Potassium Chromate as a Corrosion Inhibitors for Carbon Steel Alloy In HCl Media

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Abstract:

Potassium Chromate was used as corrosion inhibitors for carbon steel alloy in (0.1 M) HCl medium. Varied concentrations of Potassium Chromate was (0.001M), (0.002M), (0.003M), (0.004M) and (0.005M) investigated in study by using the weight loss method at interval times (1, 2, 3… 10) days. From the results we obtain that the K_2CrO_4 have a good inhibition effect in HCl medium. This is attributed to a cathodic and anodic inhibitive effects produced by the chromate ions. Also we obtain that the inhibition effect increases with increasing the inhibitor concentration. It was calculated that the optimum concentration of potassium chromate in HCl medium that give the optimum corrosion inhibition of carbon steel is (0.003M).Inhibition efficiency was calculated for potassium chromate which reached to (97.63%).

Keywords: Inhibitors, Corrosion, Potassium Chromate.

Introduction:

Corrosion of metals is a major industrial problem that has attracted a lot of investigations in recent years (Afolabi 2007, Aramide 2009). Most metals are inherently unstable and have the natural tendency to react with their environments to obtain lower energy by forming a chemical compound in a more stable state (Wright 2005, Afolabi 2007). Mild and carbon steel is a major utilized in most structural shape such as beams, plates, bars and pipes which used in industrial institutes. There are various methods for prevention or reduction the effect of corrosion. The control of corrosion by maintaining relatively small amount of chemical additives refers to corrosion inhibitors control (Limaye, et al. 2000,

Lashari 1996). Corrosion inhibitors retard the destruction of metals by chemical or electrochemical reactions with their environment (Antonijevic and Petrovic 2008, Kendig and Buchheit 2003). Several inhibitors have been used to reduce the corrosion of metals in aqueous solution. Inhibitors such as chromate set to study in this work and investigate the synergistic effect of these inhibitors on carbon steel immersed in HCl media.

According to corrosion inhibitors mechanism the effect of corrosion inhibitors is either due to the interaction between components of inhibitors composition and the metal surface or due to interaction between the inhibitor and one of the ions present in the aqueous solution (Levans 1977, Etzold, et al.1999, kendig and Buchhet 2003). It is well established that inhibitors function in one or more ways to control corrosion by adsorption of a film onto the surface of corroding material by inducing the formation of thick corrosion product, or by changing the characteristics of the environment of resulting in reduced aggressiveness (Bardal and Drugli 2004, Amin, et al. 2008).

Experimental:

The carbon steel working plates used in the present work were made of the material obtained in table (1). The plates were cut with (3cm) width and (10cm) length. All sample were polished with emery paper and smoothing their cut edges (Kalaivani, et al. 2009, Salih S. Al-Juaid 2007, Graeme Wrigth 2005). Each sample was weighted by electronic balance for 6^{th} digits before and after immersed in corroded media (0.1 M) Of HCl. The immersing was at different interval time and different concentration of inhibitors in corroded solutions. The percentage of Potassium Chromates in corrosive media was (0M), (0.001M), (0.002M), (0.003M), (0.004M) and (0.005M) respectively. The sample were left for some times (1,2,……,10) days in corrosive media and after this removed, washed in water, cleaned by ethanol, dried and weighted to determine the weight loss (Abdulkibash, et al. 2008, Kalaivani, et al. 2009, Al-Juaid 2007, Aramide 2009, Afolabi 2007).

Table (1) Spectrometry Analysis Result of the Carbon Steel Sample.

Element	C	P	Cu	Mn	S	Fe
Composition%	0.4	0.035	0.2	1.35	0.24	Balance

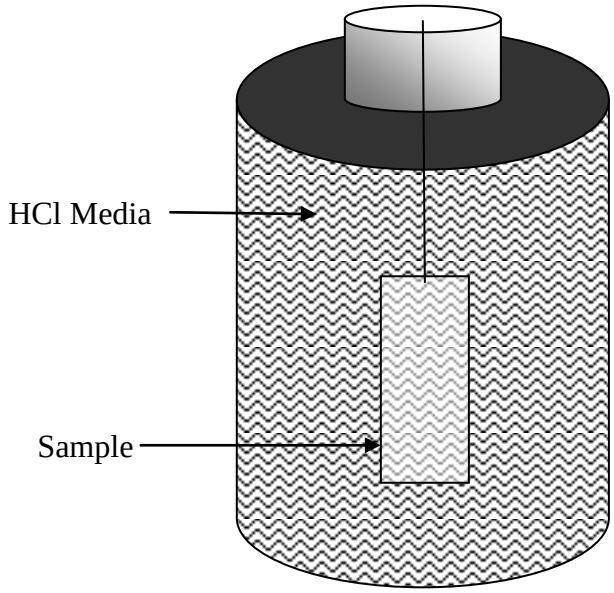


Figure (1) Show the sample immersed in HCl media.

