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EFFECTIVENESS OF CORROSION INHIBITORS ON MILD STEEL IN ACIDIC MEDIUM

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ABSTRACT

The inhibitive action of corrosion inhibitors on the corrosion of mild steel in 1 N HCl was studied by weight loss measurement. In practice the acidic cleaning solution is flowing at a velocity approximately 1m/s or more over the metallic surfaces to be chemically cleaned. Also the solution contains many suspended solid particle like rust, muck etc. These are likely to cause erosion of the protective film formed by the inhibitor and hence in practice the effectiveness exhibited by the inhibitor is likely to be lesser than that obtained in laboratory using standard method.

Keywords: Corrosion Inhibitors, Mild Steel, HCl Acid, Weight Loss Measurement, Adsorption.

I. INTRODUCTION

Corrosion inhibitor is a chemical substance which, when added in small concentrations to an environment, minimizes or prevents corrosion. Corrosion inhibitors are used to protect metals from corrosion.

Industries depend heavily on the metal and alloy. One of the most challenging and difficult tasks for industries is the protection of these metals and alloys from corrosion. Corrosion is a widespread problem that continues to be of great relevance in wide range of industrial application and products; it results in the degradation and eventual failure of components and systems both in processing and manufacturing industries also in the service life of many components. Corrosion control of metals and alloys is an expensive process and industries spend huge amount to control this problem. The use of corrosion inhibitors is the best way to prevent destruction or degradation of metal surface in corrosive media. The use of corrosion inhibitors is the most economical and practical method for reducing corrosive attack on metals.

Metal equipment must be cleaned from time to time to prevent damage and maintain efficiency of operation. The chemical cleaning of metals has a number of advantages over mechanical cleaning methods. Chemical cleaning is a process which primarily uses chemical solutions to remove fouling from inside plant and equipment such as heat exchanger and boilers.

Acid solutions are generally used for the removal of undesirable scale and rust in several industrial processes. Hydrochloric acid is widely used in the pickling processes of metals. Use of inhibitors is one of the most practical methods for protection against corrosion especially in acid solutions to prevent unexpected metal dissolution and acid consumption. In various industrial processes mild steel mostly comes in contact with acid solution and corrosion of mild steel known to occur in this environment. One of the effective methods to prevent corrosion is the use of organic inhibitors.

The primary reasons for chemical cleaning of boilers / heat exchangers are to prevent tube failures & improve unit availability. Tube failures in low pressure boilers/heat exchangers are normally the results of creep which occurs when internal deposits produce excessive metal temperature. After a boiler / heat exchanger placed into service, numerous solid constituents may enter the units with the feed water & some portion of the insoluble can be expected to deposit on surfaces. Corrosion inhibitor along with acid for general use as descalent in all types of chemical descaling operations. It removes water hardness scales, deposits from steam and hot water, mill scales, weld scales. Corrosion inhibitors are used in descaling acid solution to essentially prevent the attack on metal equipment when scale is removed. There are several other advantages of inhibitors which are saving valuable metal, saving acid and reduction of acid fume.

II. MATERIAL AND METHOD

2.1 Inhibitor Preparation

The corrosion inhibitor Rodine 213 is used to study the inhibitive action on metal in different concentration in 1 N HCl solution.

2.2 Weight Loss Measurement

The mild steel specimens were cut in to 4.89 cm x 3.91 cm x 0.45 cm coupons for immersion studies. The specimen were mechanically polished, degreased and dried in acetone. The edges were abraded with fine grade of emery paper. The weight loss measurement was carried out in absence and presence of various concentrations of the corrosion inhibitors in 1N HCl for various period of immersion time at room temperature and at different temperature. From the values corrosion rate and inhibitor efficiency were calculated by three type i.e. By standard oven method , stirred beaker which contain clean 1 N HCl solution and stirred beaker with 1 % Sand in 1N HCL.

III. RESULTS AND DISCUSSION

3.1 Weight Loss Measurement

3.1.1 Stirring & Heating in Beaker with Clean Solution

The weight loss results obtained for mild steel in 1 N HCl in the presence and absence of different concentration of Rodine 213 are summarized in Table. The corrosion rate values of mild steel in 1 N HCl decreases as the concentration of inhibitor increases i.e. the inhibition efficiency increases as the concentration of inhibitor is raised. The temperature of solution is maintained at the 50^{o}C and suspension is kept under continuous stirring condition for a period of 4 hrs and 8 hrs.

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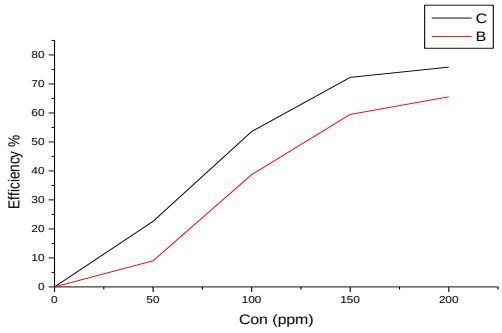

Fig1. Variation of Inhibition Efficiency in 1 N HCl at Different Concentrations of Rodine213 in Stirring Beaker

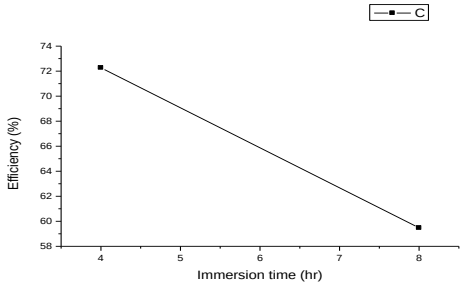

Fig.2 Variation of Inhibition Efficiency in 1 N HCl at Different Immersion Time

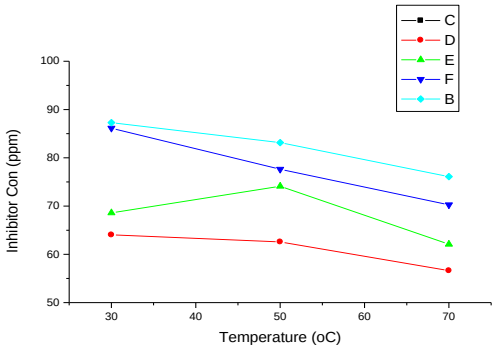

Fig.3 Effect of Temp.on Corrosion Efficiency in 1 N HCl at Immersion Time of 4 hrs.

