# EVALUATION OF THE IMPACT OF CORROSION ATTACK IN CAST STEEL C-1040 MARINE PIPING SYSTEM IN TWO MEDIA

**C 1040 is not cast iron steel**


## ABSTRACT

**delete**

This research entails the use of weight loss gravimetric method for the evaluation of corrosion disaster in marine carbon steel piping in freshwater and seawater as environmental media with a view to exposing the dangers of corrosion. The results from the experiment showed that corrosion occurred as metal weight reduction evident in cast steel C-1040. The weight loss and rate of corrosion showed in fig 5 and 6 of the two metal specimens of cast steel C-1040 in seawater and freshwater varied, as corrosion rate and weight loss (table 4 and 5) was found to be higher in 0.2M of seawater solution than in 0.4M concentration of freshwater. Weight loss and corrosion rate in the seawater environment increased steadily from week one (1) to week eight (8) as shown in tables 4 and 5, far higher than the weight loss/corrosion rate in the freshwater environment. Weight loss and corrosion rate in 0.2M concentration of cast steel C-1040 increased from 0.04g to 0.53g, 0.007133mmpy to 0.0181mmpy while 0.02g to 0.25g, 0.0035mmpy to 0.005573mmpy increased was observed in 0.4M concentration in freshwater environment. Thus, confirming carbon steel metal to be more corrosive in the seawater environment than in the freshwater environment. From the inverted metallurgical microscope , the micrograph result for cast steel C-1040 before and after immersion gave evident that steel cast C-1040 sample after the 1344hrs(0.1536yr) of immersion in 0.2M of seawater experienced uniform (general) corrosion as the surface was rough and jarring. The grain boundaries of the surface morphology revealed general corrosion effects on the metal after immersion as the film present on the surface was cracked.

*Steel is not corrosive



*Keywords: Cast Steel, Corrosion Rate, Sea Water, Fresh Water, piping system.*


## 1. INTRODUCTION

An environment may practically be regarded as corrosive to a certain degree, even though the extent of corrosion depends on a number of factors. These environments include among many others the atmosphere, a mixture of air and moisture, fresh and salty water, and the industrial atmospheres (gases, alkali, acids, etc.).
Corrosion is enormously destructive to metals and undoubtedly one of the largest consumers of metal known to man. A number of industrial designs of materials are not carried out unless keen considerations are given to the effect of corrosion on the materials' life spans (Aminu and Linus, 2015).
The impact of corrosion on a ship's hull is generally known and recognized by the material industry but the disasters by corrosion attacks in marine piping system and their arrangement used in offshore practices have been recognized by few (Murdoch, 2012).
According to Murdoch (2012) Pipes are 'workers', which conveys fluids or permits air to enter or to leave a space and are the means through which many control systems operate.
Corrosion is defined as the degradation or decay of a metal by direct attack or by reaction with its environment (Trethway and Chamberlain, 2010). According to Ikechukwu and Pauline (2015) corrosion takes place in the presence of an electrolyte; such as freshwater, saltwater or soil.
Rajendran et al, (2012) posited that corrosion degrades the metallic properties of the affected metal.
Oliver et al, (2008) postulated* that corrosion is the damaging attack on a metal by its environment which results in damage to its metallic properties, such that it can no longer meet the design criteria specified.
Environmental factors have significant effects on the corrosion of metals and other accelerating factors such as the oxygen of the fluid, chemical make-up, velocity of the fluid, temperature and pH values (Anyawu and Agberegba, 201 5). Example of a corroded pipe affected by seawater is shown in fig -----below;
*Damaging attack is not a postulate

Fig. 1: corroded piping system

Source: A master guide to ship piping system by Eric Murdoch (2012)

Pipes corrode **internally** and **externally. Internally**, they may be affected by erosion, uniform and abrasive corrosion, fatigue and galvanic action. **Externally**, corrosion is caused mainly by atmospheric conditions, but pipes can corrode locally where liquids drip onto them or erode where clamps have loosened and fretting occurs (Murdoch, 2012). However, in spite of safety/maintenance majors to combat and reduce the effects of corrosion in marine piping system, an estimated sum of 4% of the GNP of the industrial country has been spent (Gerhardus, et al, 2001). Failures in piping system are known to occur due to chemical or * corrosion is electrochemical in nature electrochemical reaction with its corrosive environment (Ailor, 2010) Corrosion can be classified into different categories based on the material, environment and the morphology of the corrosion damage (Richard, 2012).

