Comparative Studies on Inhibitor Efficiency in Mild Steel and Iron

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Abstract

Metals generally corrode mild steel is an alloy form of from which undergoes corrosion easily in acidic medium. The corrosion products are formed when a metal give its electrons to the oxidizing substances, the organic compounds containing sulphur, nitrogen and oxygen are known to be effectiveness depends on the electron density at the functional groups. We need to reduce the corrosion of steel by adding inhibitor. Tensile strength of steel varies depends on the corrosion. Thus, the aim of this project is to determine the inhibitor efficiency of thiourea, urea, and hydroquinone for the corrosion of normal steel and iron in common HCL medium consists of different concentration of inhibitor.

Keywords: Corrosion, Efficiency Electron density, inhibitor, mild steel, pitting.

1. Introduction

Corrosion inhibitors were used to reduce the corrosion of steel due to chemical reaction. Organic chemical is used to reduce to corrosion up to 25% of more efficient than other chemical.[Mumtaz Ahmad Quraishi, 2002]. From the plant extracted chemical were used as inhibitor for the reduction of corrosion. [Pandian Bothi raja, et.al. 2007]. The corrosive changes of mild steel in Mix 1 and Mix 2 HCL, Mix 3 and Mix 4 H2SO4 solutions consists of different concentrations of thiophenyl phenyl thiourea (TPTU) were investigated and that give good corrosion resistance capacity were found. [Divakara Shetty et.al, 2006 ]. The inhibition were react with the chemical give protection on the metal surface [Ashassi-Sorkhabi, et.al, 2006]. The behaviour of corrosion inhibitor were based on efficiently were found. It varies from the different concentration of TPTU [Jayaraman, et.al, 1996]. Fourier transform infrared spectrophotometry was used to obtain information on bonding mechanism between the metallic surface and the inhibitors [Abd El-Maksoud, et. al 2001].

2. Experimental Method

A. Preparation of Test Specimens

The test specimens of Mild steel and Iron required for the study was cut in a size of 6 cm is length and 1 cm breadth. The specimens are finally weighed in a four digit electronic balance.

B. Preparation of in Solution of HCL

The corrosion study is carried out by preparing Mix 1 solution of HCl. It is prepared by measuring 9.1 ml of HCL and then made up to mark in 100ml standard flask using distilled water.

C. Preparation of Inhibitors in Different Concentrations

The inhibitor solutions are prepared with Mix1(1N), Mix 2(0.5N), Mix 3(0.25N) concentrations in the following

D. Thiourea

The 1N solution of thiourea is prepared in the following manner. About 7.61g of thiourea is weighed, transferred into a 100ml standard flask and made up to the mark using distilled water. Mix 2, Mix 3 solution of thiourea is prepared by weighing 3.8g and 1.9g of it respectively.

E. Urea

Mix1, Mix 2, Mix 3 solutions of urea is prepared in the above manner by weighing 6.1g, 3.05g, and 1.525g of it respectively.

F. Hydroquinone

Mix1, Mix 2, Mix 3 solutions of hydroquinone is prepared in the above manner by weighing 1.835g, 0.9175g, 0.4587g of it respectively.

G. Determination of Inhibitor Efficiency Blank Experiment

50ml of 1N HCl is taken in a beaker. The test specimen steel which is weighed already is dipped in the solution. After a time limit of 2hours, it is taken out, air dried and weighed. The weight loss without inhibitor is noted. To test the inhibitor efficiency 25ml of 1N HCl is mixed with 25ml of 1N solution of thiourea. The test specimen mild steel is then dipped in the solution. After 2 hours, it is taken out; air dried and weighed in a four digit electronic balance. The weight loss with the
presence of inhibitor is noted. The procedure is repeated for different concentrations of inhibitors in steel and iron respectively and tabulated.

