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Corrosion Behavior of Different Percentage Al-Zn Galvanized Steel.

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Abstract:

Galvanizing or zinc coating is a method of protecting iron and steel against corrosion. When aluminum (Al) is added with zinc (Zn) in galvanizing process, properties of zinc coating varies. It effects on corrosion behavior, appearance, thickness, hardness and other physical or mechanical properties. Structure of the coating also varies. So by adding aluminum in zinc various types of properties can be analyzed for the better improvement of zinc coating. In this project effect of aluminum on corrosion behavior of hot dip galvanized steel, is mainly analyzed. The method of galvanization was done by hot dipping process. Here corrosion in different solution is also observed. Corrosion rate in 20% NaCl solution is higher than 10% NaCl solution. Varying the aluminum percentage in zinc shows different corrosion behavior on different solution.

Keywords:*Hotdipping, Galvanization,Transpassive,Corrosion, Moltenbath.*

1. Introduction

Galvanizing is an attractive and economical because of its corrosion protection for a wide variety of commercial and industrial steel articles. Hot Dip Galvanizing is a process in which an adherent, protective coating of zinc and zinc compounds is developed on the surfaces of iron and steel products by immersing them in a bath of molten zinc [1]. The usefulness of zinc coatings depends, first on the relatively slow rate of corrosion of zinc as compared with that of iron and the much less objectionable appearance of the white, nonstaining corrosion products of zinc as compared with iron rust, second on the electrolytic protection afforded to iron by zinc [2].
Zinc coating have the longest life under conditions of rural exposure where the air is free from sulfur gasses and other industrial fumes [3]. They have satisfactory service in salt air, also. They are more rapidly attacked in highly in acid industrial atmosphere. Galvanized coatings are applied to iron and steel primarily to provide protection against corrosion of the base metal. Some major applications of hot dip galvanized coatings include: Marine pilings and rails, Bridge structural members, culverts, corrugated steel pipe etc. Rather that Corrosion appearance, Abrasion resistance, High temperature Exposure, Surface reflectivity also enhance the importance of galvanized [4]. Adding Aluminum on Zinc bath enhance the corrosion properties of the galvanized steel. Resistivity of corrosion is much higher Al-Zn coating compares to pure zinc. This coating has good corrosion resistive property also. In this project, the effect of aluminum on corrosion behavior of hot dip galvanized steel is work on.

2. Experimental Procedure

In this experiment mild steel strips are galvanized by batch hot dipping process .The sample is dipped in various percentages of Al –Zn bath. Then the corrosion properties of this galvanized sample are examined in NaCl solution. The substrate that was taken in this experiment is 6 cm by 2 cm in size. Before dipping it the molten bath, it has gone through different type of cleaning procedure and protection from air as well. Here galvanization is done by dry galvanizing process where samples are degreased, pickled and immersed in an aqueous flux solution, dried and then immersed in the molten zinc bath.Work pieces must be handled properly until the coating has completely solidified, which was accomplished by air cooling. The whole procedure has been illustrated in Fig 1. Although degreasing, pickling, water rinsing, and other cleaning procedures remove most of the surface contamination and scale from iron and steel, small amounts of impurities in the form of oxides, chlorides, sulfates, and sulfides are retained. Unless removing, these impurities will interfere with the iron-zinc reaction when the iron or steel part is immersed in molten zinc.

