The 52nd International October Conference on Mining and Metallurgy
October 6th – 7th , 2021
www.ioc.tfbor.bg.ac.rs

L-LYSINE AS CORROSION INHIBITOR OF STAINLESS STEEL IN RINGER'S SOLUTION

Milan Radovanović[1], Ana Simonović[1], Marija Petrović Mihajlović[1], Žaklina Tasić[1], Vladan Nedelkovski[1], Milan Antonijević[1]

[1]Technical Faculty Bor, University of Belgrade, V.J. 12, 19210 Bor, Serbia

Abstract

The effects of L-Lysine on stainless steel 316L corrosion in Ringer's solution were investigated. The investigation comprised different electrochemical techniques: measurement of open circuit potential and linear potentiodynamic polarization. The results obtained by polarization measurements show that the L-Lysine successfully inhibits the corrosion processes on stainless steel, in Ringer's solution, acting like mixed type inhibitor with a more pronounced influence on cathodic processes. Also, potentiodynamic curves indicate that L-Lysine acts through adsorption onto the steel surface without changing the mechanism of corrosion of steel. Quantum chemical parameters indicate that L-Lysine may be used as a corrosion inhibitor which was confirmed by electrochemical measurements.

Keywords: stainless steel; amino acids; corrosion; Ringer's solution; inhibition.

1. INTRODUCTION

Extracts and plant oils are recent years intesively studied as green inhibitors of metal corrosion in different solutions. Obtained results available in the literature show that plant extracts achieved inhibition efficiency which provides promise application of plant extract as potential good corrosion inhibitors [4]. Besides that, amino acids are another very promising group of compounds which allredy proved as green corrosion inhibitors for different metals and alloys in aggressive environment. Also, amino acids have numerous benefits: low cost of production, high purity, high degree of inhibition efficiency [5].

2. EXPERIMENTAL

Table 1 – Composition of Ringer's solution

Component	Concentration, g/dm^3
NaCl	8.60
KCl	0.3
$CaCl_2$	0.33

3. RESULTS AND DISCUSSION

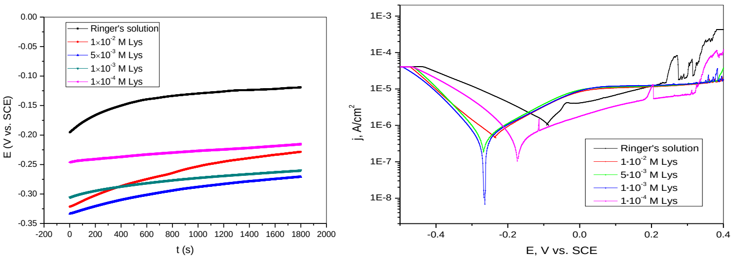

Figure 1 - Open circuit potential (a) and potentiodynamic polarization curves (b) recorded for stainless steel in Ringer's solution without and with the addition of different amount of L-Lysine

Table 2 – Electrochemical parameters of stainless steel 316L obtained using data presented in Figures 1b

Solution	E_{corr} (V vs. SCE)	j_{corr} (A/cm^2)	b_c (mV/dec)	b_a (mV/dec)	IE (%)
Ringer's solution	-0.092	$1.238\cdot10^{-6}$	-0.0189	0.0271	/
$1\cdot10^{-4}$ M Lys	-0.172	$3.284\cdot10^{-7}$	-0.123	0.085	73.5
$1\cdot10^{-3}$ M Lys	-0.265	$2.125\cdot10^{-7}$	-0.129	0.12	82.8
$5\cdot10^{-3}$ M Lys	-0.267	$1.882\cdot10^{-7}$	-0.144	0.095	76.7
$1\cdot10^{-2}$ M Lys	-0.236	$5.075\cdot10^{-7}$	-0.091	0.092	59.0

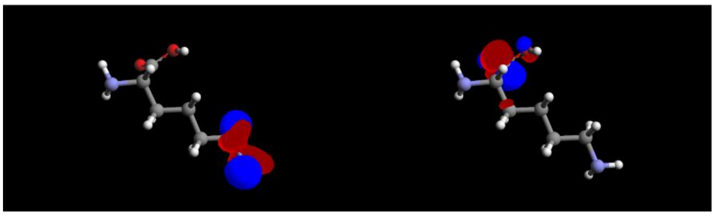

Figure 2 - Distribution of HOMO (left) and LUMO (right) of L-Lysine

Table 2 - Quantum chemical parameters

Parameter	E_{HOMO}, eV	E_{LUMO}, eV	ΔE, eV	μ, D	ΔN
Value	-9.582	0.820	10.402	2.42109886	0.252
Parameter	I, eV	A, eV	χ, eV	η, eV	
Value	9.582500204	-0.820332952	4.381083626	5.201416578	

4. CONCLUSION

L-Lysine acts like mixed type inhibitor of stainless steel 316L corrosion in Ringer's solution with more pronounced effect on cathodic processes. Potentiodynamic measurements indicate that L-Lysine forms protective film on steel surface which prevent contact between metal and aggressive ions. Corrosion mechanism of stainless steel is unchanged in the presence of L-Lysine. Quantum chemical parameters indicate that L-Lysine may be used as a corrosion inhibitor which was confirmed by electrochemical measurements.

5. ACKNOWLEDGEMENT

The research presented in this paper was done with the financial support of the Ministry of Education, Science and Technological Development of the Republic of Serbia, within the funding of the scientific research work at the University of Belgrade, Technical Faculty in Bor, according to the contract with registration number 451-03-9/2021-14/ 200131

6. REFERENCES

[1] S. L. Assis, S. O. Rogero, R. A. Antunes, A. F. Padilha, I. A. Costa, J. Biomed. Mater. Res. B, 73 B (1) (2005) 109-116.

[2] M. Talha, Y. Ma, P. Kumar, Y. Lin, A. Singh, Colloid. Surface. B, 176 (2018) 494-506.

[3] B. El Ibrahimi, A. Jmaiai, L. Bazzi, S. El Isami, Arab. J. Chem., 13 (2020) 740-771.

[4] C. Verma, E. E. Ebenso, I. Bahadur, M. A. Quraishi, J. Mol. Liq., 266 (2018) 577-590.

[5] R. T. Loto, J. Mater. Res. Technol., 8 (2019) 484-493.

[6] O. Kaczerewska. R. Leiva-Garcia, R. Akid, B. Brycki, I. Kowalczyk, T. Pospieszny, J. Mol. Liq., 249 (2018) 1113-1124.

[7] M. B. Radovanović, Ž. T. Tasić, A. T. Simonović, M. B. Petrović Mihajlović, M. M. Antonijević, ACS Omega, 5 (2020) 12768-12776.

[8] M. B. Radovanović, Ž. T. Tasić, M. B. Petrović Mihajlović, A. T. Simonović, M. M. Antonijević, Sci. Rep., 9 (2019) 16081.

[9] S. Bashir, V. Sharma, H. Lgaz, I. Chung, A. Singh, A. Kumar, J. Mol. Liq., 263 (2018) 454-462.

[10] M.A. Thompson, Planaria Software LLC, Seattle, WA. http://www.arguslab.com.

[11] M. B. Petrović Mihajlović, M. B. Radovanović, Ž. Z. Tasić, M. M. Antonijević, J. Mol. Liq., 225 (2017) 127-136.

[12] B. El Ibrahimi, A. Soumoue, A. Jmiai, H. Bourzi, R. Oukhrib, K. El Mouaden, S. El Issami, L. Bazzi, J. Mol. Struct., 1125 (2016) 93-102.