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CORROSION OF DIFFERENT MATERIALS IN DIFFERENT SOLUTIONS

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Abstract- *Mild Steel, copper, aluminum, zinc are the major usable materials used in the industries and domestic purposes. In every year huge amount of investment is made in industries and in buildings, whereas cost due to corrosion is measured in large scale worldwide. So, the measurement of corrosion of different materials in different environment should be estimated. Metals corrode in any contaminated environment as acid medium, sea water, and fresh water even in atmosphere. The experimental study under this project on corrosion behavior and mechanism in weight loss method for some materials in different medium have been studied in different medium, for instance, sodium chloride salt, sulfuric acid, nitric acid fresh water. Which were studied for a period of five days interval weighing and re-immersing. A comparison has also studied on the corrosion rates of different materials.*

Keywords: Crystal growth, Potassium aluminum sulfate, Potassium dichromate, Recycling, Recrystallization.

1. INTRODUCTION

In the world today, metals are used in different Engineering applications for the production of automobile components, structural shapes (I beam and angle) and sheets in pipelines, buildings, plants, bridges and tin cans, heat exchangers tube, fins, in laboratory equipment [1]. When these metals are exposed to the open environment or different mediums, they begin to corrode. The corrosiveness of different medium or solution can be defined as the capacity of producing and developing the corrosion phenomenon. Corrosion resistance of metals and alloys is a basic property related to the ease with which these metals react with a given environment. The importance of corrosion studies is two folds. The first is economic, including the reduction of material losses resulting from the wasting away or sudden failure of piping, tanks, metal components of machines, ships, hulls, marine, structures and many more. The second is conservation, applied primarily to metal resources, the world's supply of which is limited, and the wastage of which includes corresponding losses of energy and water resources accompanying the production and fabrication of metal structures. Corrosion is a natural phenomenon. Corrosion can be slow or fast. Practically all environments are corrosive to some degree [4]. Some example are air and moisture; fresh, distilled, salt, and mine waters; rural, urban and industrial atmospheres; steam and other gases such as chlorine, ammonia, hydrogen sulfide, sulfur dioxide, and fuel gases; mineral acids such as hydrochloric acid (HCl), sulfuric acid (H_2SO_4), and nitric acid (HNO_3); organic acids such as naphthenic, acetic, and formic; alkalis; soils; solvents; vegetables; and petroleum oils; and a variety of food products. In general, the "inorganic" materials are more corrosive than the "organic".

2. METHODOLOGY

The technique of weight loss method of corrosion measurement requires no complex equipment or procedures, merely an appropriately shaped coupon, a carrier for the coupon (coupon holder), and a reliable means of removing corrosion product without disruption of the metal substrate. Weight loss measurement is still the most widely used means of determining corrosion loss, despite being the oldest method currently in use. This method is commonly used as a calibration standard for other means of corrosion monitoring, such as Linear Polarization and Electrical Resistance. In instances where slow response and averaged data are acceptable, weight loss monitoring is the preferred technique. Preparation of the experiment are given below. Mild steels, coper, aluminum rods are cut their desired size and measured the length, diameter of the rods. The following step by step procedures were completed during this lab work experiment: [26]