Results and discussion:

Figure (2) shown the effect of the corrosive media on carbon steel in absence and presence of different concentrations of Potassium Chromate as corrosion inhibitor at interval time. It is shown that the weight loss of carbon steel increase with increasing the exposure time to corrosive media until with presence of the inhibitor(Kendig and Buchhet 2003, Aramide 2009). Also as shown in figure (3) increasing the concentration of Potassium Chromate due to decrease the weight loss because The Potassium Chromates is known to be an effective oxidizing anodic inhibitors which protect the carbon steel from the HCl corrosive media by making it in passive state thus preventing breakdown of the passive oxide which can lead to uniform corrosion. Potassium Chromates may be acts as cathodic inhibitors by accelerates the cathodic reaction which produce some catalytic action leading to evolution of hydrogen instead of reduction of the Chromates ions to the trivalent state CrO_3^{-3} which absorbs on the surface of the metal and reduce to some intermediate valence and tetravalent stateCrO_4^{-4} acts as mediator between the metal surface and corrosive media as follow (Afolabi 2007).

$$CrO_4^{-2}+2e = CrO_4^{-4} \quad (1)$$

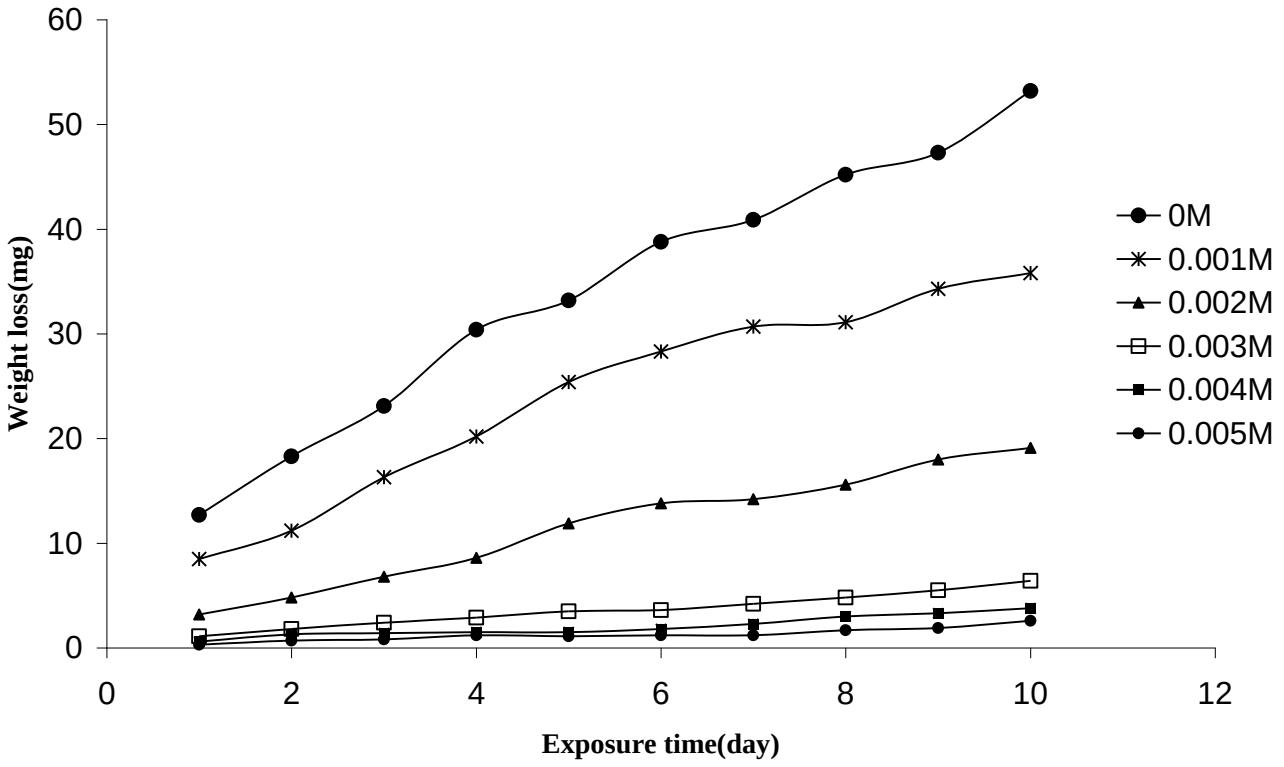
$$CrO_4^{-4}+2H_2O = CrO_4^{-2}+H_2+2OH^- \quad (2)$$