Inhibitor efficiency = \( \frac{W_b - W_i}{W_b} \times 100 \); Surface coverage = \( \frac{W_b - W_i}{W_b} \)

Where, \( W_b \) - weight loss without inhibitor in g; \( W_i \) - weight loss with inhibitor in g

For example:
The study of mild steel 1N HCl with 1N thiourea:
Weight loss without inhibitor (\( W_b \)) = 0.0016g
Weight loss with inhibitor (\( W_i \)) = 0.0009g

Inhibitor efficiency = \( \frac{0.0016 - 0.0009}{0.0016} \times 100 = 43.75\% \)

Surface coverage = \( \frac{0.0016 - 0.0009}{0.0016} = 0.4375 \)

3. Experimental Results

Results for mild steel in HCL with thiourea, urea and hydroquinone were found in Table: 1, Table: 2 and Table: 3 respectively. Corresponding graphs were mentioned in Fig.No.1, Fig. No.2 and Fig.No.3

### Table 1: Mild Steel in HCl With Thiourea (2 Hours)

| CONCENTRATION OF THIOUREA (N) | WEIGHT OF MILD STEEL | SURFACE COVERAGE | INHIBITOR EFFICIENCY % |
|-------------------------------|----------------------|------------------|------------------------|
|                               | INITIAL | FINAL | DIFFERENCE IN (g) | DIFFERENCE IN (m.g) | |
| BLANK                         | 0.7795 | 0.7779| 0.0016            | 1.6                  | |
| 1 N                           | 0.8373 | 0.8364| 0.0009            | 0.9                  | 0.4375 | 43.75 |
| 0.5 N                         | 0.8188 | 0.8176| 0.0012            | 1.2                  | 0.25    | 25    |
| 0.25 N                        | 0.8589 | 0.8575| 0.0014            | 1.4                  | 0.125   | 12.5  |

![Fig. 1: Mild Steel with Thiourea](image1.png)

**Table 2: Mild Steel in HCl With Urea(2 Hours)**

| CONCENTRATION OF UREA (N) | WEIGHT OF MILD STEEL | SURFACE COVERAGE | INHIBITOR EFFICIENCY % |
|--------------------------|----------------------|------------------|------------------------|
|                          | INITIAL | FINAL | DIFFERENCE IN (g) | DIFFERENCE IN (m.g) | |
| BLANK                    | 0.7795 | 0.7779| 0.0016            | 1.6                  | |
| 1 N                      | 0.819  | 0.8178| 0.0012            | 1.3                  | 0.1875  | 18.75 |
| 0.5 N                    | 0.787  | 0.7857| 0.0013            | 1.4                  | 0.125   | 12.5  |
| 0.25 N                   | 0.7906 | 0.7892| 0.0014            | 1.5                  | 0.125   | 12.5  |

![Fig. 2: Mild Steel with Urea](image2.png)
Table 3: Mild Steel in HCL With Hydroquinone (2 Hours)

| CONCENTRATION OF HYDROQUINONE (N) | WEIGHT OF MILD STEEL | SURFACE COVERAGE | INHIBITOR EFFICIENCY % |
|-----------------------------------|----------------------|-----------------|------------------------|
| BLANK                             | 0.7183               | 1.5             |                        |
| 1 N                               | 0.7130               | 0.0015          | 1                      |
| 0.5 N                             | 0.7620               | 0.0013          | 1.3                    |
| 0.25 N                            | 0.7720               | 0.0014          | 1.4                    |

![Mild Steel in HCL with Hydroquinone](image)

Fig. 3: Mild Steel with Hydroquinone

Results for mild iron in HCL with thiourea, urea and hydroquinone were found in Table: 4, Table: 5 and Table: 6 respectively. Corresponding graphs were mentioned in Fig.No.5, Fig. No.5 and Fig.No.6.

