Study of Corrosion Rate at Aluminum Duralumin with YCbCr Filter Method

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Abstract. Corrosion is a process of damage to metal materials that occurs due to the reaction of the metal with the surrounding environment. Corrosion can threaten structural safety, life safety, environmental protection, and economic development. The cost that must be incurred to carry out corrosion testing according to seal for life reaches $2.5 trillion. With regard to these problems, a tool is needed that can determine corrosion phenomena such as corrosion rate. The corrosion rate is a measure of how fast or slow a corrosion process is on a certain surface area and at a certain time. Corrosion test equipment is made using the principle of image technology with the YCbCr color filter method to detect corroded material surfaces. This corrosion test equipment has been successfully tested on Aluminum material with a size of 1.8 cm x 2.8 cm. The corrosion rate on aluminum duralumin increases with the length of time immersion in 2.5 M NaCl solution.

Keywords: Corrosion, corrosion rate, image processing.

1 Introduction

Corrosion is a natural phenomenon that is still ongoing due to the interaction between the environment and metal materials [1]. Interactions that occur continuously can threaten structural security, life safety, environmental protection, and economic development. The costs that must be incurred globally due to corrosion were estimated at 2.5 trillion in 2013 and will continue to increase [2]. Hence, the topic of corrosion studies continues to be studied continuously, both in terms of designing prototypes of corrosion identification tools and corrosion rates [3], designing tools for predicting damage (building age), and designing tools to protect buildings [4].

The monitoring system that has been developed to study corrosion is the use of a lens-based plastic optical fiber (LPOF). The monitoring developed has been successful in monitoring the damage to concrete structures due to beam-intensity-based reinforcement loads [5]. Another monitoring system is the use of a sensor. This sensor can provide information about linear polarization resistance [6]. Then, another monitoring system uses erosion-corrosion detection and monitoring based on resistance sensors that are integrated with electrochemical

ICAE 2022, October 05, Batam, Indonesia

DOI 10.4108/eai.5-10-2022.2327483

measurements [7]. The use of a system that is made is very good at monitoring corrosion, but this system must be supported by the use of Computational Fluid Dynamics (CFD). The use of CFD is more complex to use because it is related to the flow distribution. However, the system and monitoring that have been made well using plastic optical fibers, sensors, and resistance sensors have not provided clear information about the detected metal surface image.

On the other hand, imaging technology can be used to study corrosion [8]. Corrosion identification has been carried out using a step algorithm in analyzing corrosion, namely pre-processing, image binarization, identification of image contour, and analysis of object characteristics. The type of corrosion identified on the aluminum surface by this method is pitting corrosion [9]. Furthermore, image technology has been able to analyze the corrosion that occurs on the pipe surface using texture analysis and provides output data in the form of train and stress phases [10]. However, the use of image technology that has been done by several authors is limited to the identification of surface images due to corrosion, not providing information/correlation between metal surface images and the corrosion rate on metal surfaces. In this research, we will study about identification and calculation of corrosion rate in aluminum with the YCbCr filter method.

The chemical solution used in this study was NaCl, and the material used was aluminum duralumin. The advantage of NaCl as a solution is the costs incurred and the preparation of the solution used. While the selection of aluminum as a metal that is corroded refers to the consideration of the number of applications used, such as aircraft frames, car frames, the manufacture of measuring instrument components, and other building constructions. YCbCr filter method is one of the methods used in image identification. One of the advantages of this YCbCr method is that it is simpler than RGB and requires less computational time to identify images. Apart from that, YCbCr is more effective for quality JPEG color image enhancement and performs better than PDE-based restoration methods [11], [12]

2 Method

2.1 Preparation of Sample

The sample used in this study was aluminum duralumin with a dimension of 1.8 cm x 2.8 cm, while the type of solution used was NaCl with a concentration of 2.5 M. Generally, aluminum duralumin consists of aluminum, copper, magnesium, and manganese. Before the sample is used, the sample has been cleaned using abrasive paper. As A Qonsueqence, the dirt and dust can be removed from the surface.