Figure (4) shown the inhibition efficiency at different inhibitors concentrations were found to increase with increasing Potassium

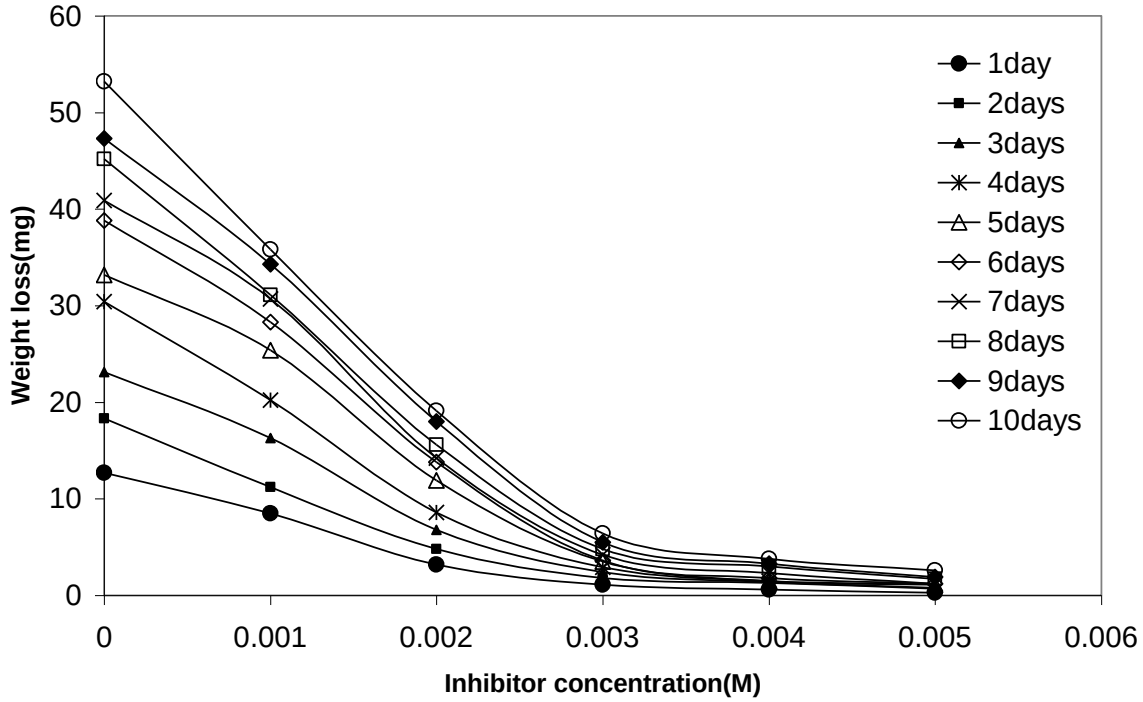
Chromates Concentration. We illustrate the variation of the protection efficiency with the concentration of Potassium Chromate where a value of (P% = 97.63) has been reached. We can calculate the inhibition efficiency from the following relation (Abulkibash 2007, Kalaivani, et al. 2009).

