THE ESTIMATION OF ANTI-CORROSION EFFICIENCY OF INHIBITOR CH1377A AGAINST SULPHATE-REDUCING BACTERIA FOR N80 STEEL

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ABSTRACT

This article examines the effects of the use of inhibitor in the treatment of the bacterial corrosion in the transport of oil pipelines in the region of Hassi Messaoud (south of Algeria) on steel N80. In order to improve the quality of the treatment and metal properties for the oil pipes used. For this aim, we have prepared a culture environment suitable for live bacteria. Then, we have put the samples of this steel. In this contaminated environments by SRB.After 60 days of incubation, we inject the inhibitor the most widely used to eliminate the bacteria responsible for the problem of oxidation during the extraction of crude oil.

KEYWORDS: Corrosion, Bacterial corrosion,Sulphate-Reducing bacteria,Inhibitors CH1377A, Steel N 80.

RESUME

Cet article examine les effets de l'utilisation de l'inhibiteur dans le traitement de la corrosion bactérienne durant le transport de pétrole brut à la région de Hassi Messaoud (sud de l'Algérie) sur l'acier N80 corrodé.Afin d'améliorer la qualité du traitement et les propriétés métalliques pour les tuyaux d'huile utilisée. Pour cela, nous avons préparé un milieu de culture adapté pour vivre des bactéries. Ensuit, nous mettons les échantillons dans ce milieu contaminés par BSR.Après 60 jours d'incubation nous injectons de l'inhibiteur le plus largement utilisé pour éliminer les bactéries responsables du problème d'oxydation au cours de l'extraction de pétrole brut.

MOTS CLES: Corrosion, Corrosion bactérienne, Bactéries sulfato-réductrices, Inhibiteur , Acier N 80.

1 INTRODUCTION

The problem of corrosion in the circuits of production is known in the operating systems of the oil fields, during the secondary recoveries by water injection, in order to maintain the pressure of the deposits. This corrosion phenomenon manifests itself as well in the equipment of bottom than in surface facilities.

Despite, the using of inhibitors as a solution to reduce the problem of the bacterial corrosion in the areas of extraction of oil, but the problem is still present. So I approached this article to study the behavior of oxidized steel by the bacteria during 60 days and we have added a type of inhibitor to follow what would happen to the surface of the steel.

This article is organized as follows: Section 1 provides the necessary background on the corrosion, bacterial corrosion, RSB, fight against bio corrosion and corrosion inhibitors. Section 2 presents our experimental method such as the material used. Section 3 presents the results obtained using the PH, the SEM and the EDX and interpretations on these results. Section 4 is the conclusion of our paper.

The corrosion is defined as a set of processes of deterioration of a metal under the E and actions

physical, chemical or electrochemical the surrounding environment. The metal and corroded tends to react toform a compound (oxide, sulfate, carbonate, etc.) more stable [1].

The Bacterial corrosion is a bacterial attack of metallic materials, in particular in the buried pipes and reservoirs. In e, and the metabolism of the development of certain bacteria causes the formation of sulfuric acidwhich attack the metal [2].

2 INFLUENCE OF SRB (THE SULFATE-REDUCING BACTERIA) ON THE DEGRADATION OF METALS

Metallic material, as any other element in contact with the natural environment aqueous, recovers itself of a biofilm formed in the presence of microorganisms. The first step of the bacterial corrosion is mandatory in the formation of a biofilm on the metal surface. However, the reverse is not true [3].

2.1 Mechanisms of the bacterial corrosion by SRB

The advanced mechanisms to account for the influence of micro-organisms in the process of biocorrosion generally takes into account the role electrochemically exercised by the iron sulphides. For some authors, the phenomenon of biocorrosion is explained only by the formation of these sulphides in a mechanism which is very close to that of the abiotic corrosion by H_2S.

For other authors, on the contrary, a specific role of micro-organisms is necessary to account for the rapid kinetics observed in biocorrosion. As well, two main theories are advanced to explain these kinetics: that of the cathodic depolarization and that of the Bacterial acidification [4][5][6][7].