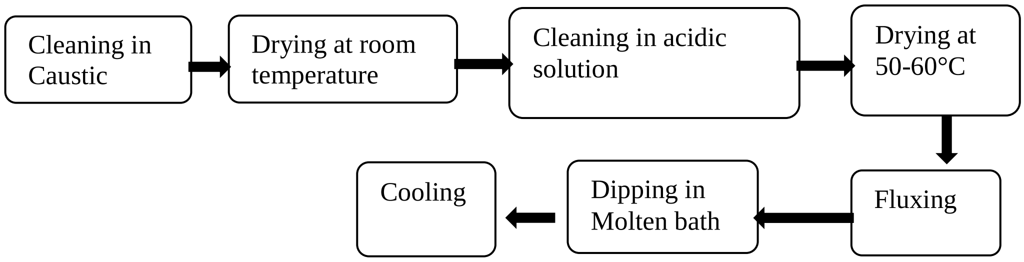

Fig. 1. Experimental procedure

In this experiment samples were dipped in various bath compositions. The temperature is maintained within the range of 600-650°C. The immersion time for all samples was 1 minute.The bath compositions for this experiment are in table 1. For corrosion test samples were immersed in different % of NaCl solution bath at various time ranges. In this paper 10% and 20% NaCl solution had been used for corrosion test. Corrosion rate of different composition of samples has also been depicting on.

Table. 1. Compositions of molten bath solution

Bath Compositions	% of Al in Zn	Notations
Pure Zn	0	Pure Zn
3.97% Al-Zn	3.97	3 Al-Zn
8.4 % Al-Zn	8.4	8 Al-Zn
15.56 % Al-Zn	15.56	15 Al-Zn

3. Results

Fig. 2a) illustrated 20% and 10 % of NaCl test of different samples. Except the sample maintained in solution for 5 hr, rest of all are in similar pattern. In other samples corrosion rate decreases up to 8.4% aluminum added sample. Then corrosion rate increases with increasing the percentage of aluminum. This behavior is observed for increasing percentage aluminum up to 10.94% Then again corrosion rate decreases. Some exceptionality has been noticed for the sample maintained for 5 hr.

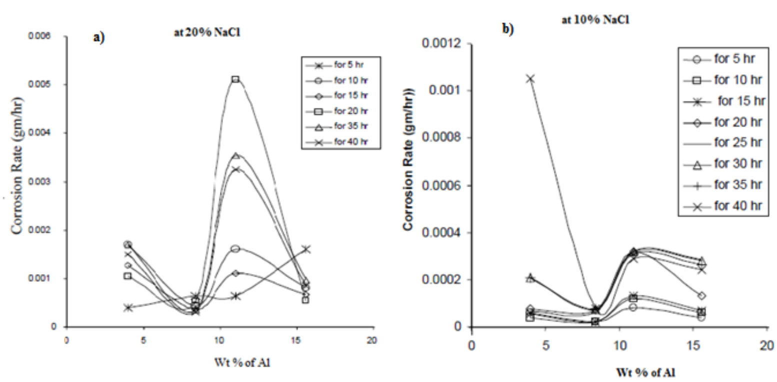

Fig. 2. Weight % of Al Vs Corrosion rate at a) 20% NaCl b) 10% NaCl

Fig. 2b) illustrated thatsamples maintained in solution for 5 to 35 hr are in similar pattern. At first corrosion rate decreases up to about 8.4 % aluminum then again increases up to about 10.94 % finally again corrosion rate decreases. But the sample which is maintained in solution 40 hr in first portion corrosion rate decreases drastically. Corrosion rate for the samples from 5 hrs to 20 hrs is comparatively higher than others samples in 35 hrs and 40 hrs. Corrosion rate for 40 hours sample is slower. From this phenomenon we can conclude that with increasing Al upto 8% corrosion rate decreases as some oxides formation occur during immersion of this solution. These oxides scale act as protective layer for further oxidation. That's why it reduces the corrosion rate. With increasing the thickness of the oxide layer, the oxide scale get off which is responsible for further oxidation.

Corrosion rate of 8.84% Al- Zn samples at different time is observed from following figure. This test is done at various NaClsolutions. From the graph it is observed that corrosion behavior of 5% and 20% NaCl test are in similar pattern. The corrosion rate decreases slowly with time. But for 10% NaCl test corrosion rate increases slowly with time upto 20 hr, after that corrosion rate increases somewhat.

