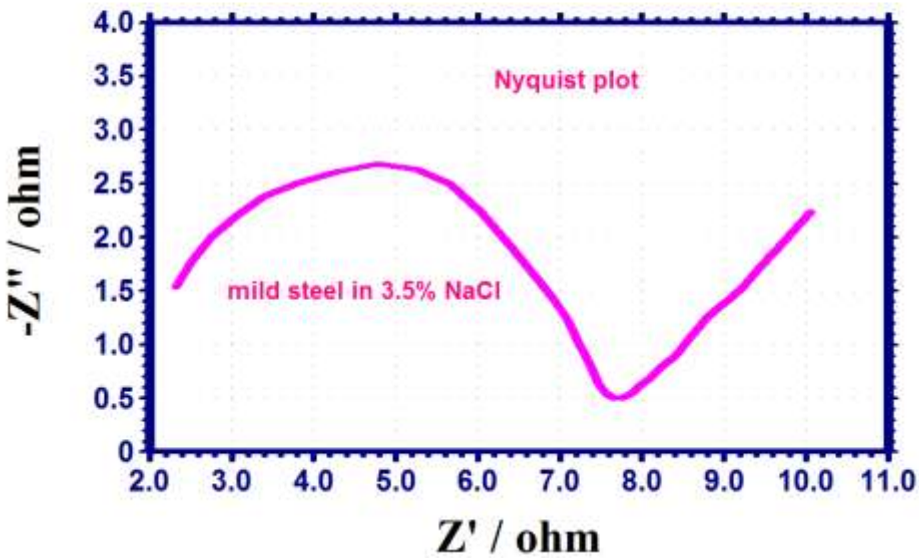

Figure 5a. Nyquist plot of mild steel in 3.5% NaCl solution

Slika 5a. Nyquist-ova kriva za meki čelik u 3.5% rastvoru NaCl

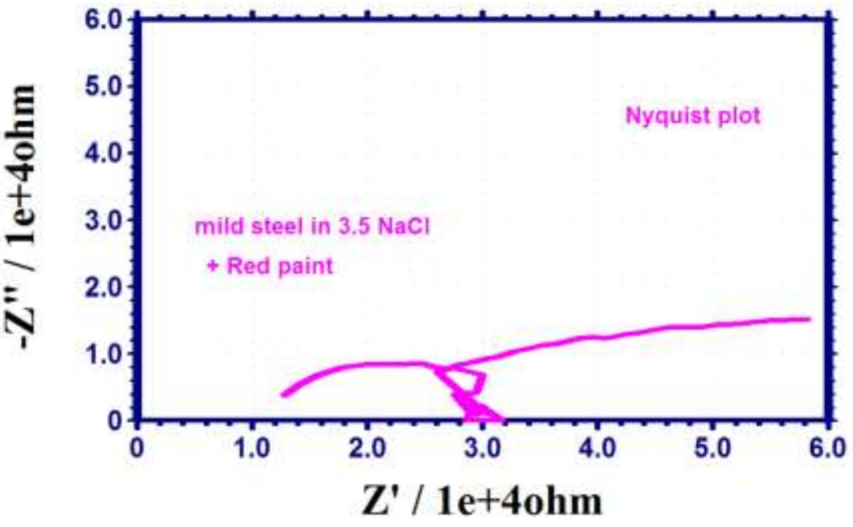

Figure 5b. Nyquist plot of mild steel coated with red paint in 3.5% NaCl solution

Slika 5b. Nyquist-ova kriva za meki čelik premazan crvenom bojom u 3.5% rastvoru NaCl