Theory of the cathodic depolarization:

- Ionization of water:

$$8H_2O \longleftrightarrow 8H^+ + 8OH^- \quad (1)$$

- Anodic corrosion of iron:

$$4Fe \longleftrightarrow 4Fe^{2+} + 8e^- \quad (2)$$

- The formation of hydrogen at the cathode:

$$8H^- + 8e^- \rightarrow 8H^\circ \quad (3)$$

- The absorption of hydrogen by the bacteria:

$$SO_4^{-2} + 8H^\circ \xrightarrow{\text{Hydrogenase}} S^{2-} + 4H_2 \quad (4)$$

Call reaction: cathodic depolarization :

- Anodic reactions secondary:

$$Fe^{2+} + S^{2-} \rightarrow FeS \quad (5)$$

$$3Fe^{2+} + 6OH^- \rightarrow 3Fe(OH)_2 \quad (6)$$

- Réaction globale :

$$4Fe + SO4^{2-} + 4H_2O \longleftrightarrow FeS + 3Fe(OH)_2 + 2OH^- \quad (7)$$

The cathodic depolarization assumes that only the SRB who possess a hydrogenase are able to produce, by displacement of equilibria, speeds of corrosion Important [4][5][6][7].

2.2 Fight and prevention against the bio-corrosion

In the area of protection against corrosion, it is possible to act on the material itself (wise choice, forms adapted, and constraints depending on the applications ...), on the surface of the material (coating, painting, any type of surface treatment ...) or on the environment with which the material is in contact (corrosion inhibitors)[8].This phenomenon is currently subject of numerous scientific studies aimed to clarify the conditions and mechanisms of interaction between the organism and the material, and to develop methods of fight against the bio-corrosion such that the use of biocides [9] [10].

2.3 Corrosion inhibitors

A corrosion inhibitor is a chemical compound, which added to low concentration in the Environment corrosive, slows down or stops the corrosion process of a metal placed in contact with this environment. Such a definition cannot be perfect; it avoids however to consider as inhibitors of the additives which, while responding 'has the second condition (decrease the speed of corrosion), do not fulfill the first (for example, the adjustment of the PH by the addition of basic or acid does not constitute a means of inhibition within the meaning of the definition). Conversely, some compounds that should be excluded in any rigor by the definition, can however be considered as of the Inhibitors (additives consuming the oxygen = scavengers).

Finally, the meaning given by this definition to the term prohibited inhibitor that the inhibition of the corrosion is interpreted in a sense too semantics as the slowdown, by whatever means, of the corrosion process of a metal (Example of the incorporation of an element of alloy in a metal: the Chrome is not an inhibitor of the iron when it enters in the composition of a stainless steel)[10].

3 EXPERIMENTAL MATERIAL AND TECHNIQUES

The studies are conducted on samples of oil pipe that carry crude oil during the extraction (steel N 80) having a high resistance to the pressure. Also, it can be used during the process of drilling of oil wells and can withstand the wall of a well after the completion of the latter, in order to ensure a normal operation in all the wells.

The surface of the coupons is rectified, degreased and dried, whose chemical composition (%) represented in the Table 1.

Table 01: The chemical composition of the base metal (mass%)

	C	Si	Mn	P	S	Cr	Mo	Ni	Nb	V	Ti	Cu
Acier N80	0.24	0.22	1.19	0.013	0.004	0.036	0.021	0.028	0.006	0.017	0.011	0.019

Table02: defines the setting of samples used in the experiment

Table 02: Description of the samples

Sample number	Description of situation
Sample 1	Sample of the steel N80 in a contaminated environment by SRB after 90days at37°C.
Sample 2	Sample of the steel N80 corroded by the SRB during 60 days and injected by an inhibitor and has been left more 30 days at 37 °C.

