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ELECTROCHEMICAL AND QUANTUM CHEMICAL STUDIES ON COPPER CORROSION PROTECTION IN 1M HCL BY N-PHENYLSULFAMIDE

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INTRODUCTION

The acidic medium is highly encountered in the industrial fields such as cleaning, descaling and pickling[1], which caused lot of degradations so the use of inhibitors is considered as a must to minimize the extent of corrosion in the acidic solutions[2] and providing protection of metal[3]. The use of inhibitors is one of the most practical methods for protection against corrosion especially in acid descaling bathes to prevent not only metal dissolution but also acid consumption by reducing the rate of either or both partial reactions of the corrosion process. The studies of organic and eco-friendly corrosion inhibitors are of great interest from an environmental perspective and are attracting a significant level of attention[4]. And to mitigate these effects the use of organic inhibitors seems to be an efficient and suitable option because it have apromising future for the quality of the environment[5-6] because they do not contain heavy metals or other toxic compounds.

MATERIALS AND METHODS

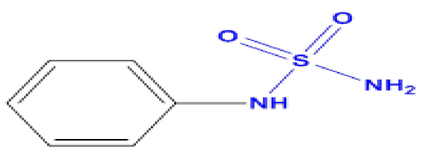

Figure 1. Chemical structure of N-phenylsulfamide

Inhibitor Sample and medium

corrosion tests were performed on the copper of the following percentage composition: Cu 99.03 %, Zn 0.12 %, Pb 0.02 %, Bi and Mn 0.03%, Fe 0.02%, and balance Fe. The aggressive solution used was prepared by dilution of analytical reagent grade 37% HCl with bidistilled water. Inhibitor solutions were prepared in the range, 25 ppm -400 ppm concentrations in a 1M HCl solution.

Electrochimicals tests

Polarization measurements were conducted in aconventional three-electrodecell, which includes a working electrode (sample), a platinum counter electrode (CE) and saturated Ag/AgCl reference electrode (RE). Measurements were carried out using SP300 Potentiostat/Galvanostat piloted by a micro computer with EC-Lab V 10.33 Software. The potentials were scanned at a scanrate of 0.5 $\boldsymbol{mV.S^{-1}}$ in the range of -200 mV to +200mV, The electrochemical impedance spectroscopy EIS was carried out with the open circuit potential, Eocp, for each sample; all of the samples were immersed for 60 min over a frequency range of 50 KHz to 10 MHz with a signal amplitude perturbation of 10 mV. Next, it was fitted with sets of circuits that give the best value.

REFERENCES

[1] H. Ferkous, S. Djellali, R. Sahraoui, Y. Benguerba, H. Behloul, A. Çukurovali. *J. Mol. Liq.*,**2020**, *307*,1473-1478.
[2] H. Ferkous, M. Zerroug, M. Radjai, M.A. Chaouch, Z. Jebali, H. Majdoub. *Proceedings of Euro-Mediterranean Conference for Environmental Integration*, **2018**, 1291-1292
[3] A. Ehsani, M.G. Mahjani, M. Hosseini, R. Safari, R. Moshrefi, H. Mohammad Shiria. *J. Colloid Interface Sci.*, **2016**,*490*,444-451.
[4] O.K. Abiola, A.O. James, *Corros. Sci.*, **2010**, *52*, 661-664.
[5]M.A. Quraishi, A. Singh, V.K. Singh, D.K. Yadav, A.K. Singh. *Mater. Chem. Physics.*, **2010**, *122*, 5456-5771
[6] A. Rodriguez-Torres, M.G. Valladares-Cisneros, V.M. Salinas-Bravo, J.G. Gonzalez-Rodriguez. *Int. J. Electrochem. Sci.*, **2017**, *12*, 5756-5771.