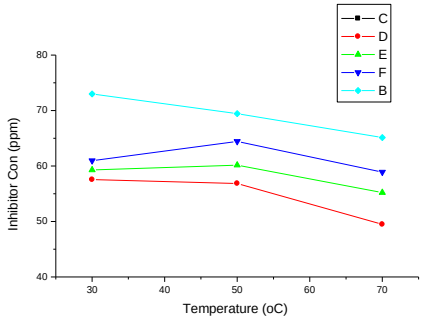

Fig. 4 Effect of Temp.on Corrosion Efficiency in 1 N HCl at Immersion Time of 8 hrs.

3.1.2 Standard Oven Method

The weight loss results obtained for mild steel in 1 N HCl in the presence and absence of different concentration of Rodine 213 are summarized as shown in fig. The corrosion rate values of mild steel in 1 N HCl decreases as the concentration of inhibitor increases i.e. the inhibition efficiency increases as the concentration of inhibitor is raised. The temperature of solution is maintained at the 50^{o}C in the standard oven for a period of 4 hrs and 8 hrs.

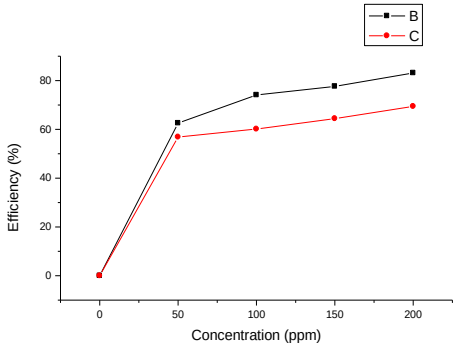

Fig.5 Variation of Inhibition Efficiency in 1 N HCl at Different Concentrations of Rodine 213 in Standard Oven at 50 ^{o}C

3.1.3 Stirring & Heating in Solution with 1 % Sand (Slurry)

The weight loss results obtained for mild steel in 1 N HCl in the presence and absence of different concentration of Rodine 213 in solution with 1% sand are summarized as shown in fig. Due to sand particles the erosion of the specimen takes place more as compare to clean solution. The corrosion rate values of mild steel in 1 N HCl decreases as the concentration of inhibitor increases i.e. the inhibition efficiency increases as the concentration of inhibitor is raised. The temperature of solution is maintained at the 50^{o}C.

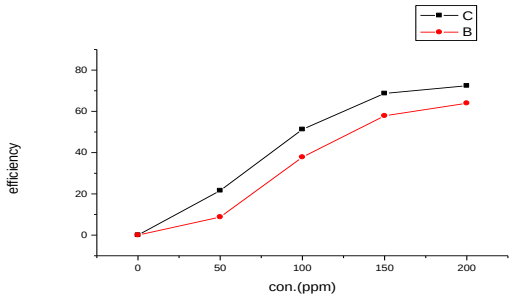

Fig.6 Variation of Inhibition Efficiency in 1 N HCl at Different Concentrations of Rodine 213 in Stirring Beaker with 1 % sand.

IV. ADSORPTION ISOTHERM

The adsorption isotherms provide useful information for the mechanism of corrosion inhibition. The surface coverage, θ, was calculated from the equation,

$$\frac{CR - CRinh}{CR} = \theta$$

Where, C_R and $C_{R\ inh}$ are the corrosion rates of mild steel in the absence and presence of the Rodine respectively. By fitting the θ values obtained from weight loss data to various isothermnamely Langmuir, Temkin and Frumkin, the best fit was obtained with Langmuir isotherm. A staright line was obtained on plotting (Con/ θ) Vs θ for Langmuir isotherm with regression coefficient (R2= 0.99974).

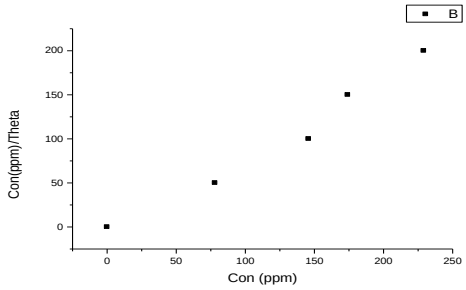

Fig.The Langmuir Adsorption Isotherm Plot for Mild Steel at Different Concentrations of Rodine 213 by Weight Loss Method.

V. DISCUSSION

1. As the concentration of corrosion inhibitors increases the corrosion efficiency also increase.
2. As the temperature increases corrosion efficiency decreases for different inhibitor concentrations.
3. Results shows that the more erosion of metal is due to sand particles present in the solution than the stirred clean solution than the standard oven method.
4. Therefore the Efficiency of corrosion inhibitor is less in a solution 1 N HCl which contains 1 % sand particles.
5. The adsorption of inhibitor molecule on the mild steel surface in 1 N HCl solution follows Langmuir Adsorption Isotherm. A straight line was obtained on plotting (Con/θ) Vs Con for Langmuir isotherm.

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