The chemical components in which we have the appropriate environment to activate the representative bacteria is presented in Table 3

Table 03: The chemical composition of the culture medium of bacteria

The components	The quantity
Magnesium Sulfate MgSO4	1.0g
Ammonium sulphate(NH4)2SO4	1.0g
Sodium citrate trisodium NaC6H5O7.2H2O	1.0g
DI-potassium Hydrogenophosphate K2HPO4	1.0g
Ascorbic acid	0.2g
Yeast extract	0.2g
Agar-agar	0.1g
Sodium Lactate	4.0ml
Distilled water for the manufacture of mid	1L

After the preparation of the culture environment, we measured the PH of the environment. Then, we have filled 9 ml of environment prepared in vials penicillin, in order to add our metal samples defatted prior to acetone in these vials. We have plugged the vials to using capsules of rubber, capsuling then were blocked by the aluminum. After, we have purged the vials with nitrogen to create the anaerobic environment and sterilize by autoclaving under wet pressure has' 120°C during 50 m. Then, using a syringe, we collected 1 ml of water contains bacteria, and we eliminated the trapped air bubbles possibly in the syringe. Subsequently, we injected the contents of the latter through the capsule in the rubber stopper of the vial containing 9 ml of culture.Finally, we have labeled the vials. They have incubated in the oven at 37°C for 60 days.

After 60 days of incubation, we added the type of inhibitor used against the problems caused by the SRB.

Inhibitor: Is a chemical corrosion inhibitor of type film, soluble in water, specifically designed to prevent corrosion in the water system-wet. A low trend has' the formation of foam, effects not emulsifiers and a good stability characterize the product. As collateral actions, the product is also a biocide effective. The product is suitable to all the applications in the fields of oil and gas. The systematic use of the product prevents corrosion, thus contributing to reduce maintenance costs and thus ensuring a performance of high production.

Table 04: The chemical components of the inhibitor

No	Component	Resultant	Unit
1	Mg	0.0568	Mass%
2	Si	0.279	Mass%
3	P	0.0096	Mass%
4	S	0.0031	Mass%
5	Cl	3.15	Mass%
6	Ca	0.0119	Mass%
7	H2O	96.5	Mass%

4 RESULTS AND DISCUSSION

First, we measured the PH of environment samples before and after treatment. The results of the PH measurement presented in Table 5.

Table 05: PH in the environment of the samples

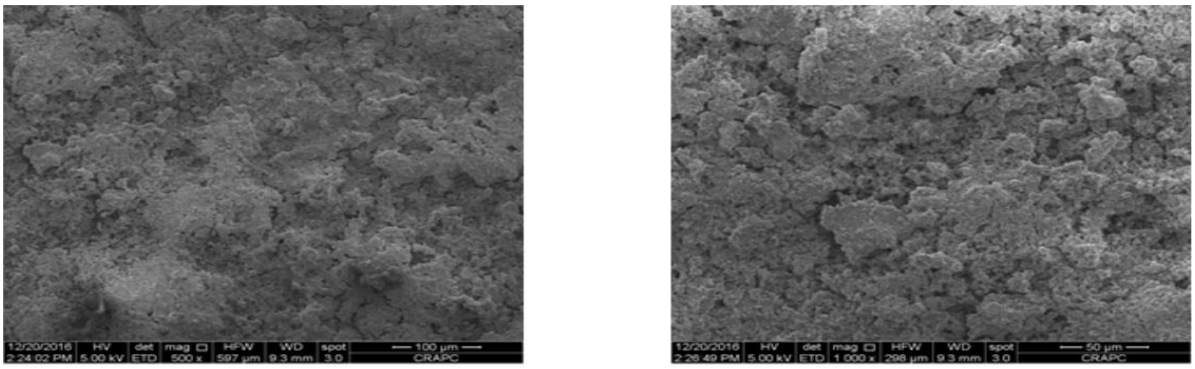
No	PH (front)	PH (after)
Environment of sample 1	7.1 0	9.01
Environment of sample 2	7.1 0	8.83

4.1 Analysis of the surface of the samples by scanning electronic microscope (SEM)

The determination of the morphology of deposit and formed on the surface of the steel N 80 has been carried out by

