Development of Suitable Corrosion Inhibitor for Pipeline Corrosion

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Abstract: *Corrosion is a serious issue in drinking water supplies. Corrosion of pipelines in drinking water distribution system can be caused by several factors like the type of materials used, the age of piping and fittings, the stagnation time of water in the pipeline and water quality in the system. Corrosion control refers to the action of controlling the corrosion of materials used in drinking water distribution system. The present work aimed to develop a suitable corrosion inhibitor for minimizing the corrosion of pipelines used for supply of drinking water. The inhibitor selected for the study was sodium meta silicate and the inhibition efficiency is calculated based on OCP decay measurements, weight loss method and estimating the iron contamination in the solutions. The corrosion inhibition of metallic pipe (mild steel) increases with increase in concentration of the inhibitor and maximum corrosion prevention is observed when the medium contains 2000ppm of sodium meta silicate. The inhibitor adsorb on the oxidized surface of the iron leading to the formation of a passive layer which prevents further decay of the material.*

Keywords: *Sodium meta silicate, corrosion inhibitor, Open circuit potential*

1. INTRODUCTION

Mild steel pipes have been commonly used to supply potable water and corrosion of mild steel was one of the major problems in the supply network. Corrosion of drinking water systems and release of contaminants into the conveyed water depend on both the material that is subject to corrosion and water comes in contact with the material. The corrosion product in water will affect the quality of water and also result in increased pipeline chocking [1-3]. The contact time of water with the material greatly influence the levels of metals present in drinking water. Therefore, a first mechanism of defense to reduce exposure of contaminants from drinking water is to flush the plumbing materials prior to human consumption of the water. Drinking water corrosion is controlled by adjusting its P^H or alkalinity or by introducing corrosion inhibitors. Organic compounds especially those having N, S and O showed significant inhibition efficiency. The organic compounds adsorbed on the metal surface and thereby forming a protective layer which prevent further oxidation of the metal [4,5]. Unfortunately most of these compounds are not only expensive but also toxic to living beings. The inhibitors to be used in potable water systems ought to be safe to human and friendly to the environment [1]. Plant extracts have become important as an environmentally acceptable, biodegradable, readily available and renewable source for wide range of inhibitors. The corrosion inhibition effect of many naturally occurring substances as has been reported in literature [6-8]. The present research work focused to develop a safe and cheap corrosion inhibitor for drinking water systems. The inhibitor selected for the present study was an inorganic compound sodium meta silicate which is eco friendly and cost effective.

2. EXPERIMENTAL METHODS

The metal specimens were produced from strips of mild steel. The percentage composition of mild steel sample were studied using AAS and the carbon content in sample was analyzed using LECO carbon analysis and are given in Table 1.

Table 1. *Percentage composition of mild steel sample*

Elements	C	Si	Mn	Cr	Ni	Mo	Fe
Percentage	0.1	0.1	0.7	0.2	0.01	0.1	98.97

The specimens were of size 5x2x0.2 cm. They were polished by using different metallo-graphic grade of emery papers, ultrasonically degreased by using isopropanol, cleaned by water, dried in a stream of air and store in desiccators. The metal specimens of size 5x2x0.2 cm were cleaned and dried. They were immersed in beakers containing 250 mL water with and without inhibitor. The inhibitor concentration selected for the present studies are 50, 100, 150, 200, 1000 & 2000 ppm respectively. They were kept undisturbed. After a week these specimens were taken out for further study. The inhibitor selected for the study was sodium meta silicate of analytical regent grade. The rate of corrosion is evaluated using three methods. They are weight loss method, Estimation of iron using titration method and the open circuit potential decay study method. The potential of the working electrode was measured in mV with respect to saturated calomel electrode using potentiometer of made. The variation of OCP was noted as a function of time until a steady value was obtained. The metal specimens were cleaned, dried and weighed. They were immersed in beakers containing the ordinary tap water with and without inhibitor for a week without any disturbance and maintaining the electrolytic level. After a week, they were taken out dried and weighed. The self corrosion rate of each specimen was calculated using the formula.Self corrosion = (wt.loss/Area) X Time ($gcm^{-2}h^{-1}$)

