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# Comparison of Corrosion Rate on Paint Coated and Uncoated SS400 Steel

**Eko Hariyadi [a], and Moh. Jufri [b], Hasan [c]**
[a,b,c]Department of Mechanical Engineering, Engineering Faculty
University of Muhammadiyah Malang
Jl. Raya Tlogomas No. 246, Malang, Indonesia
Telp. (0341) 464318-128 Fax. (0341) 460782
e-mail: ekohariyadi@umm.ac.id

***Abstract***

*To prevent corrosion in metal, especially carbon steel, always need efforts which considered expensive one. But, compared with costs and losts when the corrosion attack is not properly managed then the cost of efforts is much lower. The most popular method in preventing corrosion attack is by coating of metal which also has decorative objective. In this research, four coating materials were applied to the surface of low carbon steel strips (SS400) and as control uncoated SS400 steel strips were also employed. The steel strips then were dipped into electrolite solution consisted of 30% of consentration of $H_2SO_4$, and NaCl soluted in river water for 15 (fifteen) days. After the presetted time was elapsed, the steel strips then examined for lost of mass. It was found that the highest lost of mass was for unpolished uncoated one dipped in $H_2SO_4$ with corrosion rate of 4,566.06 mpy. The lowest lost was for paint coated one dipped in NaCl-river water solution with corroion rate of 0.64 mpy.*

***Keywords****: corrosion rate; paint; uncoated; steel*

## 1. INTRODUCTION

In general, corrosion is the chemical process or electrochemical between metals and it surrounding environment (corrosive one) which caused degradation of metal properties [1]. There are two main types of corrosion; internal corrosion and external corrosion. The previous one is a product of $CO_2$ and $H2_S$ content from petroleum when in contact with water will produce aid which the main trigger of corrosion. The later one is occurs in surface area of structure such as piping system or equipment in contact with acid in the air or ground [2].

SS400 steel is a low alloy carbon steel with the content of 0.20% C, 0.53% Mn, 0.09% , and 0.04% Si [3]. The steel is relatively soft and weak but has great toughness and ductility. This type of low carbon steel is easy to forge, machined and welded [4]. It easily corroded when in direct contact with the air or in corrosive environment. When the air is very humid (more than 70%) then the corrosion may occur easily [1] [2] [3] [4].

The corrosion in the metal can not be avoided, but only can be prevented or controlled so that the structure or component has longer lifetime. The lost related to the corrossion consisted of financial and safety and it include the deterioration of material strenght, thining, downtime of equipment, crack and pitting, leakage (for fluids), embrittlement degradation of surface property of material, decrease in value or product and modification [5].

To avoid such corrosion attack, prevention measures need to be established such as by employing coating. The coating serves as layer to separate surface of steel from surrounding environment, control micro-environment of steel surface, and also as decorative purpose (beauty and appearance). This method may use paint, lacquers, varnish, or other means of steel coating. The most popular method so far is by painting as coating and preventing means of corrosion [6]. To decide the proper paint for this purpose,

i.e. able to withstand corrosive environment, is not an easy task to perform. It needs testing of the performance of the paint for the resistance in acid environment.

## 2. METHODOLOGY

This research was performed by experimental methods as a tool to search the causality of two factors influencing the observed phenomenon. The material for the research was low carbon steel strip (SS400) cut into speciments with dimension of 5 x 100 x 50 mm in thickness, length and width respectively. The variable for the experiment were paint coated steel srip and uncoated one. Also the other one was the electrolite which consisted of solution of H2SO4 and NaCl and river water with consentration of 30% for each solution. Serve as objective was corrosion rate. The flowchart of the experiment was shown in Figure 2.1.

