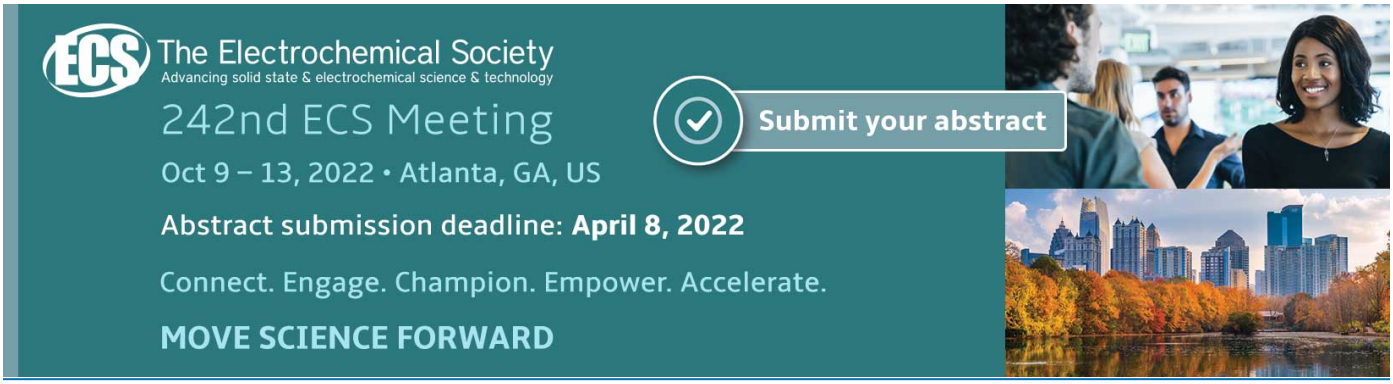
Electrochemical control of high carbon steel corrosion using rosemary oil in citric acid medium



Electrochemical control of high carbon steel corrosion using rosemary oil in citric acid medium

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Abstract. The Inhibition efficiency of Rosemary oil **(***Rosmarinus officinalis)* for corrosion control of high carbon steel was done in citric acid medium by weight loss method. The *Rosmarinus officinalis* was administered in the proportion of 0%, 0.50%, 1.00%, 1.50%, 2.00% and 2.50% concentration. This study unveiled that the inhibition efficiency performed excellently with maximum percentage of 88.3% at room temperature in 0.5M citric acid solution. This has shown the effectiveness of *Rosmarinus officinalis* inhibitor in corrosion analysis of high carbon steel.

Keywords: High Carbon Steel, corrosion inhibitors, weight loss method, rosemary oil.

1. Introduction

Corrosion, the gradual destruction of materials due to chemical or electrochemical reaction with the environment. The easily identified occurrence of corrosion is the oxidation of Iron known as Rust. It has brought about great challenges to the applications of metallic material mostly in industries, such as petrochemical, food, automobile etc. [1-3] causing the destruction of industrial infrastructures. Therefore, corrosion control is required. The damage of metals by acids can be greatly controlled by the corrosion inhibitors. Researches have been carried out on both organic (nitrogen, Sulphur, oxygen) and inorganic (chromates, phosphates, molybdates) compounds as corrosion inhibitors [4-8]. Extracts of plants are found to be biodegradable, non-toxic, environment friendly, easily available and relatively cheap unlike the pure synthetic chemicals. Many of the naturally occurring substances like black pepper [9], onion, garlic [10] among others prevented corrosion of steels in different media from recent researches, also rosemary oil extract yielded 90% inhibitor efficiency on mild steel in water-base and 85% on 439LL ferritic stainless steel in 1M H_2SO_4 solution in previous researches[11,12]. As a result of these, rosemary oil was used to confirm the behavioral effect on high carbon steel in citric acid solution for this research.

This steel is among the commonest types of steel because of its high strength and low cost. Its material characteristics is widely preferred in several applications [13]. High carbon steels have 0.55 to 1.4% carbon. They are strong and hard, and the least ductile of the carbon steels [14]. They possess higher

carbon content than mild carbon steel. They are used mostly in metal manufacturing such as drills, axes, saws, hammers, knives and wood [15]. This study investigates the effectiveness of *Rosmarinus officinalis* on high carbon steel in 0.5M citric acid at every 24 hours for 21days at room temperature by weight loss method.

2. Materials and method

The steel has the following composition: 0.9% Carbon, 0.5% Manganese, 0.04% Phosphorus, 0.05% Sulfur and 98.51% Iron. The samples were machined into cylindrical shapes of these dimensions: 1cm (L), 1.2cm (diameter) and 6.03cm^2 (A_S). Abrasive papers were used for the preparation of the metal surface. *Rosmarinus officinalis*, a leaf extract of a woody shrub-type plant which is a transparent yellowish liquid was used for corrosion inhibition in citric acid medium. It was purchased from Jannys beauty store in Ikoyi, Lagos.

