

Behavior of mild steel in acidic medium

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Abstract - This paper is concerned with regard that the alloy like mild steel is behaving different in acidic medium like hydrochloric acid and nitric acid and it being reviewed here the behavior of the mild steel in presence of a particular medium. While keeping of nitric acid in presence of mild steel is not much more beneficial as compared to the hydrochloric acid as the corrosion of mild steel is found more in nitric acid and less in hydrochloric acid. So, at the final conclusion of this paper is found that behavior of mild steel in presence of hydrochloric acid is much more feasible as compared to the nitric acid.

Key Words: Acidic medium, hydrochloric acid, nitric acid, corrosion etc.

1. INTRODUCTION

Mild steel is one of the major construction material. It is excessively used in oil and chemical industries for handling acid and salt solutions [1]. The mild steel contains upto 10% manganese with carbon content up-to 0.05 to 0.25% [2]. Mild steel is used as a structural member in bridges, buildings etc. It is widely used for the construction of storage tanks, ships etc. [3]. It is readily available, easy to produce with outstanding ductility and toughness. It is extracted from pig iron, thus less expensive. Its high machinability and weldability ad's into its application in almost all engineering fields. The exposure of mild steel leads to acidic medium leads to corrosion hence Corrosion is responsible for failure of material. The main aim is to study the effect of acidic medium on mild steel at 25 degrees Celsius. The acidic medium here is hydrochloric acid (HCL) and nitric acid (HNO₃). The concentration of HCL is 0.25-2-5 mole dm⁻³. The methods chosen are chemical methods. By chemical methods we mean it as weight reduction.

2. SPECIFICATIONS OF SPECIMEN:

The specimen of mild steel is of 1 mm in thickness mechanically press and cut into 5x5 coupons. The specimen is obtained from the workshop of mechanical engineering department of SSM College of Engineering and Technology. The chemical composition of mild steel material used in the experiments performed below is shown.

- | | |
|---------------------|---------------------|
| 1. C - 0.14 wt (%) | 2. Si - 0.18 wt(%) |
| 3. Mn - 0.48 wt (%) | 4. P - 0.017 wt(%) |
| 5. S - 0.005 wt (%) | 6. N - 0.007 wt (%) |
| 7. Cr - 0.79(%) | 8. Fe - remaining |

The experiment is carried in 6 sets consisting of 42x250 ml of beakers in each set. The distilled water is required for the preparation of solution. Hydrochloric acid and nitric acid solutions are prepared to the following molarities of standard procedure [4]. The experiment is carried on 0.5, 0.8, 1.0, 1.5, 2.0, 3.0 M solutions of HNO₃ and Hcl.

2. EXPERIMENTS CAREEIED IN ACIDIC MEDIUM (WEIGHT LOSS MEASUREMENT)

The coupons are immersed in a beaker containing 200 ml of solution at 25 degrees Celsius. The span of experiment is of 7 days and the weight is measured after every 24 hours.

2.1 EXPERIMENT NO. 1

The experimental observations made during HNO₃ as acidic medium are:

Variation of weight loss (g) with time (days) for mild steel in different concentration of HNO₃:-

Table -1: Observation made during HNO₃ as acidic medium

DAYS	0.5M	0.8M	1.0M	1.5M	2.0M	3.0M
1	1.80 g	3.80 g	3.90 g	7.90 g	9.50 g	14.00 g
2	2.00 g	3.90 g	4.40 g	8.40 g	9.60 g	14.10 g
3	2.10 g	3.95 g	4.90 g	8.45 g	10.20 g	15.00 g
4	2.30 g	4.00 g	5.20 g	8.45 g	11.90 g	15.20 g
5	2.32 g	4.00 g	5.60 g	8.50 g	11.90 g	15.30 g
6	2.40 g	4.10 g	5.80 g	9.40 g	12.00 g	15.90 g
7	2.60 g	4.20 g	6.00 g	9.50 g	12.20 g	17.00 g

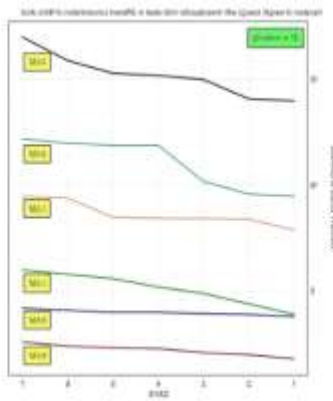


Chart-1: Between number of days and weight loss in grams.

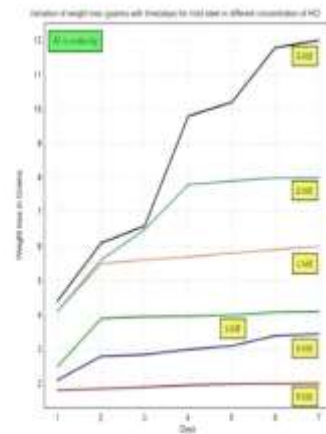


Chart-2- Between number of days and weight loss in grams.