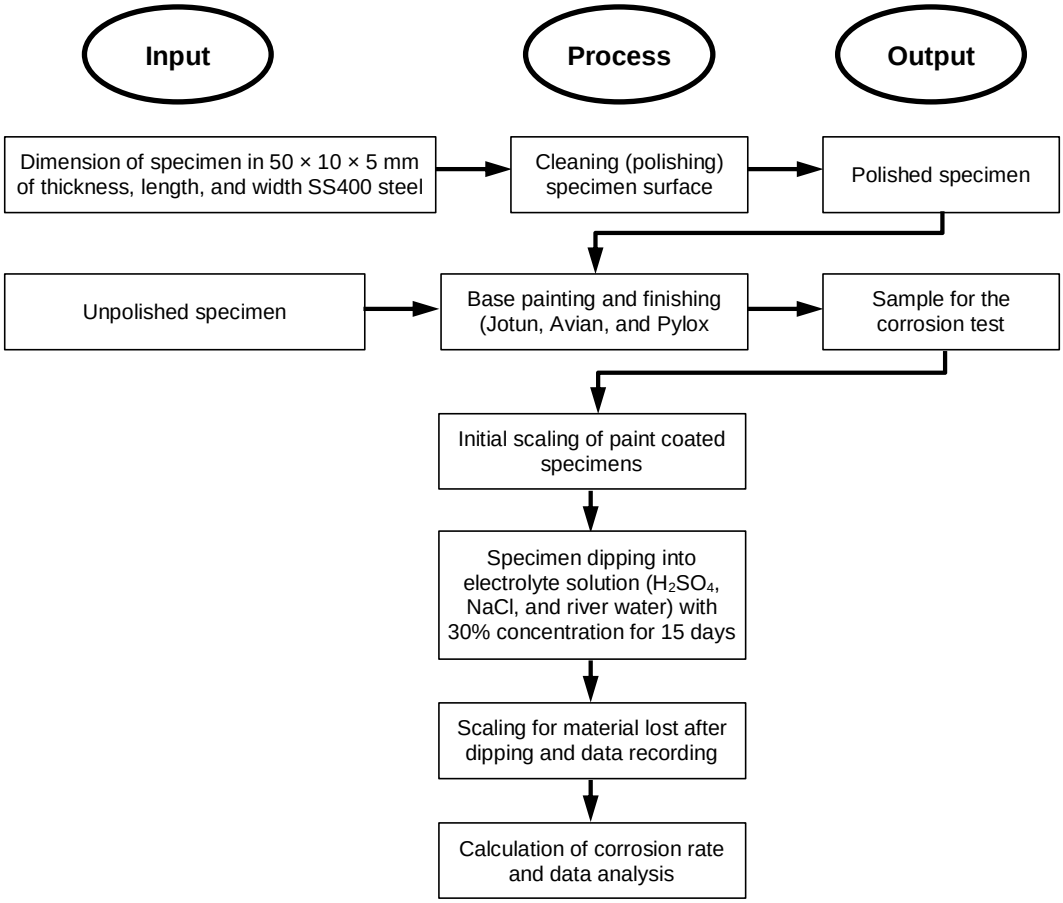


*Figure 2.1 Flowchart of Experiment*

### 3. Results and Analysis

Data from the experiment on comparison of corrosion rate of paint coated and uncoated SS400 low carbon steel dipped in electrolite solution of Shulphid acid, salt, and river water showed certain trends as discussed in the following.

### 3.1. Corrosion rate in $H_2SO_4$ solution

In general, the corrosion rate for uncoated specimen was higher than coated ones both for polished and unpolished one. Also different paint gave different corrosion rate. This result was in accordance with other research [6] [8]. The main cause was the paint consisted of platform, pyment, and additive so that able to control corrosion rate on the surface. Inert pygments make additional path for diffusion of oxygen and water droplets

trying to penetrate membrane and makes corrossion process delayed and also decreasing reaction rate [7].

According the data, the most effective one in decreasing of reaction rate was pylox for 1791.86 mpy. For unpolished specimens, the trends shows it was higer than polished one since in unpolished one the bonding of paint and metal surface is weak and paint cannot wet whole surface of metal when paint was applied. The one which has higher rate of corrossion was uncoated one for 4587.13 mpy and the lower one was Pylox coated one for 28433.43 mpy as depicted in Figure 3.1.

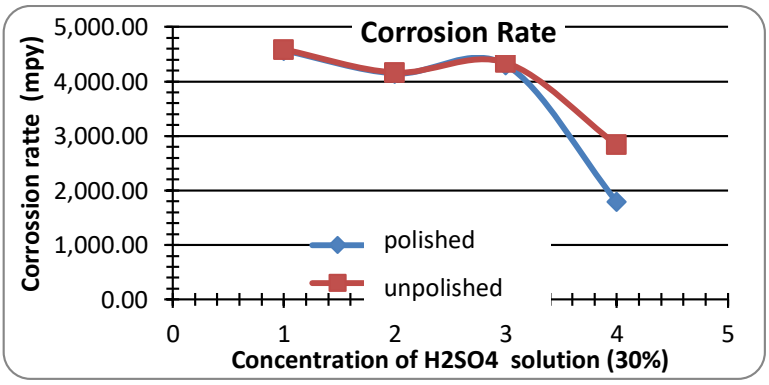


*Figure 3.1 Corrosion Rate for Unpolished and Polished Speciment dipped in $H_2SO_4$ Solution*

Note:

1. Uncoated specimen
2. Paint coated Jotun
3. Paint coated Avian
4. Paint coated Pylox

The result was in accordance with previous research [8] with corrosion rate of 62.51 mpy for uncoated specimen and 18.95 mpy for coated one. It also hown that coating/painting is able to protect speimen and has good resistant to corrosion [4].