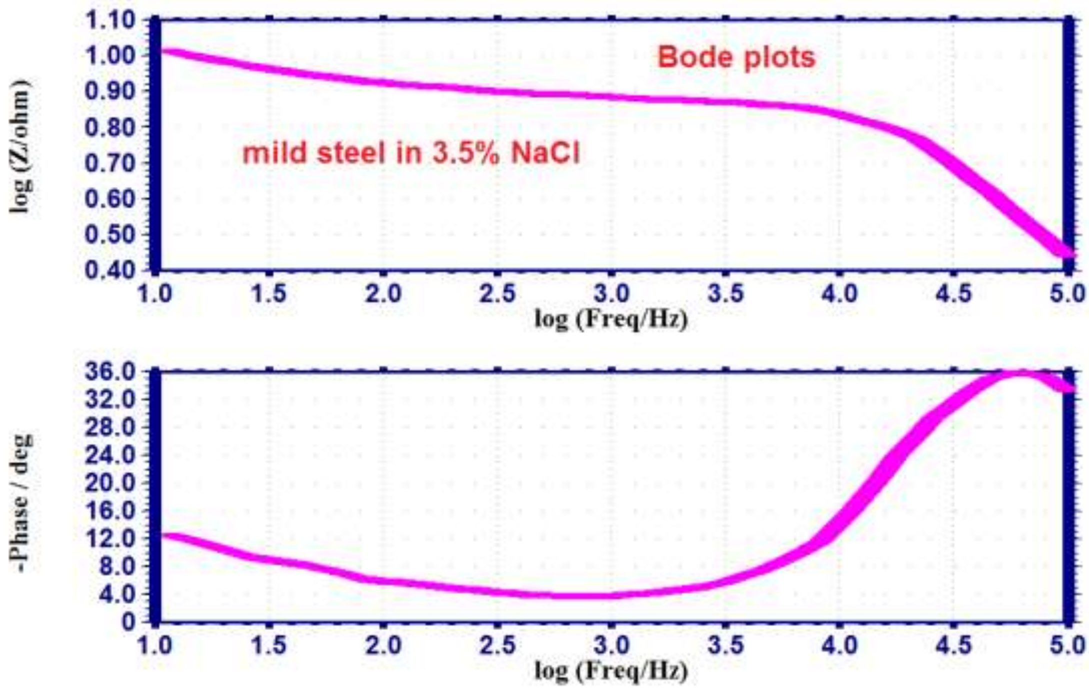

Figure 6. Bode plots of mild steel in 3.5% NaCl solution

Slika 6. Bode-ova kriva za meki čelik u 3.5% rastvoru NaCl

AC impedance spectra have been used to detect the formation of the film on the metal surface. If the protective film is formed, the charge transfer resistance (R_t) increases and double layer capacitance (C_{dl}) value decreases. The impedance value increases and phase angle decreases (Figure 8).

The AC impedance parameters, namely charge transfer resistance (R_t) and double layer capacitance (C_{dl}) are given in Table 2. When mild steel is immersed in 3.5% NaCl solution, the R_t value is 7.744ohmcm^2 and C_{dl} value is 6.5857×10^{-7} F/cm^{2}. The impedance value is 1.012.