(1)The coupons were pre-treated in absolute ethanol followed by acetone in order to be degreased. (2)The degreased coupons were heavily rinsed with de-ionized (distilled) water. (3)The coupons were dried. (4)Every coupon was accurately weighted and the mass recorded by balance. (5)300 ml of distilled water was placed in each of the beakers in addition to 14.625g of NaCl for 1M NaCl , 13.6ml HNO_3 for 0.5M of HNO_3 , 12ml H_2SO_4 for 0.5M H_2SO_4 . (6)400ml was filled carefully. (7)Coupons were placed in each of the beakers. (8)After 5 days (120 hours), the coupons were removed from the beakers. (9)The coupons were rinsed with de-ionized water followed by 15% HCl to remove the corrosion products, and then rinsed again with de-ionized water. (10)The coupons were then dried-up and weighted to obtain the new mass. Coupon Preparation and Cleaning are the choice of technique for initial preparation of the coupon surface, and for cleaning the coupon after use, is critical in obtaining useful data. Both the relevance and reproducibility of weight loss data are highly sensitive to the inherent suitability of these techniques, and to the care with which they are executed. Surface finishing methods vary across a broad range for specific applications. Blasting with glass bead, sand, or other aggregate can provide an acceptable finish for some applications. Sanding with abrasive belts, or surface or double disc grinding with abrasive stones also provides an excellent surface for evaluation. Cleaning of specimens before weighing and exposure is critical to remove any contaminants that could affect test results. Reference should be made to NACE Recommended Practice RP-0775 and ASTM G-1 & G-4 for further detail on surface finishing and cleaning of weight-loss coupons [24]. Positioning is a critical factor in obtaining relevant information. For example, a multi-phase product may produce layered flow, giving rise to corrosion rates that vary with depth in the process stream. Such situations can be monitored with a ladder-strip coupon holder. Corrosion test are (1)1M of NaCl , 0.5M of HNO_3 , 0.5M of H_2SO_4 were prepared in the beakers. (2)Dried and weighted coupons are placed into the beakers. (3)Waited for five days. (4)Again weighte. (5)Calculated the corrosion rate. Required solution are 1M of NaCl , 0.5M of HNO_3, 0.5M of H_2SO_4. Corroding media of 400ml with distilled water in each of the beakers. 1.0M NaCl solution – 14.625g of NaCl pellets in a dry paper is weighed on a digital electronic scale. Then transferred to a clean beaker which contained some quantity of distilled water, enough to dissolve the solid NaCl salt. The solution after vigorous shaking is transferred from beaker into a 400 cm^3 volume flask. Distilled water was gradually poured into the flask until it reached the meniscus level. 0.5M H_2SO_4 solution – 12ml of H_2SO_4 acid in a dry measuring flask is measured carefully. Then transferred to a clean beaker which contained some quantity of distilled water, enough to dissolve the H_2SO_4 acid. The solution after vigorous shaking is transferred from beaker into a 400 cm^3 volume flask. Distilled water was gradually poured into the flask until it reached the meniscus level. 0.5M HNO_3 solution – 13.6ml of HNO_3 acid in a dry measuring flask is measured carefully. Then transferred to a clean beaker which contained some quantity of distilled water, enough to dissolve the HNO_3 acid. The solution after vigorous shaking is transferred from beaker into a 400 cm^3 volume flask. Distilled water was gradually poured into the flask until it reached the meniscus level [27].

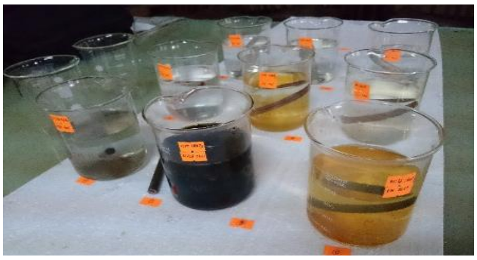

Fig. 1: Corroding solutions for this experiment

3. EXPERIMENTAL SETUP

Similar sizes of mild steel, copper, aluminum, zinc, were exposed to different corrosive environments and were left for a stipulated period of five weeks with a weekly interval of collection, weighing and re immersing into the various environments. Based on the weight assessment, appropriate corrosion formulae are employed to ascertain reliable analysis. It is based on standard practice, the liquid media are changed at the time of reweighing and re-immersing.

Fig. 2: Sample rod for this method

The laboratory corrosion test revolves around the actualization of facts for the perfect selection of materials for specific environments, determination of environments in which materials are especially suitable, corrosion control methods that can be applied and the study of corrosion mechanisms. In this experiment, four different environments were used; hydrochloric acid, salt water, fresh water, atmosphere. Metals of the same dimensions will be exposed to the corrosive properties of these environments and monitored on weekly basis. This describes the procedures use for specimen preparation, apparatus, and test conditions, methods of cleaning specimens, evaluation of results and calculations and reporting of corrosion rate.

The surfaces of the specimen were finished with abrasive paper, rinsed in water, degreased in Acetone and air dried. After drying, the coupons were immediately weighed. Four coupons will be used for this experiment. On each string and test bottles, a masking tape with label name of the corrosive medium was pasted.