### 3.2. Corrosion rate in NaCl solution

The data related to corrosion rate in 30% NaCl was given in Figure 3.2. It was found after 15 days that corrossion rate for uncoated specimen was higher than coated ones both for polished and unpolished ones. Also different made of paint gave different corrosion rate. This result was also in accordance with previous research [6] [8].

From the data, it was obvious that corrosion rate of Pylox coated one has the lowest one for 0.64 mpy. The highest one was for uncoated one for 5.40 mpy. It was caused by effect of paint coating which give protection against corrosion [4].

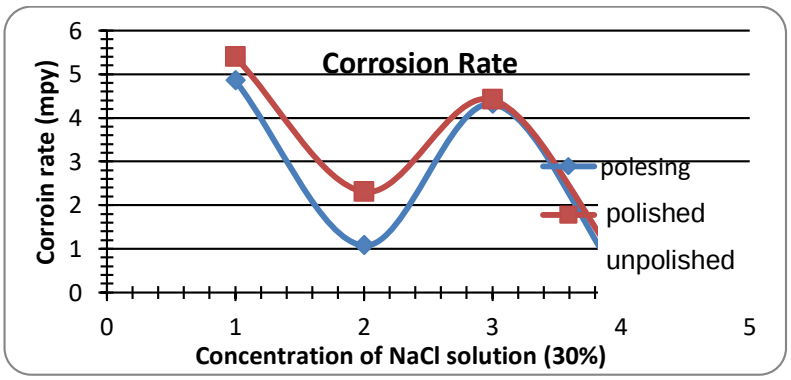


*Figure 3.2 Corrosion Rate for Unpolished and Polished Speciment dipped in NaCl Solution*

Note: 1. Uncoated specimen 3. Paint coated Avian
2. Paint coated Jotun 4. Paint coated Pylox

### 3.3. Corrosion rate in river water

Corrosion rate for river water solution gave the similar results. The corrosion rate for uncoated specimen was the highest both for unpolished and polished one. Different paint also gave different result on corrosion rate after dipped into 30% concentration of river water solution for 15 days as shown in Figure 3.3.

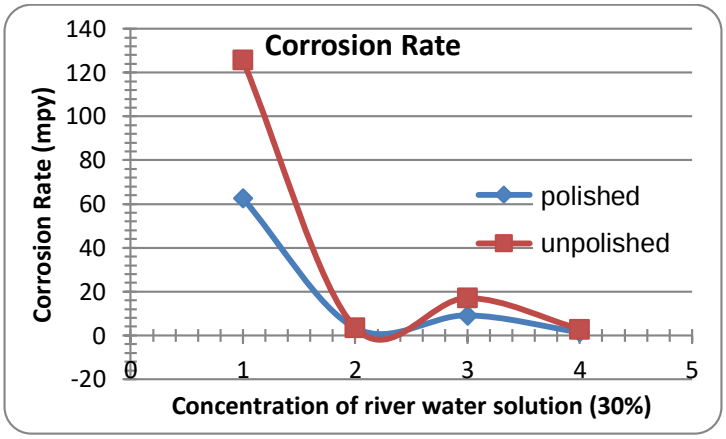


*Figure 3.3 Corrosion Rate for Unpolished and Polished Speciment dipped in River Water Solution*

Note: 1. Uncoated specimen 3. Paint coated Avian
2. Paint coated Jotun 4. Paint coated Pylox

Pylox coated specimen was most resilient againts corrosion for 1.33 mpy for polished one and 2.75 mpy for unpolished one. The uncoated specimen was pronest to corrosion process for 125.68 mpy. The results were in accordance with previous research [8].

### 3.4. Average corrosion rate dipped in 3 (three) media

For $H_2SO_4$ solution, the highest average corrosion rate was for the unpolished SS400 steel dipped into 30% concentration of $H_2S0_4$ solution for 3,983.64 mpy. The polished one had lower average corrosion rate for 3,700.80 mpy as shown in Figure 3.4.