In Nigeria, corrosion is seen as a normal process needing limited attention (Akinyemi, Nwaokocha and Adesanya, 2012). According to ASM (2000), corrosion affect the useful lives of our possession, result in damage of buildings and collapse of electric towers. Hence, an enlightened approach to materials selection, protection and corrosion control is needed to reduce this burden of wasted materials, wasted energy and wasted money (marinecorrosionforum.org).

## 2.0 Experiment and method

In early corrosion studies, (Oliver et al, 2008) classify the corrosion parameters namely as; salinity, pH**,** dissolved oxygen concentration, temperature, velocity and biological species type as the prevailing factors influencing corrosion. 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. However, seawater and freshwater environment was entirely the focus of the study. Corrosion test methods are namely; weight loss analysis, Electrical resistance, linear polarization, Electrochemical Impedance Spectroscopy (EIS) and AC Impedance, X-ray diffraction (XRD), Scanning electron microscope (SEM), Inverted metallurgical microscope (IMM) and transmission electron microscope (TEM). Hence, this work employed the use of Weight loss technique, X-MET7000 spectrometer positive material identification and inverted metallurgical microscope (X 400) as test methods.

### 2.1 Positive material identification (PMI)

Positive material identification is a well-established analytical non-destructive material testing and material identification technique, which guarantees material's elemental composition for safety compliance and quality control. Method of positive material identification used in this work was the x ray fluorescence and spark emission spectrography. Thus, x ray fluorescence method of positive material identification (PMI) was used in this study to determine the chemical compositions of the corroded metal before carrying out weight loss analysis.

#### 2.1.1 Equipment used for the PMI test

Oxford instruments X-Met 700 XRF spectrometer, wire brushes, industrial rags.

### 2.1.2 Sample preparation and Analysis

The location to be tested is cleaned to remove dirt, rust or adhering grease. The X-MET7000 series has factory settings which are applicable to many measurement. X-met is however tested for by measuring the sample specimen. Chemical composition of the selected material (cast steel C-1040) obtained from Turret Engineering services Ltd is shown in fig. 2 below


**Fig. 2. Cast steel C-1040 chemical composition**

### 2.2 Weight Loss Technique

The simplest, and longest established, method of estimating corrosion losses in plant and equipment is weight loss analysis. A weighed sample (coupon) of the metal or alloy under consideration is introduced into the process, and later removed after a reasonable time interval. The coupon is cleaned of all corrosion product and is re-weighed. The weight loss is converted to a corrosion rate (CR) or a metal loss (ML). Weight loss analysis was used as experimental method for the immersion test using samples of cast steel C-1040, X MET7000 fluorescent Positive material identification to obtain the chemical composition of the cast steel specimens and inverted metallurgical microscope to show the grain boundaries of the specimen before and after immersion to the corrosion media. Hence, weight loss technique was used in this research to determine the weight difference of the sample, in order to calculate the rate of corrosion of the selected material. The specimen also called coupon was weighed before it was exposed to the solvent, at a known concentration of 0.2M concentration in seawater and 0.4M concentration in freshwater after exposure for a stipulated time. Corrosion products on the metals were properly cleaned off and reweighed. The weight loss in (g) was taken as the difference in the weight of the coupons before and after immersion in the two different test solutions. The corrosion rate of the given specimen's was calculated from the weight loss obtained.

Original weight of the carbon steel coupon obtained from the weigh balance is shown in table 1.

**Table 1.**

| Metal | Sample 1 | Sample 2 |
|---|---|---|
| **Carbon steel** | 15.79g | 15.79g |

Two carbon steel coupon was selected, of cylindrical shape and weighed. Specimen 1 and 2 were used for the experimental set up with concentration of 0.2M of seawater and 0,4M of freshwater. Surfaces of the cut specimen where filed, brushed and made smooth by means of an emery cloth. The metals were then cleaned with water and washed with acetone and then left to dry.