RESULTS AND DISCUSSION

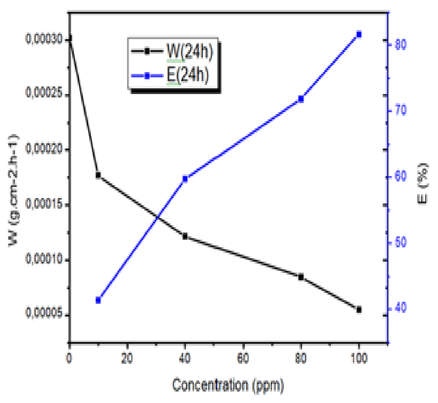

Figure 2. Evolution weight loss at the end of immersion (48h) as a functions of inhibitor content

The gravimetric data obtained in the absence and presence of N-phenylsulfamide at different concentrations. The respective corrosion rate illustrated that the addition of inhibitor molecule decreases hugely corrosion rate. This finding elucidated by Figure 2, confirms that inhibitor adsorbs on copper surface and then inhibits the corrosion process. The inhibition efficiency of N-phenylsulfamide with inhibitor concentration to reach higher value (82%) at 400 ppm. This behaviour indicates that natural molecule acts as an efficient inhibitor for the corrosion of copperr in HCl media.

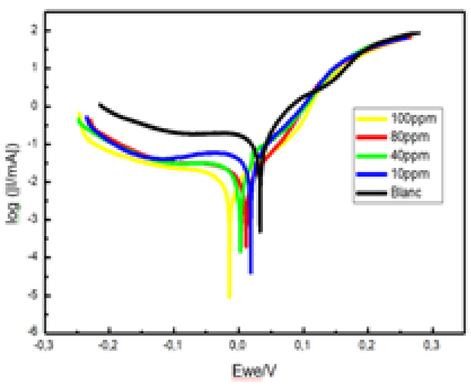

Figure 3. Polarization curves of steel in 1M HCl with and without addition of inhibitor

Concentration de l'inhibiteur	E corr (mV)/Ag/AgCl	I corr (µA/cm²)	Rp (Ohm.cm²)	Bc (mV)	Ba (mV)	θ	EI (%)
Blanc	15,344	97,360	107	325,6	74,7	-	-
10 ppm	-21,521	37,229	349	1 047,2	73,7	0.617	61.7
40 ppm	-10,735	21,179	593	209,8	56,8	0.782	78.2
80 ppm	-30,583	15,396	255	213,4	67,3	0.841	84.1
100 ppm	11,433	6,441	1 572	218,8	46,7	0.933	93.3

Table 1. Electrochemical parametrs and inhibitory effciency of steel in 1M HCl without and with the addition on the inhibitor at different concentrations

-The I corr values decrease with increasing inhibitor concentration.
-The E corr values were shifted to ward the negative in the presence of the inhibitor,
The values of βa and βc do not change in a regular way, the inhibitor considered as mixed type inhibitor, According to electrochemical impedance diagrams we found that the charge transfer resistance in creases and the capacity of electric double layer decreases when the inhibitor concentration in the solution increases.

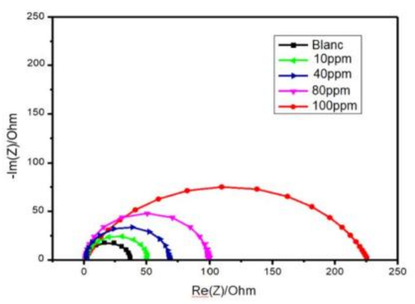

Figure 4. Electrochemical impedance of copper in 1M HCl solution and at different concentrations of inhibitor

The Nyquist curve (Figure 4) indicating that the corrosion reaction is controlled by a charge transfer process and a diffusional process. and the inspection reveals that the capacitive loops' diameters grow larger as the concentration of the inhibitor increases

CONCLUSION

As conclusion we have demonstrated that:
1.The extract N-phenylsulfamide is effictif inhibiter of corrosion of copper in 1M HCl
2.Polarization studies showed that the compounds under investigation were mixed type inhibitors.
3.The weight loss, electrochemical impedance spectroscopy, polarization curve and sand linear polarization were in good agreement.