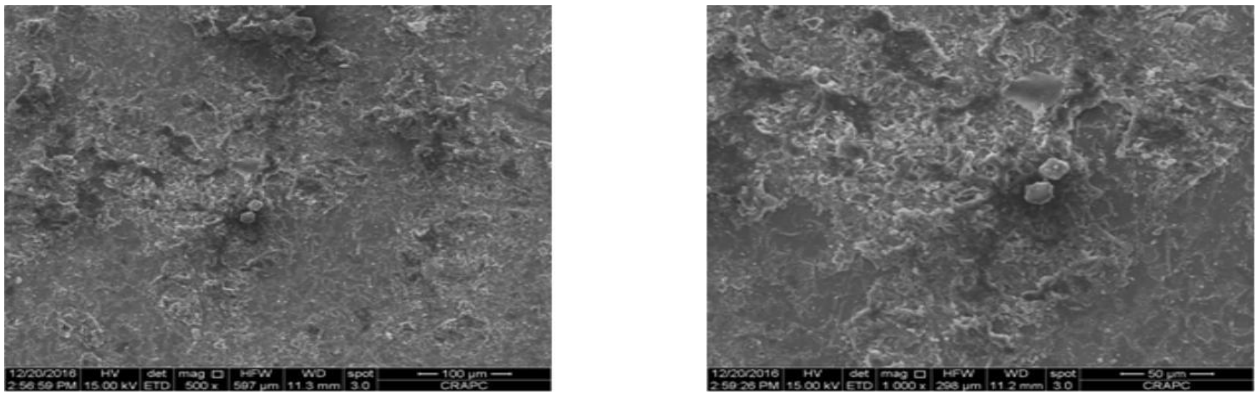
scanning electron microscopy.

We have achieved for each sample an image with expansions.



(a) Magnification 500X *(b) Magnification 1000X*

Figure 01: Photographs taken by the SEM from the surface of sample 1



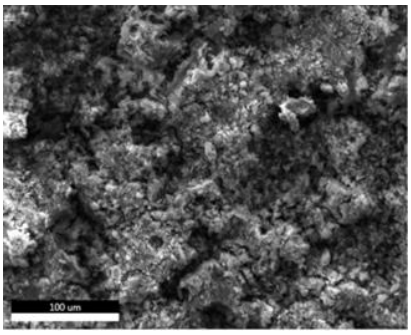
(c) Magnification 500X *(d) Magnification 1000X*

Figure 02: Photographs taken by the SEM from the surface of sample 2

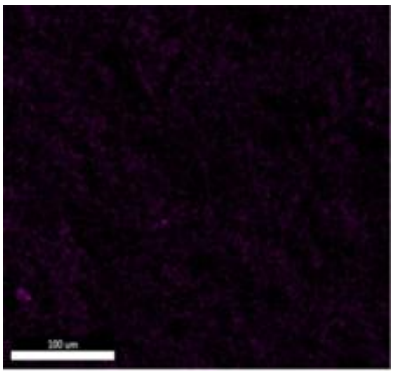
The general observation by the SEM of the without protection sample 1 surface clearly shows the presence of a deposition layer possess a colony structure. However, the images of sample 2 clearly shows the elimination of a deposit which formed of colonies on the surface. consequently, a layer of smooth deposit is created.

4.2 Analysis of the surface of the samples by EDX

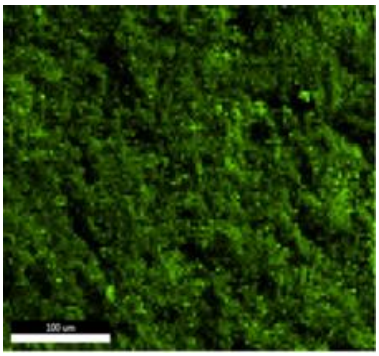
On the other hand, in order to know the chemical compositions of the layer are formed on the surface of the samples, we observed the samples by EDX (Energy Dispersive X-ray spectrometry). The maps were carried out for each sample to obtain a distribution of chemical elements with an allocation of color for each element detected. Note that, ROI means : Region Of Interest, and K the shell used by EDX machine.