2.2 Experiment no. 2

The experimental observations made during HCL as acidic medium are:

Variation of weight loss (g) with time (days) for mild steel in different concentration of HCL:

Table no. 2: - Observation made during HCL as acidic medium

DAY S	0.5 M	0.8 M	1.0 M	1.5 M	2M	3M
1	1.80 g	2.10 g	2.50 g	4.10 g	4.10 g	4.40 g
2	1.85 g	2.80 g	3.90 g	5.50 g	5.60 g	6.10 g
3	1.90 g	2.85 g	3.95 g	5.60 g	6.50 g	6.60 g
4	1.95 g	3.00 g	3.96 g	5.70 g	7.80 g	9.80 g
5	1.98 g	3.10 g	4.00 g	5.80 g	7.90 g	10.20 g
6	2.00 g	3.40 g	4.08 g	5.90 g	8.00 g	11.80 g
7	2.01 g	3.45 g	4.10 g	6.00 g	8.01 g	12.00 g

3. CORROSION RATE:

Corrosion rate may be defined as the penetration or the thinning of structural pieces and can be easily used to predict the life of material.

The corrosion rate equation is given by

$$R \text{ (mpy)} = 534w/\rho A t \text{ [5].}$$

w = weight loss {initial weight - final weight} in mili grams.

A = total surface area {5cmx5cm} in cm²

t = total time the sample was in sample was immersed in acidic medium in hour.

R = corrosion rate. Here mpy is ml per year.

In the following case the corrosion rate is determined for a mild steel immersed in 1M of acidic medium

3.1 CASE 1: When specimen is immersed in 1M nitric acid

Variation of corrosion rate R (mpy) for mild steel immersed in 1M nitric acid for 7 days:

Table no. 3: - Observation made between numbers of days and rate of corrosion

DAYS	R(mpy)
1	442 x 10 ⁻³
2	249 x 10 ⁻³
3	185 x 10 ⁻³
4	147 x 10 ⁻³
5	126 x 10 ⁻³
6	109 x 10 ⁻³
7	97 x 10 ⁻³

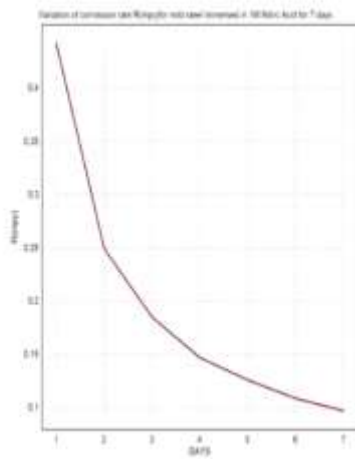


Chart no.3: - Between number of days and rate of corrosion.

3.2 CASE 2: When specimen is immersed in 1 molar hydrochloric acid

Variation of corrosion rate R (mpy) for mild steel immersed in 1M hydrochloric acid for 7 days:

Table no. 4: - Observation made between number of days and rate of corrosion.

DAYS	R(mpy)
1	283 x 10 ⁻³
2	221 x 10 ⁻³
3	149 x 10 ⁻³
4	112 x 10 ⁻³
5	90 x 10 ⁻³
6	77 x 10 ⁻³
7	66 x 10 ⁻³

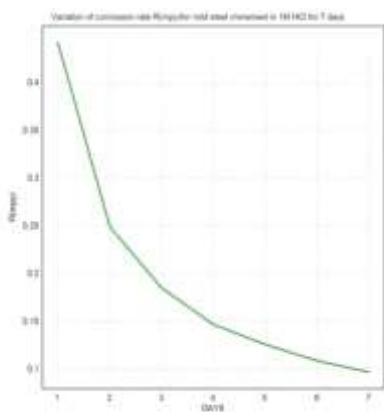


Chart no.4: - Between number of days and rate of corrosion.

The corrosion rate is highest in nitric acid as it is the strong oxidizing agent. In the following reaction.



The reaction gives nitrogen (II) oxide and production of

Fe(NO₃)₂ which is responsible for the coloration of medium. Corrosion in mild steel is found to be higher than any other high carbon steel. It is evident from the above data that the corrosion rates of coupons is faster in 3 days then it slows down due to passivating corrosion complexes that normally shield the metal surface from the medium. It has been also observed from the experiment that more the specimen is revealed to atmosphere less is the corrosion rate. This behavior could be explained from the concept of passivity and the decrease in the strength of the acid as corrosion complexes get formed in the media [6].

4. RESULTS AND DISCUSSION:

Since HNO₃ is more acidic than HCL hence mild steel corrodes more in HNO₃. The results are directly obtained from observations. Since corrosion is the chemical process involving the release of H⁺. Therefore, there is reduction of weight. With the increase in concentration of acidic medium, the rate of weight reduction is also increased.

5. CONCLUSION:

1. It is evident from the above that the corrosion is maximum due to nitric acid.
2. With the increase in concentration of acidic medium, the corrosion rate also increases.
3. The corrosion rate of mild steel is high in first 3 days after then it decreases gradually.
4. The environment acts as natural inhibitor.

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BIOGRAPHIES

Shakeel Ahmad Dar working as Assistant Professor, Department of Mechanical Engineering, SSM college of engineering and technology J&K. He has completed M.Tech in Mechanical Engineering with specialization in Production and Industrial Engineering from Integral University, Lucknow. His

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