Table 4: Iron in HCL With Thiourea (2 Hours)

| CONCENTRATION OF THIOUREA (N) | WEIGHT OF MILD IRON | SURFACE COVERAGE | INHIBITOR EFFICIENCY % |
|-------------------------------|---------------------|-----------------|------------------------|
| BLANK                         | 51.453              | 258             |                        |
| 1 N                           | 45.985              | 0.258           | 165                    |
| 0.5 N                         | 44.328              | 0.174           | 174                    |
| 0.25 N                        | 41.315              | 0.178           | 178                    |

![Iron in HCL with Thiourea](image)

Fig. 4: Iron in HCl with Thiourea
Table 5: Iron in HCl With Urea(2 Hours)

| CONCENTRATION OF UREA (N) | WEIGHT OF MILD IRON | SURFACE COVERAGE | INHIBITOR EFFICIENCY % |
|--------------------------|---------------------|------------------|------------------------|
|                          | INITIAL            | FINAL            | DIFFERENCE IN (g)      | DIFFERENCE IN (mg) |               |                      |
|                           | 37.453             | 37.195           | 0.258                  | 258                | 0.3527        | 35.27               |
| BLANK                    |                     |                  |                        |                    |               |                      |
| 1 N                      | 38.626             | 38.459           | 0.167                  | 167                | 0.341         | 34.1                |
| 0.5 N                    | 37.721             | 37.551           | 0.170                  | 170                | 0.2984        | 29.84               |
| 0.25 N                   | 36.598             | 36.417           | 0.181                  | 181                |               |                      |

Comparison results is mentioned in Table: 7 and Graph is mentioned in Fig.No.7

Table 7: Comparison of Inhibitors Efficiency

| DATA                      | THIOUREA | UREA | HYDROQUINONE |
|---------------------------|----------|------|--------------|
|                           | 1 N      | 0.5 N| 0.25 N       | 1 N         | 0.5 N | 0.25 N |
| SURFACE COVERAGE          | STEEL    |      |              | IRON        |      |       |
|                           | 0.4375   | 0.25 | 0.125        | 0.25        | 0.1875| 0.125  |
|                           | 0.3604   | 0.3255| 0.31         | 0.353       | 0.341 | 0.2984 |
| INHIBITOR EFFICIENCY %   | STEEL    |      |              | IRON        |      |       |
|                           | 43.75    | 25   | 12.5         | 25          | 18.75| 12.5   |
|                           | 36.04    | 35.27| 31           | 34.1        | 29.84| 43.02  |
|                           | 32.55    |      |              |             |      |        |
|                           | 35.27    |      |              |             |      |        |
|                           | 31.5     |      |              |             |      |        |

Iron in HCl with Hydroquinone

Comparison results is mentioned in Table: 7 and Graph is mentioned in Fig.No.7
4. Observation

1. The inhibitor thiourea in mild steel shows an inhibitor efficiency of 43.75, 25, 12.5 in Mix 1, Mix 2, Mix 3 concentrations respectively.
2. The inhibitor urea in mild steel shows an inhibitor efficiency of 25, 18.75, 12.5 in Mix 1, Mix 2, Mix 3 concentrations respectively.
3. The inhibitor hydroquinone in mild steel shows an inhibitor efficiency of 33.33, 13.33, 6.66 in Mix 1, Mix 2, Mix 3 concentrations respectively.
4. The inhibitor thiourea in iron shows an inhibitor efficiency of 36.04, 3.55, 31.00 in Mix 1, Mix 2, Mix 3 concentrations respectively.
5. The inhibitor urea in iron shows an inhibitor efficiency of 35.27, 34.10, 29.84 in Mix 1, Mix 2, Mix 3 concentrations respectively.
6. The inhibitor hydroquinone in iron shows an inhibitor efficiency of 43.02, 39.53, 24.80 in Mix 1, Mix 2, Mix 3 concentrations respectively.

5. Result and Discussion

This study indicates that the organic compound thiourea taken for study acts as a best inhibitor in 1 N concentration. In general, organic compound containing lone pair of electrons acts as a best inhibitor.

6. Conclusion

From the table and chart the following conclusions is made:

The inhibitor efficiency of 1 N thiourea in steel found to be maximum than urea, hydroquinone the value is 43.75%. The next effective inhibitor in steel in hydroquinone, the value is 33.33%. The inhibitor efficiency of 1 N hydroquinone in iron is found to be maximum, the value is 43.02%. The next effective inhibitor efficiency in iron in hydroquinone, the value is 39.53% (0.5 N)

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