$$p\% = \left(1 - \frac{w}{w^o}\right) \times 100 \qquad (3)$$

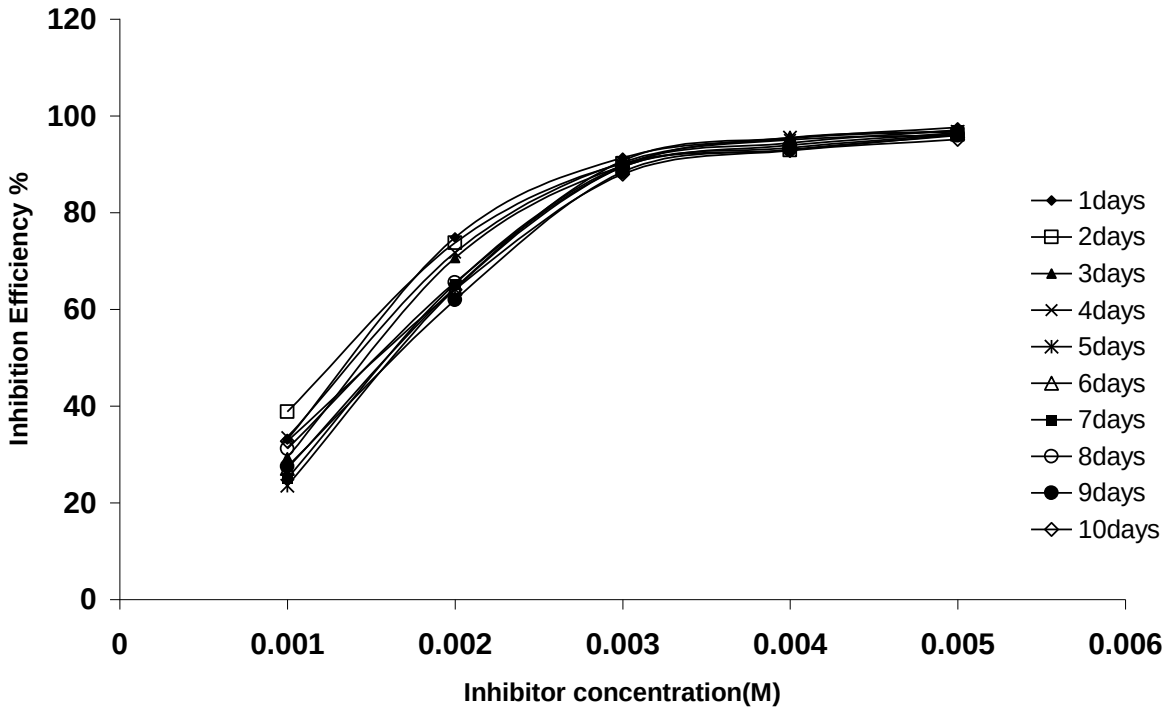
Where w and w^o are the weight loss of the carbon steel in the presence and absence of the inhibitor respectively.



Figure(2) Weight loss as a function to exposure time with different concentrations



Figure(3) Weight loss as function to inhibitor concentration at interval time



Figure(4) Inhibition efficiency as a function to inhibitor concentration at interval time

Conclusions:

From this work on Potassium Chromate as corrosion inhibitor on carbon steel in chloride media we can get the following:

1- The corrosion rate of carbon steel is increase with increasing the exposure time to the corrosive media with absence or presence of the inhibitor.
2- The corrosion rate of carbon steel is decrease with increasing the concentration of Potassium Chromate as inhibitor.
3- Potassium Chromate can be effects as a cathodic and anodic inhibitor.
4- The inhibition efficiency was found to increase with increasing the concentration of the Potassium Chromate and the optimum percentage of inhibitor in corrosive media was found (0.003M).

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استخدام كرومات البوتاسيوم كمثبط للتاكل على سبيكة الكاربون ستيل في وسط حامض الهيدروكلوريك

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الخلاصة

تم في هذا البحث استخدام كرومات البوتاسيوم كمثبط للتاكل على سبيكة الفولاذ الكاربوني في محلول حامضي من (0.1M) من حامض HCl. تم استخدام تراكيز مختلفة من كرومات البوتاسيوم في المحلول و لفترات زمنية مختلفة. باستخدام طريقة الفقدان بالوزن تم حساب مقدار التاكل في المعدن خلال الفترات من (1,2,3…….,10) يوم. من خلال النتائج تبين بان كرومات البوتاسيوم K_2CrO_4 له تأثير كبير جداً على عملية التاكل في محلول HCl. ان هذا التأثير يعود الى التأثير الكاثودي و التأثير الانودي لأيونات الكرومات في عملية التثبيط لمعدل التاكل. كما تبين ان عملية التثبيط تزداد بزيادة تركيز ايونات المادة المثبطة. ايضاً تم حساب افضل تركيز للمادة المثبطة في محلول HCl على سبيكة الكاربون ستيل والتي هي بحدود (0.003M). بالاضافة الى ذالك تم حساب كفائة التثبيط لكرومات البوتاسيوم والتي وصلت الى (97.63%).