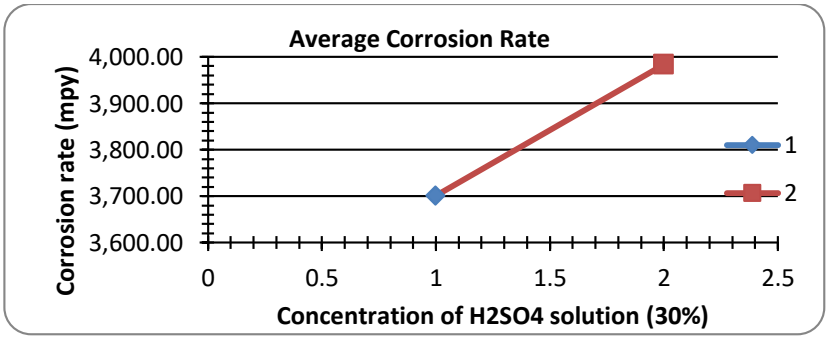


*Figure 3.4 Average Corrosion Rate for 30% Concentration of $H_2SO_4$ Solution*

Note:
1. Polished specimen 2. Unpolished specimen

Specimen dipped into HCl solution also show similar trend with the polished specimen has lower average corrosion rate compare with unpolished one. The unpolished one has average corrosion rate of 3.19 mpy while the polished one has average corrosion rate for 2.64 mpy as shown in Figure 3.5.

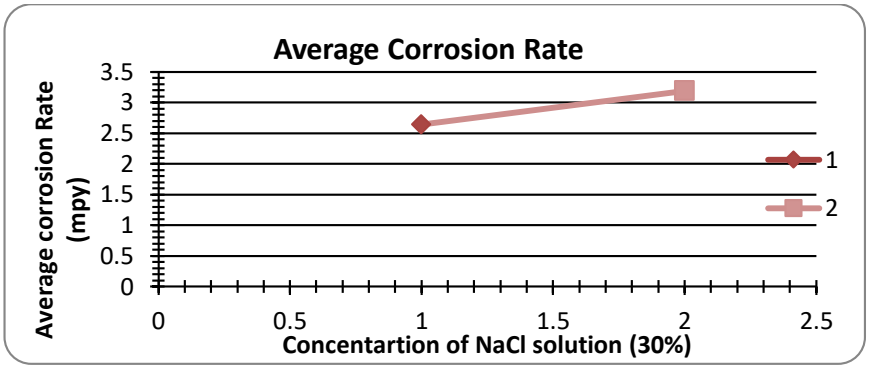


*Figure 3.5 Average Corrosion Rate for 30% Concentration of $H_2SO_4$ Solution*

Note: 1. Polished specimen 2. Unpolished specimen

For river water, the average corrosion rate for unpolished SS400 steel was 37.22 mpy and for polished SS400 was 19.09 mpy as shown in Figure 3.6.

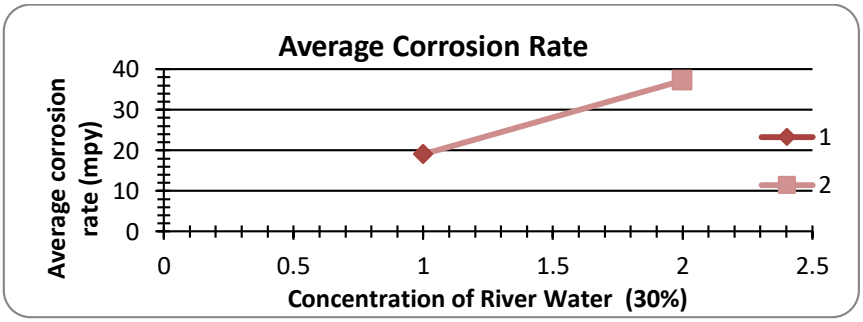


*Figure 3.6 Average Corrosion Rate for 30% Concentration of River Water Solution*

Note: 1. Polished specimen 2. Unpolished specimen

## 4. CONCLUSION

From the research on corrosion rate of coated and uncoated SS400 steels with treatment of umcoated and coated with varied paint (Jotun, Avian, and Pylox) and dipped into several solution ($H_2SO_4$, NaCl, and river water) of 30% concentration for 15 (fifteen) days, it can be concluded that unpolished one show higher corrosion rate compared with polished one for all dipping media (30% concentration of $H_2SO_4$, NaCl, and river water solution), but this corrosion rate was not as high as the two factors, i.e. polished and unpolised one with variations of solutions combined together. The most effective paint to prevent corrosion was Pylox, then Jotun, and Avian and last one was uncoated one. Solution of $H_2SO_4$ leads to the fastest corrosion rate followed by NaCL solution, and river water solution. Unpolished SS400 steel lead to fastest corrosion rate for all variations than polished ones. The highest corrosion rate was for unpolished SS400 dipped into 30% concentration of H2SO4 solution and the lowest one was for polished SS400 dippend into 30% concentration of river water solution.

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