4. DATA COLLECTION AND RESEARCH ANALYSIS

The data were collected from the experimental setup and calculated the corrosion rate of the metals and were compared.

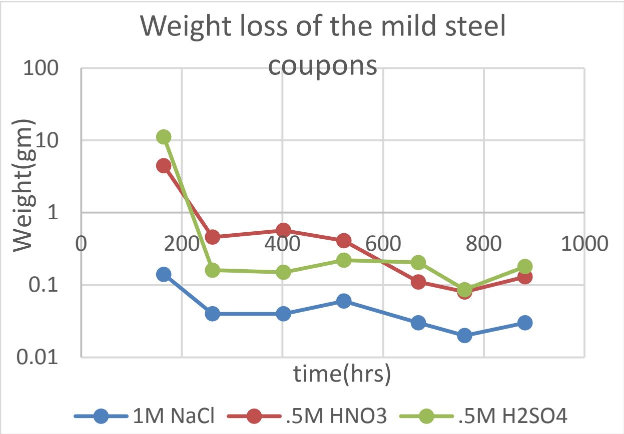

Fig. 3: Weight loss of the mild steel coupons

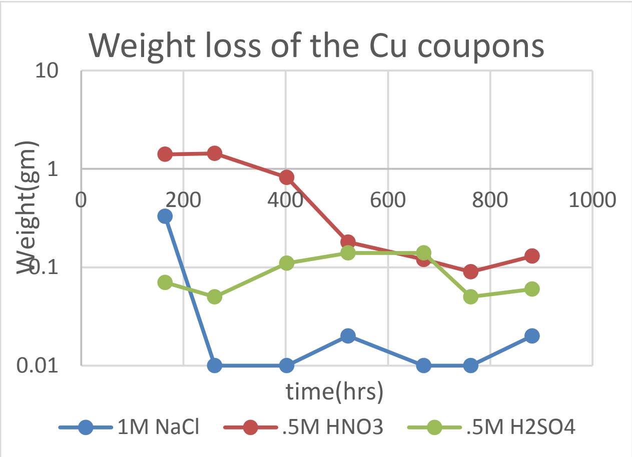

Fig. 3: Weight loss of the Cu coupons

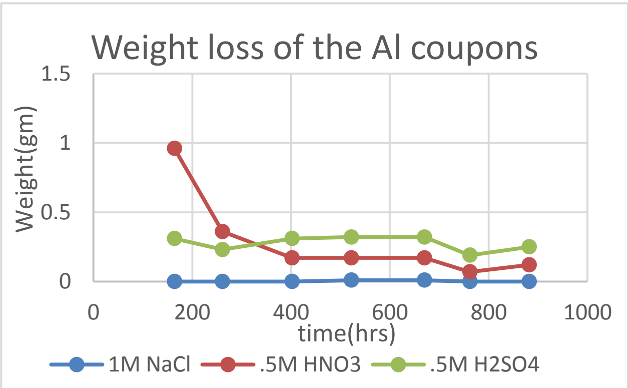

Fig. 5: Weight loss of the Al coupons

Table 1: Density table for the sample

Sample no.	Name of the materials	Density (g/cm^3)
1	Mild steel	7.86
2	Copper	8.92
3	Aluminum	2.72

Table 2: Exposed area of the sample

Sample no.	Area (cm^2)	Sample no.	Area (cm^2)
1A	65.34528	2C	67.23024
1B	64.71696	2D	66.91608
1C	64.71696	3A	92.708616
1D	64.71696	3B	90.666576
2A	68.48688	3C	90.666576
2B	67.23024	3D	97.201104