How did the researcher obtain 0.2M and 0.4M of sea water and fresh water?

### 2.2.1 Preparation of size, shape and area of specimen

The carbon steel metal of cylindrical shape was cut and filed into two equal parts, their area was obtained along with the length, and radius. The two carbon steel samples comprises of the same length and radius, however their weight varies when weighed on an ultra-sensitive balanced. Emery cloth and file was used to dress the edges of the coupon to reduce or remove the roughness of their surfaces.

Table 2. Shows the shape, size and area of the specimen used for the experimentation.

| Specimen | Shape | radius $(mm)$ | Length $(mm)$ | Area $(mm^2)$ |
|---|---|---|---|---|
| Carbon steel | Cylindrical | 6.0 | 80 | 3243 |

### 2.2.2 Method of exposing specimens to solvents

The coupon were exposed to the seawater and freshwater in such a way as to expose a large surface area of the specimen to the corrodents. Each coupon was suspended in a known volume (250ml) of corrosion media through a supporting rod and a thread. This was with a view to ensure uniform contact of the specimen with the medium as shown in figures 2 and table 3 shows the concentration of the various solvent.

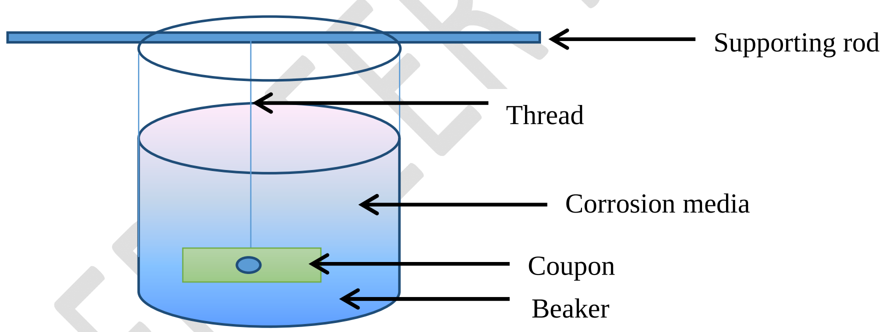


**Fig. 3. Beaker used as seawater corrosion media**

**Table 3. Solvent used at different at different concentration**

| Solvent? | Concentration |
|---|---|
| Seawater | 0.2M |
| Seawater | 0.4M |

**Fig. 4. Ultrasensitive weighing balance used for weighing the cast steel coupon.**

### 2.2.3 Calculation of Corrosion Rates

Calculation of corrosion resistance by the difference in weight method is a very important information of testing the corrosion rate of metals. This method involves noting the difference in weight of the metal specimen prior to exposure in the organic solvents and after it was determined. Result obtained from the experiment can be referred to a unit of metal surface ($mm^2$ or $cm^2$) and sometimes (hour, day, year etc.). Hence, corrosion rate are expressed in $g/cm^2.hr$ or $mg/mm^2.day$. The corrosion resistance of a metal and the data obtained from the weight losses are converted into an index, which indicate the reduction in metal thickness. Such unit of corrosion resistance measurement is millimeter penetration per year (mm/y).

The corrosion rate in absence of inhibitors is expressed using millimeter penetration per year (mmpy) is given as follows:

$$\text{Corrosion rate (C.R)} = \frac{\text{Weight Loss (W)} \times K}{D\ (\frac{g}{mm^3}) \times A\ (mm^2) \times T\ (yr)} \qquad (1)$$

Where,

K = Rate constant= 87.6

$\Delta W$ = Weight in grams

$$D = \text{Density of metal in } \frac{\text{mass (g)}}{\text{volume } (mm^3)} \qquad (2)$$

A = surface area of metal in ($mm^2$)

T = Time of exposure in yrs.

$$\text{Corrosion rate (mm/y)} = \frac{87.6 \times \Delta W}{D \times A \times T} = \frac{g}{\frac{g}{mm^3} \times mm^2 \times yr} = \frac{mm}{yr} \text{ or mmpy}$$

Calculation of the sample area, weight loss and corrosion rate were coded and solved using engineering equation solver and plotted comparatively at the two different concentration on MS excel spreadsheet. The results from engineering equation solver (EES) is shown in the appendix.