Estimation of iron in the solution before and after dipping the metal specimen is estimated using titration method. Weigh 4g AR mohr's salt into a 100mL steel flask, dissolve it in water. The solution is acidified with 20ml dil.H_2SO_4 and make up using water. Pipette out 20 ml into a conical flask, add 20 ml 2N H_2SO_4 and 10 drops N-Phenyl Anthranilic acid and titrate against $K_2Cr_2O_7$ solution. Repeat the experiment to get concordant values.   Transfer the given solution to 100ml standard flask, add 10ml dil. H_2SO_4 and make up using water. Pipette out 20ml into a 250 ml beaker provided with a cover glass and glass rod. Add 5ml pure conc.HCl and the solution is heated to boiling. To the hot solution add $SnCl_2$ solution drop by drop with stirring until the yellow colour just discharge. Reduction is then completed with very dilute $SnCl_2$ solution (concentrated solution of $SnCl_2$ diluted with 5 volumes of dil.HCl) in drops till the solution becomes colourless. Two drops more of $SnCl_2$ are then added. Cool, dilute to 50 ml and add 5 ml 10%$HgCl_2$ rapidly and mix. Allow to stand. Add 40 ml of 6N H_2SO_4 & 10 drops N-phenyl Anthranilic acid and titrate against $K_2Cr_2O_7$ solution. Repeat the experiment to get concordant values.

3. RESULTS AND DISCUSSIONS

3.1 Open Circuit Potential Decay Study

From the OCP decay study we find that the OCP values of the samples increase in the anodic direction as the concentration of the inhibitor increases, showing that the corrosion prevention of the metal sample increases. The OCP values of each sample at definite intervals were studied and given in Table 2.

Table 2. *The OCP values of samples under study*

Inhibitor concentration (ppm)	Potential of samples				
	Day 1	Day 4	Day 5	Day 7	Day 8
0	-0.325	-0.656	-0.665	-0.680	-0.698
50	-0.345	-0.676	-0.655	-0.686	-0.679
100	-0.355	-0.648	-0.595	-0.659	-0.655
150	-0.395	-0.674	-0.666	-0.695	-0.665
200	-0.410	-0.410	-0.661	-0.666	-0.675
1000	-0.389	-0.388	-0.567	-0.595	-0.627
2000	-0.359	-0.359	-0.221	-0.193	-0.188

3.2 The Self Corrosion Study

The self corrosion of the samples dipped in different concentrations of sodium meta silicate is studied and their corrosion rate is calculated and shown in Table 3

Table 3. *The corrosion rates of samples dipped in different concentrations of Sodium meta silicate.*

Inhibitor load (ppm)	Initial Weight of metal piece (g)	Weight of metal piece after 1 week (g)	Weight loss (g)	Corrosion rate= weight loss/ Area x Time (gcm^{-2}day^{-1})
0	18.6259	18.5828	0.0431	3.884 x 10^{-4}
50	18.3526	18.3200	0.0326	2.938 x 10^{-4}
100	18.3843	18.3558	0.0285	2.568 x 10^{-4}
150	17.7577	17.7306	0.0271	2.442 x 10^{-4}
200	17.9844	17.9585	0.0259	2.334 x 10^{-4}
1000	18.4103	18.3914	0.0189	1.703 x 10^{-4}
2000	18.1391	18.1322	0.0069	0.621 x 10^{-4}

3.3 Estimation of Iron in the Solution

The concentration of Iron in water at the time of dipping and after a week is also studied and given in Table 4.

Table 4. *Estimation of iron concentration in solution*

Inhibitor concentration (ppm)	50	100	150	200	1000	2000
Concentration of iron after one week (g/500ml)	4.132	3.406	2.876	2.234	1.731	0.977

It is observed that the solution in which 2000 ppm sodium meta silicate is added shows the least iron concentration. That is corrosion of iron decreases as the concentrations of the sodium meta silicate increases and maximum corrosion prevention is seen in the solution containing 2000 ppm of sodium meta silicate.

4. CONCLUSION

The corrosion study of iron samples having specific area were studied using sodium meta silicate as corrosion inhibitor. The concentration of inhibitor selected was 50, 100, 150, 200, 1000 and 2000ppm respectively. The corrosion study was performed using OCP decay measurements, weight loss method and measuring iron concentrations in solutions. From all these studies it is clear that the corrosion inhibition increases with increases in concentration of inhibitors and maximum corrosion prevention is observed for sample which dipped in 2000ppm of sodium meta silicate. From this study, it is concluded that as the concentration of inhibitors increases, the corrosion prevention increases. This is due to the fact that the oxidation of iron from the metal surface is prevented by the inhibitor. The inhibitor will adsorb the metal surface forming a passive layer which prevents the corrosion.

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