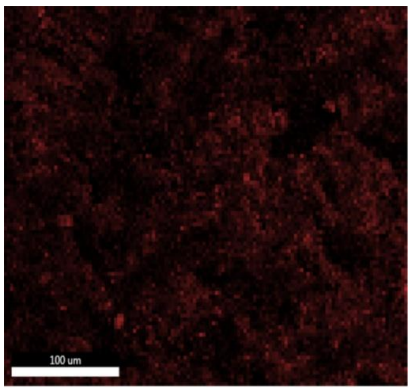
C K_ROI (29)



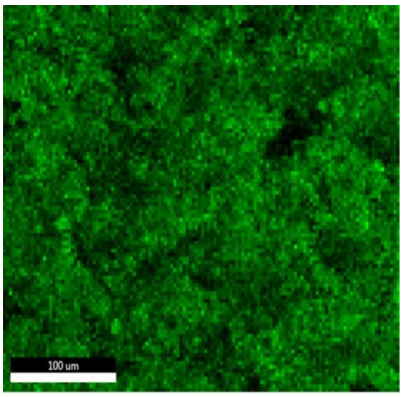
OK_ROI (109)



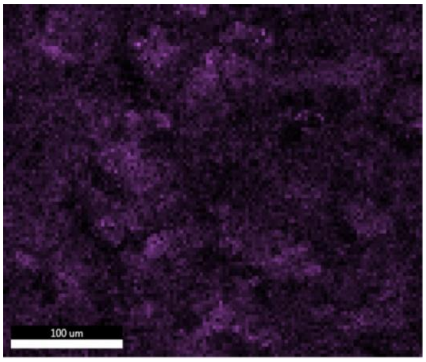
MgK_ROI (59)



P K_ROI (70)



S K_ROI (67)



FeK_ROI (87)

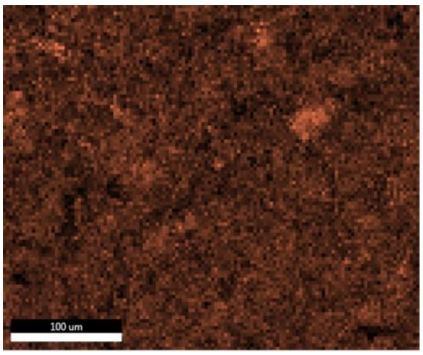


Figure 03: Mapping-chemistry of the surface of the sample without protection after 90 days of incubation