2.2 Prototype Software Design

The design of the software prototype is the stage of the application interface to calculate the corrosion rate value. The results of image processing obtained from the camera on the application interface are shown in **Fig. 1**. The interface shows some of the features that will be used in calculating the corrosion value.

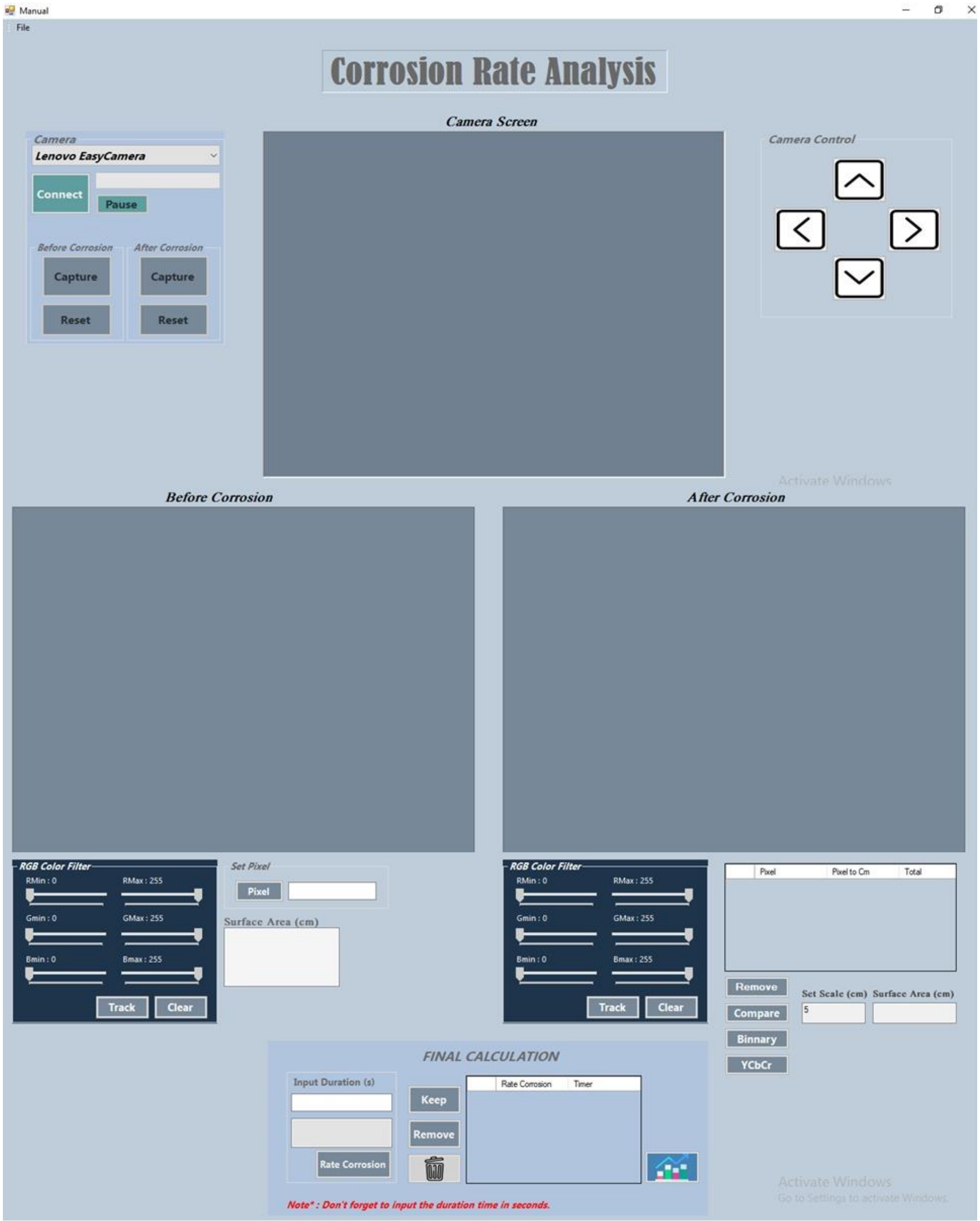

Fig 1. Prototype Software Design

2.2 Testing

The steps taken in calculating the corrosion rate using an application that has been made are: Enter images before corrosion and after corrosion. Then, calibrate the image size using the set scale. The process of setting scale can be done manually or by drawing a line on the image so that the pixels of the image can be counted. Next, after the scale value is obtained, press the YCbCr button to get the value of the corroded surface area. After that, input the corrosion rate value obtained into the Final Calculation section to determine the duration of corrosion. Finally, press the rate corrosion button, the corrosion rate value will be calculated, and press the save button to enter the value into the data box. Furthermore, the graph button is used to graph patterns. The steps in testing this corrosion test can be seen in **Fig. 2**.