### 2.3 Inverted Metallurgical Microscope

An inverted metallurgical microscope X 400 is a microscope invented in 1850 by Lawrence Smith, which is used in micromanipulation application where space above the specimen is required for manipulator mechanism with polished sample placed on top of the stage and viewed using reflecting objective. Inverted metallurgical microscope is a surface analysis tool which allows for inspection of grain size and the state of the metals Prepared metallographic samples of cast steel and copper were inspected using dedicated microscope to assess the grain size and phase of metals. Sample of cast steel C-1040 surface was analyzed before and after immersion into the seawater environment of 0.2M concentration.

Before the specimens were inspected with the microscope, the following preparatory steps were taken to ensure the visibility of the microstructure:

- **Sampling:** This involves cutting of the metal specimens to sizes that will fit into the mold for mounting. The metal specimens were cut into smaller dimensions using a hacksaw.
- **Mounting:** The specimens were placed in a mold that has a punch, phenolic powder (Thermosetting material) is been poured into the mold and a heater placed round it. Pressure is applied on the content of the mold with a hydraulic press and the specimen is heated in a heater until the light indicator goes off. The material is ejected out from the heater to form a mounted sample.
- **Grinding:** This is done to ensure smooth finish and uniformity of the surface of the specimen to be scanned. Hence, 5 different abrasive papers were used ranging from P220, 320, 400, 600 and 800.

The mounted surface to be scanned was thoroughly scrubbed on the abrasive paper starting from the P800 till the P220 to ensure the surface smoothness.

- **Polishing:** Using a polishing machine, velvet clothe and a polishing reagents (diamond suspension and lubrication), the sample is inverted while the polishing wheel moves round until a mirror like surface is achieved.
- **Etching:** Different etching reagents were used on the different specimens. The steel is immersed in a solution containing 2% nitride for at least 30seconds and then rinsed with another solution containing 98% alcohol. The specimen was dried with a specimen dryer.
- **Scanning:** The prepared sample is then placed under the microscope for scanning.

**Grinding polishing etc of metal exposed to corrosion will remove all the tell-tale effects of corrosion. Hence what you observed was not the effect of corrosion**

## 3. RESULTS AND DISCUSSION

### 3.1 Presentation of Results

The experimental result obtained from weight loss technique was calculated using engineering equation solver (EES) from specimens 1 and 2 of cast steel C-1040 immersed in seawater and freshwater at 0.2M and 0.4M at room temperature showed evidence of corrosion attack after eight (8) weeks (1344hrs, or 0.1536yr). Table 4 and 5 showed evidence of increased weight loss and corrosion rate of the specimen while Figure 5 and 6 graphically illustrated the comparative behavior of the specimen in seawater and freshwater in 0.2M and 0.4M respectively. So what is the comparative?

**Table 4. Weight loss results of carbon steel immersed after four (4) weeks in freshwater and seawater media.**

| Conc. | Initial weight before immersion | Wt. after 1st week | Wt. after 2nd week | Wt. after 3rd week | Wt. after 4th week | Wt. after 5th week | Wt. after 6th week | Wt. after 7th week | Wt. after 8th week |
|---|---|---|---|---|---|---|---|---|---|
| 0.2M of seawater | 14.79g | 14.75g | 14.70g | 14.63g | 14.56g | 14.50g | 14.41g | 14.33g | 14.26g |
| 0.4M of freshwater | 14.79g Can not be the same! | 14.77g | 14.74g | 14.70g | 14.67g | 14.64g | 14.62g | 14.59g | 14.54g |

**Table 5. Weight loss of coupons after eight (8) weeks of immersion**.

| Conc. | Wt. loss aft wk. 1 | Wt. loss aft wk. 2 | Wt. lost aft wk. 3 | Wt. loss aft wk. 4 | Wt. loss aft wk. 5 | Wt. loss aft wk. 6 | Wt. loss aft wk. 7 | Wt. loss aft wk. 8 |
|---|---|---|---|---|---|---|---|---|
| 0.2M of seawater | 0.04g | 0.09g | 0.16g | 0.23g | 0.29g | 0.34g | 0.46g | 0.53g |
| 0.4M of freshwater | 0.02g | 0.05g | 0.09g | 0.12g | 0.15g | 0.17g | 0.2g | 0.25g |

