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Research Article

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Application of some ferrocene derivatives in the field of corrosion inhibition

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ABSTRACT

This work is to study the inhibitory power of compound ferrocene (ferrocénylméthyl N-(o-cyano) aniline) (fc22), vis-à-vis the corrosion of steel XC70 PSL2 in an environment of aqueous sulfuric acid. The inhibitory power fc22 is evaluated by the electrochemical method, based on achieving equilibrium potential of steel in the corrosive medium followed by tracing the polarization curves that provides access to the parameters of corrosion (B_c, B_a, i_{corr}, V_{corr}, E_{corr}…..) using Tafel curve. The results obtained shows that the compound has the largest fc22 inhibitory power when the concentration 20 ppm.

Keywords: Corrosion, carbon steel XC70, Inhibition, ferrocene Derivative, Acid (0.5M H_2SO_4).

INTRODUCTION

Corrosion affects all achievements of the engineer, the largest to smallest: energy production [1], civil engineering [2], transport, machinery, medical devices [3], micro-electronic components, etc... In industrialized countries the costs of corrosion are three to four percent of gross national product. Corrosion is not only wasteful of raw materials and energy, plus it can cause accidents with serious consequences and, in some cases, contribute to pollution of the natural environment [4].

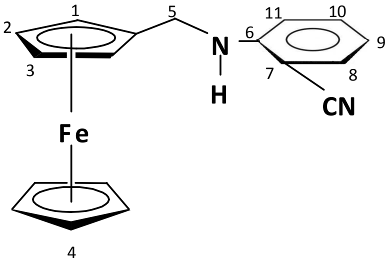
In the petroleum industry and specifically the production of oil and gas, the internal corrosion of pipes and collection of steel surface is a well known phenomenon and is a serious problem. In this case, inhibitors organic amine base are the most used because of their effectiveness.

EXPERIMENTAL SECTION

A mild steel sample of the following chemical composition (as percentage) was served as working electrode:

C	Si	Mn	p	S	Cr	Mo	Ni	AI
0 ,065	0 ,245	1,685	0,002	0,001	0,042	0,005	0 ,026	0 ,042
Cu	Nb	Ti	V	Fe				
0,010	0,067	0 ,019	0 ,014	97,77				

H_2SO_4 (0.5 M) solutions were prepared from concentrated solutions and bi-distilled water. Solutions of ferrocene derivative (fc22) were prepared by dissolving the required weight in Ethanol.



ferrocénylméthyl N-(o-cyano) aniline (fc22)

For potentiostatic experiments, a cylindrical rod of each sample was embedded in araldite leaving an exposed bottom area of 1.0 cm^2, and used as working electrode. Each working electrode was polished with different grades of emery papers (400, 600, 800 and1000 in late 4000 μm), degreased with acetone and rinsed with distilled water, before its immersion in the test solution. Potentiostatic polarization studies were carried out using Potentiostat/Galvanostat PGP-201. Three-compartment cell with a saturated calomel reference electrode (SCE) and a platinum foil auxiliary electrode were used. For potentiodynamic experiments, the working electrode was held at the potential of hydrogen evolution for 10 min before the starting of the potential sweep to get rid of any pre-immersion oxide film which may be present on the surface. The electrode was then disconnected from the potentiostat, gently shaken in the solution to release the hydrogen bubbles attached to its surface and left in the test solution until the reach of its steady state potential. Once the electrode acquires its steady state potential it is reconnected to the potentiostat for the polarization experiment procedure. The inhibition efficiency IE was calculated using the following equation:

$$IE\% = [(I - I_i) / I] \times 100$$

Where I and I_i are the corrosion rates in free and inhibited solutions, respectively.