5. RESULT & DISCUSSION

The corrosion rate of different metals in different solutions from the experiment were obtained as follows: Average corrosion rate of mild steel in 1M NaCl solution is 0.0134 mmpy. Average corrosion rate of mild steel in 0.5M HNO_3 solution is 0.1258 mmpy. Average corrosion rate of mild steel in 0.5M H_2SO_4 solution is 0.0582 mmpy. Average corrosion rate of copper in 1M NaCl solution is 0.0036 mmpy. Average corrosion rate of copper in 0.5M HNO_3 solution is 0.0288 mmpy. Average corrosion rate of copper in 0.5M H_2SO_4 solution is 0.0262 mmpy. Average corrosion rate of aluminum in 1M NaCl solution is 0.0024 mmpy. Average corrosion rate of aluminum in 0.5M HNO_3 solution is 0.1544 mmpy. Average corrosion rate of aluminum in 0.5M H_2SO_4 solution is 0.1939 mmpy. The results show that: Mild steel in all solutions: weight loss increased over time almost same but decreasing corrosion rate. Copper in all solutions weight loss increased over time almost same train like mild steel. Aluminum in all solutions weight loss increased over time almost same train like mild steel also. Corrosion rate of mild steel is higher in nitric acid solution than sulfuric acid and in the sodium chloride solution this rate is less than acid solution. Corrosion rate of copper in sodium chloride and nitric acid is decreasing with the increase of time hours. And in sulfuric acid solutions corrosion rate of copper decreases gradually. Corrosion rate of aluminum in sulfuric and nitric acid solutions gradually decreases overtime and in sodium chloride solution again decreases after increasing once.

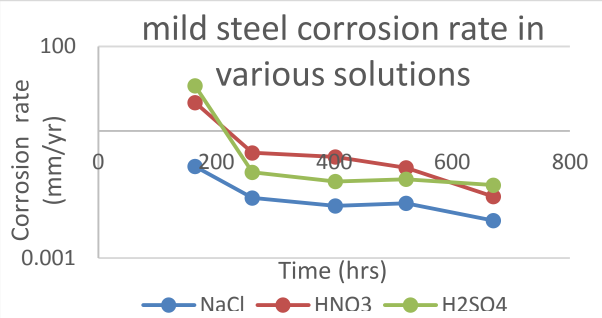

Fig. 6: Mild steel corrosion rate in various solution

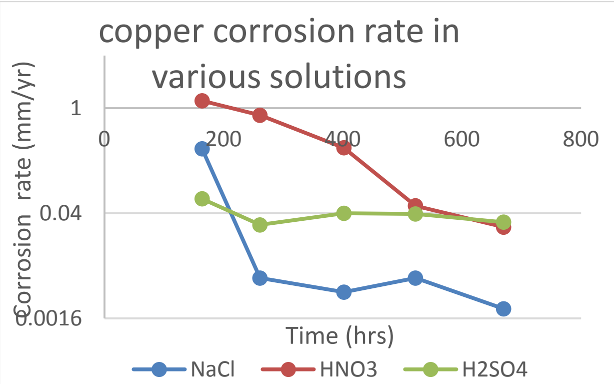

Fig. 7: Copper corrosion rate in various solutions

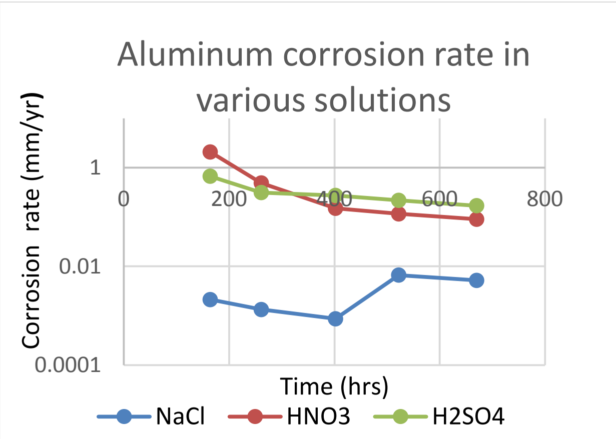

Fig. 8: Aluminum corrosion rate in various solution

6. CONCLUSION

As metal undergoes corrosion in corroding environment, there tends to be an inverse relationship in the weight loss and corrosion rate trends in metals. While weight loss tends to increase over time, the highest being at the time that the corrosion process is initiated, corrosion rate tends to decrease simultaneously due to the formation of the passive layer. The laboratory immersion test remains the best method of screening and eliminating from further consideration of those metals that should not be used for specific applications. While these tests are the quickest and most economical means for providing a preliminary selection of best suited materials, there is no simple way to extrapolate the results obtained from this simple test to the predictions of systems service lifetime.

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