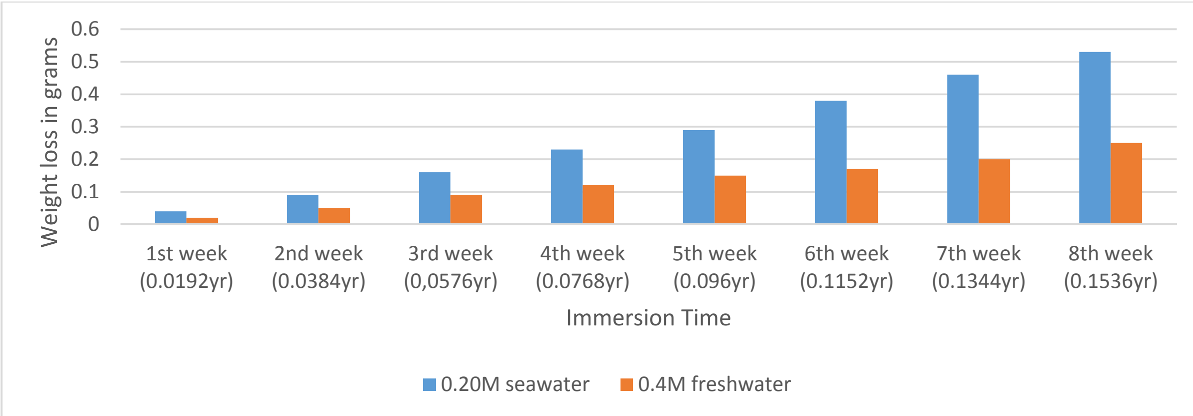


**Fig. 5. Weight loss results of carbon steel specimen in 0.2M of seawater and 0.4M of freshwater exposed for eight weeks against Time**

**Table 6. Corrosion rate of carbon steel immersed after eight (8) weeks in freshwater and seawater media**

| Con | Cr after1st week | Cr after 2nd week | Cr after 3rd week | Cr after 4th week | Cr after 5th week | Cr after 6th week | Cr after 7th week | Cr after 8th week |
|---|---|---|---|---|---|---|---|---|
| 0.2M of seawater | 0.007133 mmpy | 0.008025 mmpy | 0.009511 mmpy | 0.01025 mmpy | 0.01034mmpy | 0.01129mmpy | 0.01172mmpy | 0.01181mmpy |
| 0.4M of freshwater | 0.003567mmpy | 0.004458 mmpy | 0.00535 mmpy | 0.00535 mmpy | 0.00535mmpy | 0.005053 mmpy | 0.005095 mmpy | 0.005573 mmpy |