RESULTS

Table -1: electrochemical parameters relating to the steel in a medium XC70 0.5M sulfuric acid in the presence of compound fc22

C (ppm)	R_P $ohm.cm^2$	B_a (mV)	B_c (mV)	i_{corr} (mA/cm^2)	E_{corr} (mV)	V_{corr} (mm/an)	R $(\%)$
0	28.52	57.8	-87.8	0.3901	-497.1	4.562	60.22
10	82.04	100.7	-110.1	0.1918	-505.31	2.243	50.83
20	82.68	31.8	-62.1	0.0879	-483.1	1.028	**77.46**
30	84.76	44.1	-109.8	0.1374	-496.6	1.607	64.77
40	89.04	41.6	-112.6	0.0976	-497.6	1.51	66.85
50	92.66	32.4	-101.1	0.1078	-473.8	1.141	74.98
60	67.44	31.6	-65.2	0.1085	-482.7	1.261	72.35
70	65.75	37.6	-106.9	0.0928	-548.6	1.269	72.18
80	85.61	32.0	-73.9	0.0910	-551.2	1.080	76.32
90	60.96	25.4	-48.7	0.0896	-542.4	1.047	77.04

According to the results in Table-1 and the curve Fig.1, we observe that the addition of the compound fc22 to the corrosive environment causes a decrease in the rate of corrosion for the concentrations 10, 20 ppm, then there is a increase the corrosion rate for concentrations greater than 20 ppm (at this concentration there movement of the corrosion potential to anodic areas.), the rate of inhibition at this concentration of 77.46% is optimal.

The corrosion rate over the rise is equal to 2.24 mm/yr; it is obtained at a concentration of 10 ppm, while the lowest is 1.03 mm/yr obtained for a concentration of 20 ppm. This value represents a good protection for steel.

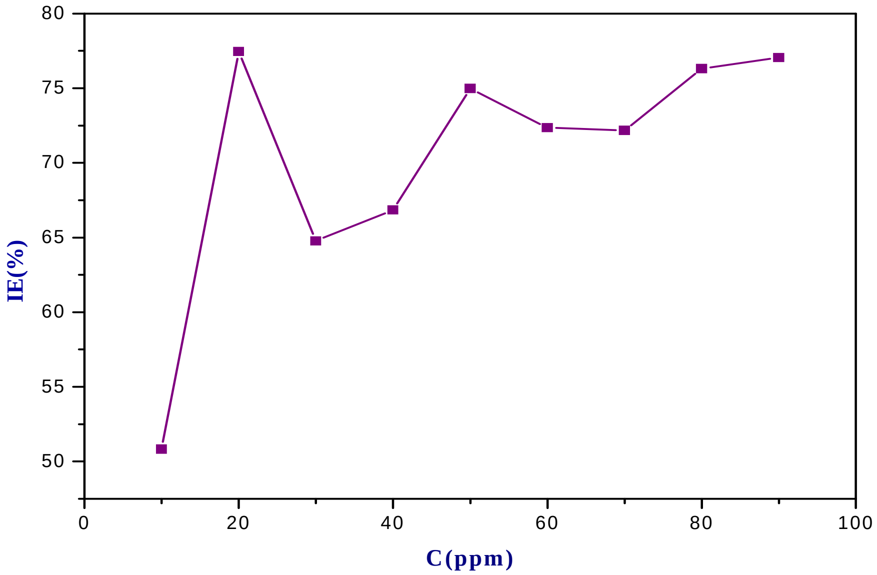


Fig.1: Variation of the inhibition efficiency with the concentration of fc22 in H_2SO_4 solution.

CONCLUSION

This work takes place in the context of applied research on the aqueous corrosion inhibition by ferrocene compounds. For this we studied the inhibitory effect of three ferrocene derivatives on the corrosion of steel XC70 in an acid medium.

The results show that the yield reached 77.46% inhibition for the compound fc22 concentration of 20 ppm. The layout was Tafel curves to calculate a number of parameters such as corrosion of the coefficients of anodic and cathodic Tafel, the transfer coefficient, the current and the corrosion potential. The plot of corrosion potential depending on the concentration of inhibitors show that the potential in the presence of inhibitors, is moved to the most positive values which leads to the conclusion that the compounds studied are anodic inhibitors.

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