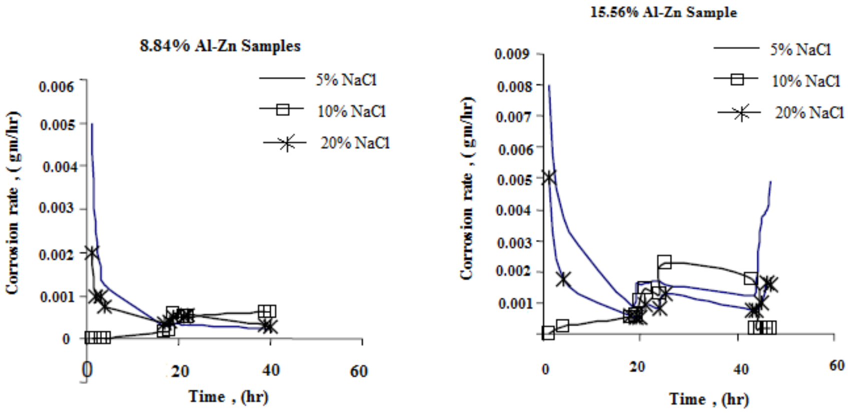

Fig. 3. Corrosion rate Vs time for a) 8.84%Al-Zn Sample b) 15.56% Al-Zn Sample

From the following figure it is observed that corrosion rate behavior for 5% NaCl and 20% NaCl are similar pattern. In both case corrosion rate at first decreases with time, then constant for some time, then again increases. 10% NaCl test shows different pattern, at first corrosion increases slowly with time. After 20hr it increases rapidly, and then it is constant with time.

4. SEM analysis

From the SEM picture it can be shown that coating is very uniform, homogenous microstructure. The coating thickness varies in between 59- 60 µm.

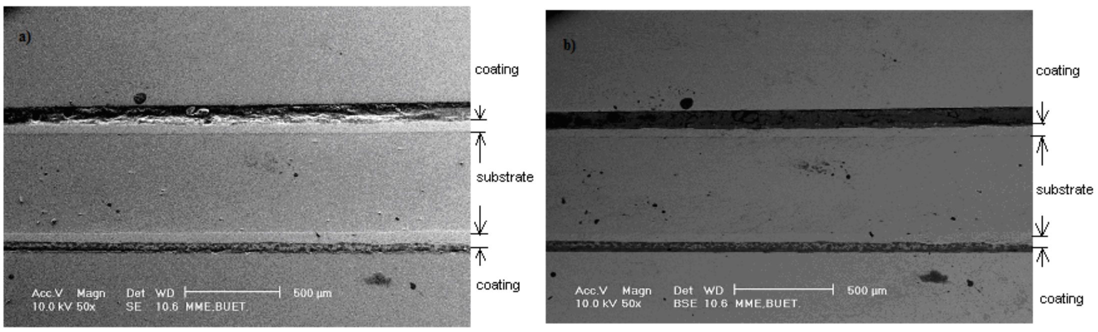

Fig.4.SEM images a) Secondary electron image b) Backscattered electron image

5. Conclusion

In this paper corrosion experiment has been done at different types of NaCl solution medium and different composition of Aluminum as well. In all cases corrosion rate decrease with increasing the Aluminum content after that it again increases. High concentrated NaCl solution increases corrosion rate.Coating from increased amount of aluminum in zinc bath shows good resistive properties of corrosion. At the very beginning corrosion rate decreases slowly with time then constant for some time and increases again. It can be concluded that the total corrosion effect can be divided into three parts active, passive and transpassive. . In the active region the behavior of this material is identical to that of a normal metal. Increasing the time weight loss increases rapidly, then at a time reached when weight losses slightly. This is passive region. Overcoming this passive region weight loss again increases with time. That means corrosion rate increases .This region known as transpassive region.

6. Acknowledgement

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7. Reference

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