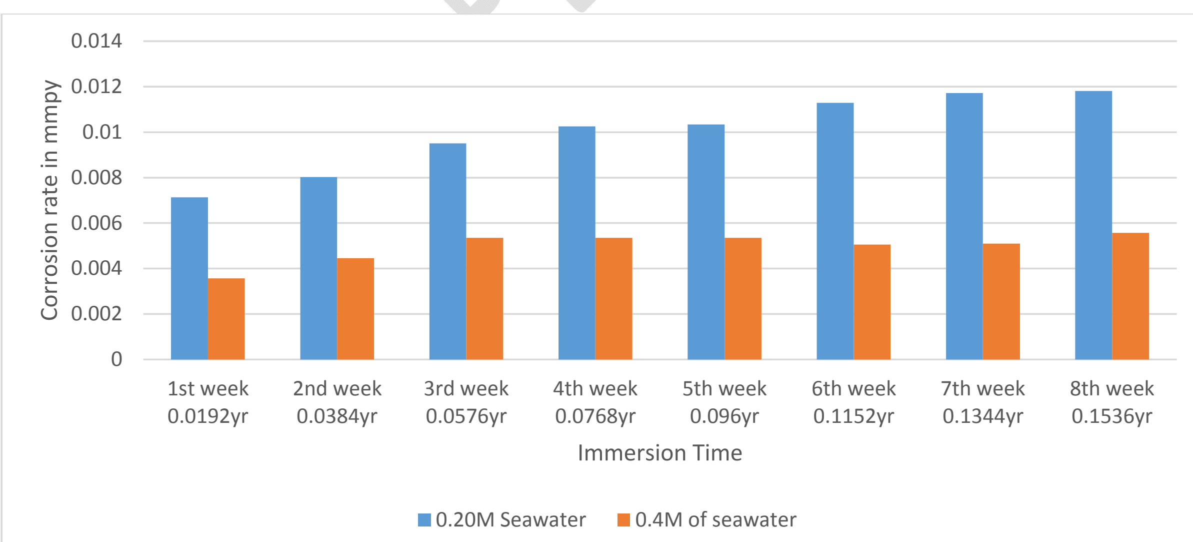


**Fig. 6 Corrosion rate results of carbon steel specimen in 0.2M of seawater and 0.4M of freshwater exposed for eight weeks against Time.**

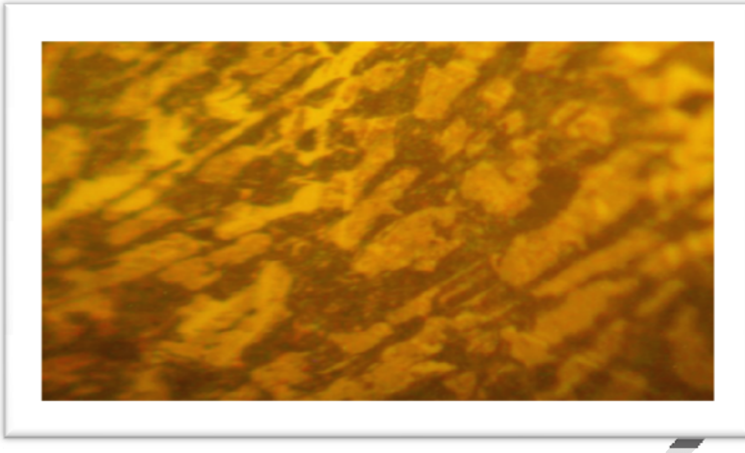

**Fig. 7 Micrograph of cast steel C-1040 before immersion X 400**

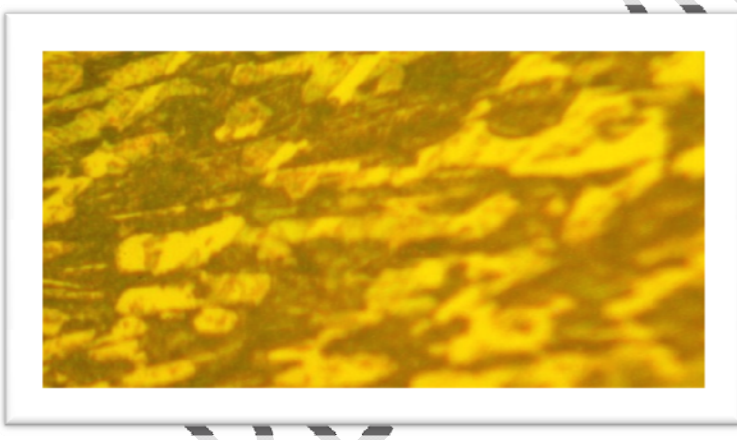

**Fig. 8 Micrograph of cast steel C-1040 after immersion X 400 in 0.2M of seawater**

### 3.2 Discussion of Results

#### 3.2.1 Physical changes observed in the coupons during the experiment

The specimen exhibited different features in terms of color, texture, surface appearance, type and size of the corrosion products on the metal. The physical features observed in the seawater environment of 0.2M concentration is discussed:

**I. Seawater Water**

By the end of the first week the carbon steel rod showed patches of grey and black on its surface. Between the seventh (7rd) to eight (8th) week about 60-80% of the surface was rough, with a hard brownish corrosion product, which when washed off left the surface with more black patches than the grey patches. Towards the end of the experiment circular bumps were formed on the surface which when washed off exposed circular pits inside. The base of the pits was grey in color. The remaining surface was black. Generally at the eight (8th) week, the water appeared dark yellowish brown with brown particles at the bottom. Inside where?