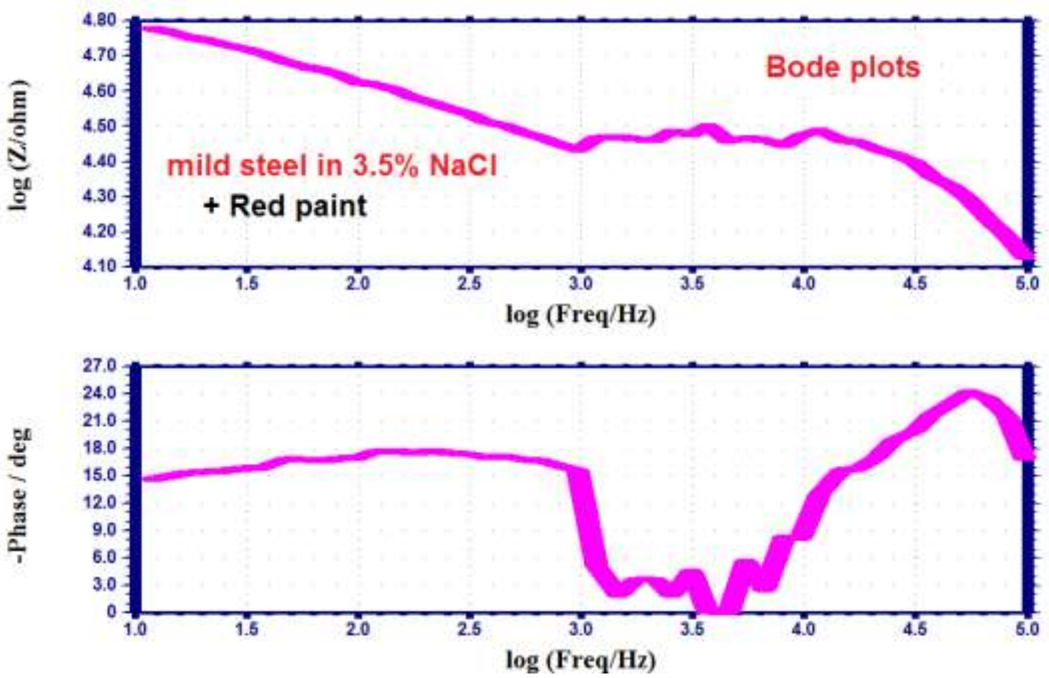

Figure 7. Bode plots of mild steel coated with red paint in 3.5% NaCl solution

Slika 7. Bode-ova kriva za meki čelik premazan crvenom bojom u 3.5% rastvoru NaCl

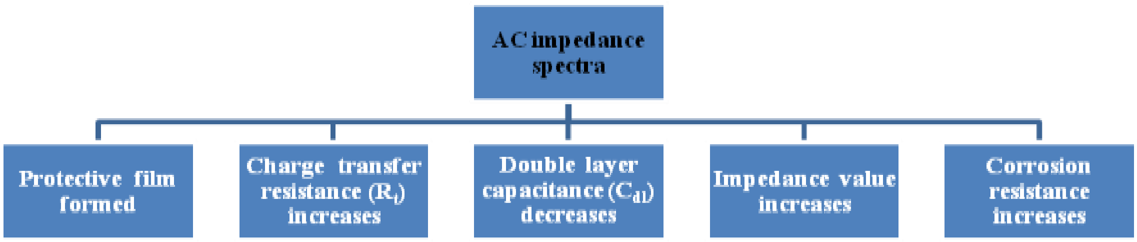

Figure 8. Protective film and corrosion parameters

Slika 8. Parametri zaštitnog filma i korozije

Table 2. AC Impedance parameters of mild steel immersed in various solutions obtained from AC impedance spectra

Tabela 2. Parametri impedanse naizmenične struje za meki čelik, uronjen u različite kombinacije, dobijeni iz spektra impedanse naizmenične struje

System	R_t, Ohmcm^2	C_{dl}, F/cm ^{2}	Impedance, (log z/Ohm)
3.5%NaCl	7.744	6.5857×10^{-7}	1.012
3.5%NaCl+asian guard red paint (AGRP)	45690	1.1162×10^{-10}	4.777

Influence of asian guard red paint (AGRP) on the corrosion resistance of mild steel immersed in 3.5%NaCl

When the paint coated electrode is immersed in 3.5%NaCl, the R_t value increases from 7.744 to 45690 Ohmcm^2 (Figure 9) and C_{dl} value decreases from 6.5857×10^{-7} to 1.1162×10^{-10}F/cm^2. The impedance value increases from 1.012 to 4.777. These values indicate that the coated film is very strong and it is not broken by the ions present in 3.5%NaCl medium. Corrosion inhibition efficiency calculated from R_t values is 99.98%, which is more appreciated.

Implication

When a mild steel robot or machinery coated with Asian guard red paint (AGRP) is immersed 3.5%NaCl, the corrosion resistance of the increases. This is due to the fact, the coating of the film prevents the corrosion of mild steel 3.5% NaCl. Hence, it is recommended that the mild steel used in under water technology may be coated with the Asian guard red paint (AGRP).