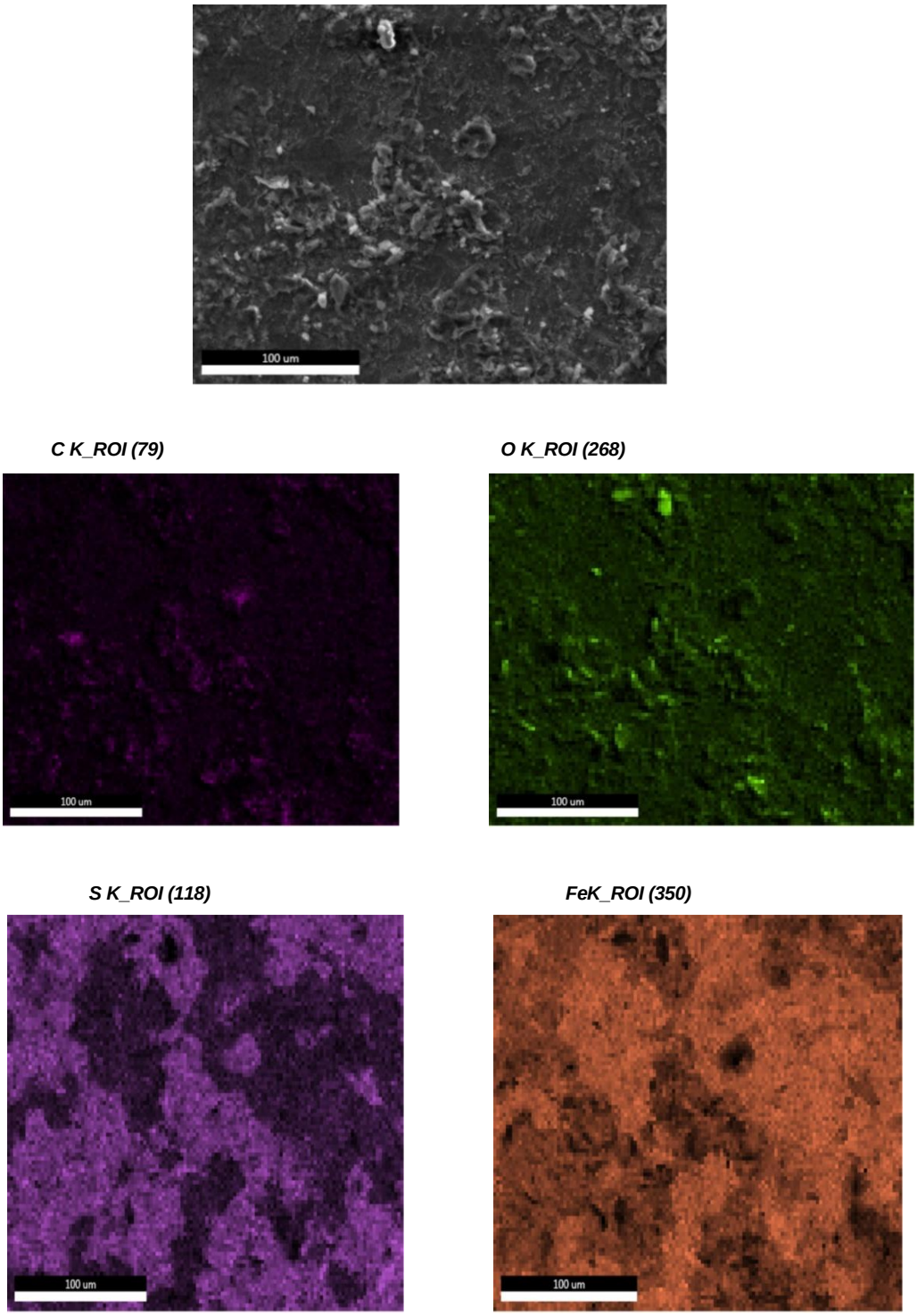


Figure 04: Mapping-chemistry of the surface of the sample under protection after 90 days of incubation

5 CONCLUSION

This work is to follow the bacterial corrosion caused by the bacteria on the oil pipeline and the effect of the inhibitor on the steel N80 already corroded by the bacteria (SRB), to treat the problem of the bacterial corrosion and protect the pipes of oil from this type of corrosion. To confirm the activation of the bacterium, we measure the PH of environment. And to observe the deposit on the surface of the sample, we use the SEM and the EDX.The two samples are based in the environment contaminated by SRB live during 90 at 37 °C.We conclude the following results:

The observation of sample 1: The increase in the pH means that the bacteria (SRB) are active.

Sample 2. Note that the pH is high but not as the sample 1, this means that the bacteria were active and have stopped

their activity because of the inhibitor that we have added after 60 days.

The analysis of images 1 (corresponding to the sample 1) clearly shows the existence of a deposit wide adhesive sealant stable this shape of the colonies on the surface. This sample contains a bacterial activity to through deposits on the surface in the form of colonies.by against, the analysis of the images 2 (corresponding to the sample 2) clearly shows the elimination of a deposit this form of colonies on the surface, but there is a layer of deposit almost smooth.

The chemical composition of the sedimentation (before treatment) confirms the presence of: oxygen, iron, carbon, sulfur and with low concentration of the magnesium, potassium, calcium. Though, the chemical composition (after treatment) appears reduction in the sulfur, with respect to the oxygen, iron and carbon.

The bacterial corrosion is divided into two main phases; the oxidation of iron in the water, and the role of bacteria in the dismantling of the sulfate. In the two phases, we find bacterial corrosion resulting in the iron oxide (Fe(OH)2) and sulfur iron (FeS) that we see in the form of deposits on the surface of the samples.

In this way, we conclude that the steel N80 which the corrosion is formed on its surface as result the her interaction with the water and on account of the activity of bacteria. While, the effect of biocide on the oxidant steel N80 is the partial elimination of these deposits which form the colonies.

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