#### 3.2.2 Overall result on weight loss and corrosion rate

The results from the experiment obviously showed that corrosion occurred as metal weight losses were evident. The weight loss and rate of corrosion showed in fig 5 and 6 of the two metal specimens of cast steel C-1040 in seawater and freshwater varied, as higher corrosion rate and weight loss (table 4 and 5) was higher in 0.2M of seawater solution than in 0.4M concentration of freshwater. Weight loss and corrosion rate in the seawater environment increased steadily from week one (1) to week eight (8) as shown in table 4 and 5, far higher than the weight loss/corrosion rate in the freshwater environment. Weight loss and corrosion rate in 0.2M concentration of cast steel C-1040* increased from 0.04g to 0.53g, 0.007133mmpy to 0.0181mmpy

*How 0.2M conc of cast steel?

while 0.02g to 0.25g, 0.0035mmpy to 0.005573mmpy increased was observed in 0.4M concentration in freshwater environment. Thus, confirming carbon steel metal to be more corrosive HOW? in the seawater environment than in the freshwater environment. From the inverted metallurgical microscope , the micrograph result for cast steel C-1040 before and after immersion gave evident that steel cast C-1040 sample after the 1344hrs(0.1536yr) of immersion in 0.2M of seawater experienced uniform (general) corrosion as the surface was rough and jarring. The grain boundaries of the surface morphology revealed general corrosion effects on the metal after immersion as the film present on the surface was cracked as shown in figure 7 and 8 respectively.

### 3.3 Surface analysis of cast steel C-1040 in 0.2M of seawater

From the micrograph result for cast steel C-1040 before and after immersion, it was evident that the steel cast C-1040 sample after the 1344hrs of immersion in 0.2M of seawater experienced uniform (general) corrosion as the surface was rough and jarring. The grain boundaries of the surface morphology revealed general corrosion effects on the metal after immersion as the film present on the surface was cracked. The micrographic view above in figures. 7 and 8 provided evidence of the corrosion impact.

## 4. CONCLUSION

Corrosion and its attack in marine piping system and other fluid equipment is evitable, as they can only be maintained, or reduced to ensure marine equipment functions within their specified competence or design. However, higher corrosion rate and weight loss are prominent in seawater environment than in freshwater environment as demonstrated in the research work, due to the effects of salinity in seawater that is always higher than in freshwater environment. The research work proved the dangers of operating marine piping system in seawater and freshwater environment by comparatively analyzing the metal behavior in both corrosive environment, thus driving the attention of material engineers and corrosion engineers in the need to combat corrosion while searching and seeking for better material design that will be more resistance to corrosion and its influence in marine piping.

## 5. **RECOMMENDATION**

From the result obtained from the experimental work, the following recommendation should be noted;

1. Routine monitoring of the condition of marine piping system equipment.
2. Proper design of corrosion resistant materials.
3. The use of inhibitors should be adopted to protect piping systems