2.1. Experimental procedure

The weight loss analysis of the cylindrical shaped carbon steel coupons was done using weighing balance. The samples were immersed in 400ml of 0.5M citric acid solution. The experiment was exposed to the atmosphere and the coupons fully immersed at ambient temperature for 21 days. Each sample was analyzed every 24 hours after being washed with distilled water and dried.

3. Result

3.1. Weight loss plot

The plots of weight loss against exposure time for high carbon steel in citric acid solution is shown below:

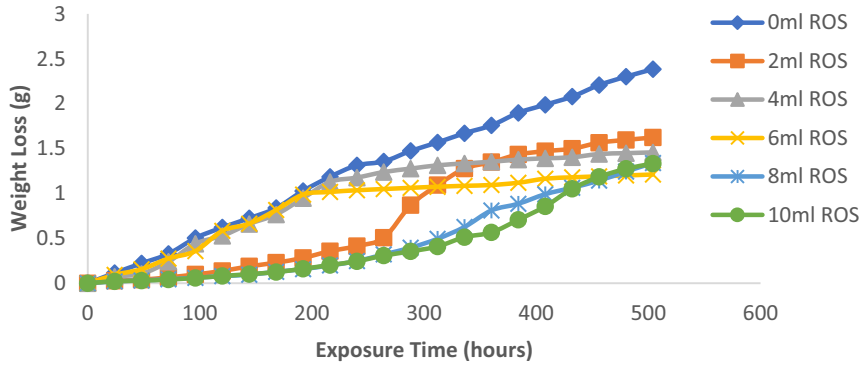

Figure 1. WL against exposure time of high carbon steel in 0.5M citric acid solution

3.2. Corrosion rate plot

Rate of corrosion of carbon steel in citric acid solution is shown in the figure below:

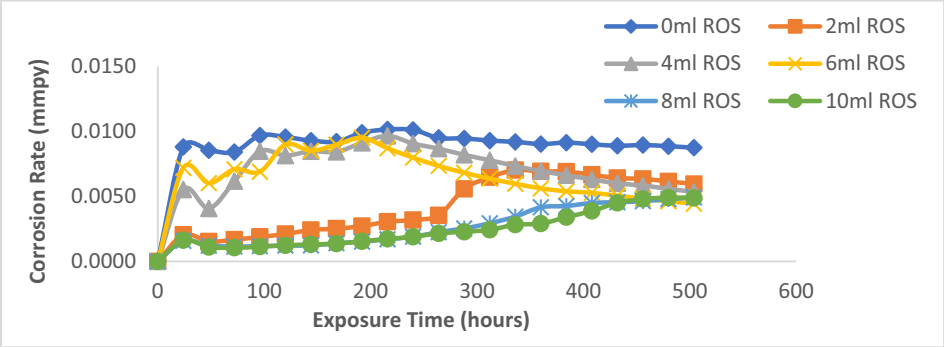

Figure 2. Corrosion rate against exposure time of carbon steel in 0.5M citric acid solution

3.3. Corrosion rate plot

The inhibitor efficiency of *Rosmarinus officinalis* from weight loss experiment in the corrosion of high carbon steel in citric acid is shown below:

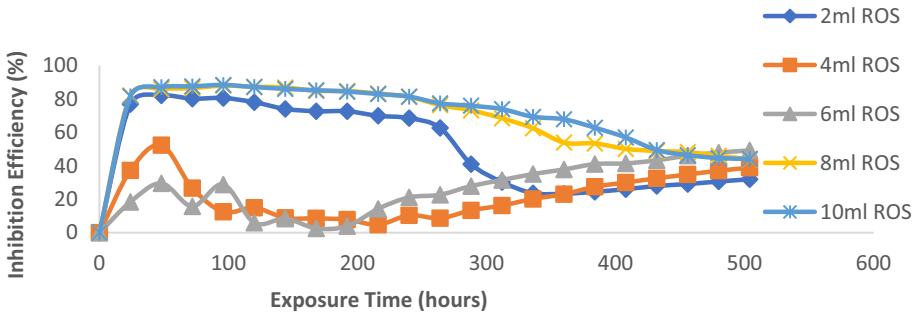

Figure 3. Inhibition efficiency of *Rosmarinus officinalis* against exposure time in 0.5M citric acid.

4. Discussion of results

The result showed that the maximum inhibition efficiency was obtained as 88.3% at 10ml inhibitor concentration. This could be traceable to the high performance of film protection formation of *Rosmarinus officinalis* on the surface of the steel sample to prevent further attack on the steel. Furthermore, the inhibitor also displayed an excellent level of adsorption process by protonating the steel samples from continuous corrosion effect. Adsorption process actually occurs by the interactive force between the molecular properties of rosemary oil and the surface of the high carbon steel samples.

5. Conclusion

Rosmarinus officinalis performed successfully well on high carbon steel with 88.3% maximum inhibitor efficiency in 0.5M citric acid solution. Therefore, rosemary oil displayed an excellent inhibition of high carbon steel which makes it suitable for industrial applications. This further explains the adsorption reaction between the surface of the high carbon steel and the *Rosmarinus officinalis* inhibitor. It also a high level of eco-friendly inhibitor for a sustainable world.

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