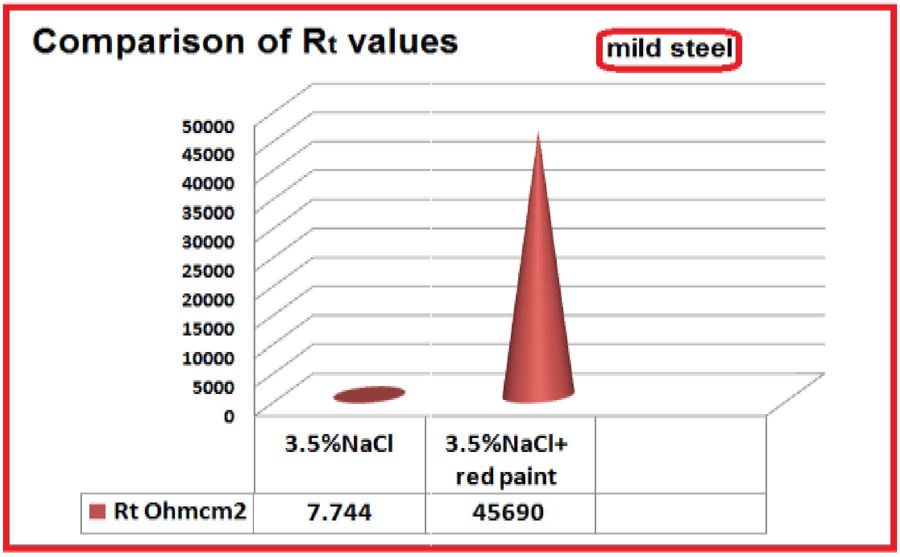

Figure 9. Comparison of R_t values

Slika 9. Poređenje vrednosti R_t

3. CONCLUSION

Metallic parts of machines of ships or aero planes may submerge in sea water. They may undergo corrosion when they come in contact with sea water which contains 3.5% sodium chloride [21]. This is most commonly responsible for the corrosive nature of the sea water. The robots made of materials such as mild steel may also undergo corrosion when they come in contact with sea water, while is search. If a paint coating is given, it will control the corrosion of these proposed materials. Hence this work is undertaken. Mild steel is coated with Asian guard red paint. Corrosion resistance of mild in3.5% sodium chloride solution is measured before coating and after coating by electrochemical studies such as such as polarization study and AC impedance spectra. The corrosion inhibition efficiency offered by red paint to mild steel in 3.5% sodium chloride is 99.98%.

When a mild steel robot or machinery coated with Asian guard red paint (AGRP) is immersed 3.5%NaCl, the corrosion resistance of the increases. This is due to the fact, the coating of the film prevents the corrosion of mild steel 3.5% NaCl. Hence, it is recommended that the mild steel used in under water technology may be coated with the Asian guard red paint (AGRP).

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IZVOD

DETEKTOVANJE PODVODNIH METALNIH OBJEKATA POMOĆU VEŠTAČKE INTELIGENCIJE I ZAŠTITA OD KOROZIJE PREDMETA OD MEKOG ČELIKA KORIŠĆENIH U PODVODNOJ STUDIJI - STUDIJA SLUČAJA

DEO B - ZAštita od korozije predmeta od mekog čelika korišćenih u podvodnoj studiji

Ukopani metalni predmeti u morskoj vodi mogu proći koroziju zbog korozivnih jona, poput hloridnih jona prisutnih u morskoj vodi. Međutim, boja može kontrolisati koroziju metalnih predmeta kao što su roboti. Otpornost na koroziju mekog čelika u 3,5 % rastvoru natrijum hlorida pre i posle premazivanja azijskom zaštitnom crvenom bojom procenjena je polarizacionom studijom i spektrom impedanse naizmenične struje. U prisustvu azijske zaštitne crvene boje, otpor linearne polarizacije se povećava, struja korozije se smanjuje, otpor prenošenja naboja raste, kapacitet dvostrukog sloja se smanjuje, a vrednost impedanse raste. Tako je otpornost na koroziju predmeta od mekog čelika u 3,5 % rastvoru natrijum hlorida nakon premazivanja azijskom zaštitnom crvenom bojom poboljšana.

Ključne reči: *predmeti od meki čelik, roboti, premazi, azijska zaštitna crvena boja, polarizaciona studija, spektri impedanse naizmenične struje, morska voda.*

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