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**APPENDIX**

**Engineering equation solver (EES) code for weight loss calculation and results**

“Determination of Area, weight loss and corrosion rate of carbon steel in **SEAWATER environment** after immersion for two months"

```
r=6 [mm]; L=80 [mm]; pie=3.142
A= (2*(pie)*r*L) + (2*(pie)*r^2)
“Weight difference for the first week”
W_R=14.79 [g]; Wone=14.75 [g]
W_1loss=W_R -Wone
“Corrosion rate after immersion for the first week”
K=87.6; T_week1=0.0192 [mmpy]; D=7.89 [g/mm]
Cr_week1= (K*W_1loss)/ (A*T_week1*D)
“Weight difference for the second week"
Wtwo=14.70 [g]
W_2loss=W_R-Wtwo
T_week2=0.0384 [mmpy]
Cr_week2= (K*W_2loss)/ (A*T_week2*D)
“Weight difference for the third week of immersion"
Wthree=14.63 [g]
W_3loss=W_R- Wthree
“Corrosion rate after the third week of immersion"
T_week3=0.0576 [mmpy]
Cr_week3= (K*W_3loss)/ (A*T_week3*D)
“Weight difference after the fourth week of immersion”
Wfour=14.56 [g]
W_4loss=W_R-Wfour
“Corrosion rate after fourth week of immersion”
T_week4=0.0768 [mmpy]
Cr_week4= (K*W_4loss)/ (A*T_week4*D)
"Weight difference after fifth week of immersion"
Wfifth=14.50 [g]
W_5loss=W_R-Wfifth
“Corrosion rate after the fifth week of immersion"
T_week5=0.096 [mmpy]
Cr_week5= (K*W_5loss)/ (A*T_week5*D)
“Weight difference after six week of immersion"
Wsix=14.41 [g]
W_6loss=W_R-Wsix
“Corrosion rate after six week of immersion"
T_week6=0.1152 [mmpy]
Cr_week6= (K*W_6loss)/ (A*T_week6*D)
“Weight loss after the seventh week of immersion"
Wseventh=14.33 [g]
W_7loss=W_R-Wseventh
“Corrosion rate after seventh week of immersion"
T_week7=0.1344 [mmpy]
Cr_week7= (K*W_7loss)/ (A*T_week7*D)
"Weight loss after eight week of immersion"
Weight=14.26 [g]
W_8loss=W_R-Weight
“Corrosion rate after eight week of immersion"
T_week8=0.1536 [mmpy]
```

```
Cr_week8= (K*W_8loss)/ (A*T_week8*D)
```

"Determination of Area of the cylinder used, weight loss in grams and corrosion rate of carbon steel in **FRESHWATER environment** after immersion for two months"

```
r=6 [mm]; L=80 [mm]; pie=3.142
A= (2*(pie)*r*L) + (2*(pie)*r^2)
"Weight difference for the first week"
W_R=14.79 [g]; Wone=14.77 [g]
Wloss_wk1=W_R -Wone
"Corrosion rate after first week of immersion"
T_week1=0.0192 [mmpy]; K=87.6; D=7.89[g/mm^3]
Cr_week1= (K*Wloss_wk1)/ (A*T_week1*D)
"Weight loss after the second week of immersion"
Wtwo=14.74 [g]
Wloss_wk2=W_R-Wtwo
"Corrosion rate after the second week of immersion"
T_week2=0.0384 [mmpy]
Cr_week2= (K*Wloss_wk2)/ (A*T_week2*D)
"Weight loss after the third week of immersion"
Wthree=14.70 [g]
Wloss_wk3=W_R-Wthree
"Corrrosion rate after the third week of immersion"
T_week3=0.0576 [mmpy]
Cr_week3= (K*Wloss_wk3)/ (A*T_week3*D)
"Weight loss after the fourth of immersion"
Wfourth=14.67 [g]
Wloss_wk4=W_R-Wfourth
"Corrosion rate after the fourth week of immersion"
T_week4=0.0768 [mmpy]
Cr_week4= (K*Wloss_wk4)/ (A*T_week4*D)
"Weight loss after the fifth week of immersion"
Wfifth=14.64 [g]
Wloss_wk5=W_R-Wfifth
"Corrosion rate after the fifth week of immersion"
T_week5=0.096 [mmpy]
Cr_week5= (K*Wloss_wk5)/ (A*T_week5*D)
"Weight loss after the six week of immersion"
Wsix=14.62 [g]
Wloss_wk6=W_R-Wsix
"Corrosion rate after the sixth week of immersion"
T_week6=0.1152 [mmpy]
Cr_week6= (K*Wloss_wk6)/ (A*T_week6*D)
"Weight loss after the seventh week of immersion"
Wseventh=14.59 [g]
Wloss_wk7=W_R-Wseventh
"Corrosion rate after the seventh week of immersion"
T_week7=0.1344 [mmpy]
Cr_week7= (K*Wloss_wk7)/ (A*T_week7*D)
"Weight loss after the eight week of immersion"
Weight=14.54 [g]
Wloss_wk8=W_R-Weight
T_week8=0.1536 [mmpy]
"Corrosion rate after the eight week of immersion"
Cr_week8= (K*Wloss_wk8)/ (A*T_week8*D)
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