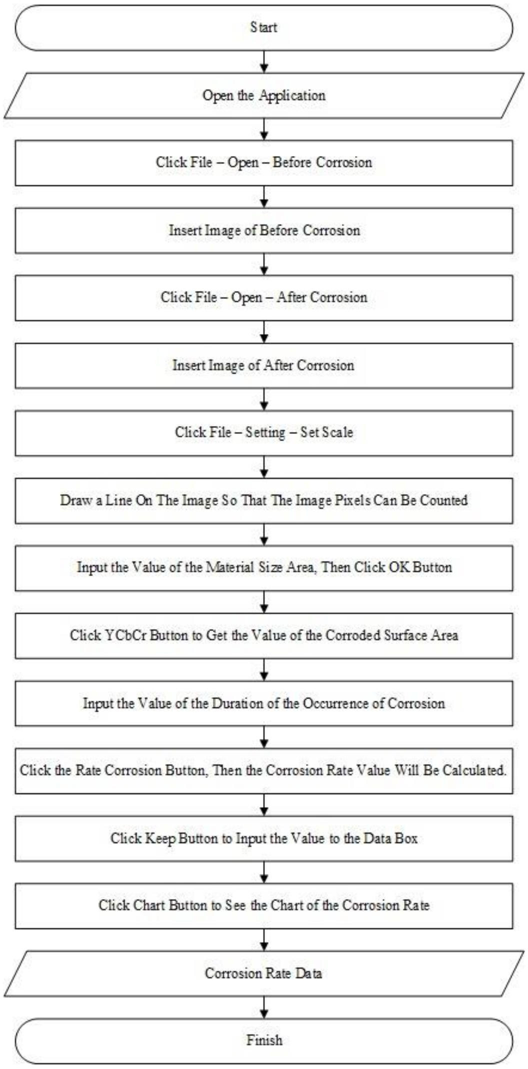

Fig 2. Corrosion Rate Testing Steps

3 Result and Discussion

After testing on aluminum duralumin measuring 1.8 cm x 2.8 cm immersed in a 2.5 M NaCl solution for 15 days with a light intensity of 4100 lumens or 45 watts equivalent, the results obtained from taking pictures of the sample before and after corrosion can be seen in the image below:

Fig 3. Front View Before Corrosion

Fig 4. Back View Before Corrosion

Fig 5. Front View After Corrosion

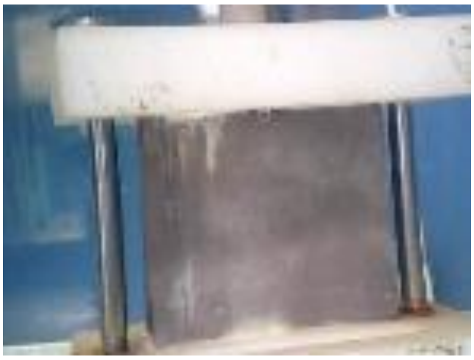

Fig 6. Back View After Corrosion

From **Fig 3** until **Fig 6,** it can be seen that there are differences in color before and after corrosion. In the picture above, the color on the surface of the material turns dark or yellowish, it can be said that the surface has been corroded. To detect it with, an image processing system was used, the YCbCr filtering method. In the YCbCr method, the bright surface color of the material (before it is corroded) will be filtered and converted into black pixels. While the surface color of the material that does not change to black pixels is identified as a corroded surface. The image of the YCbCr filtering is shown in **Fig 7**, and the image of the YbCr process is shown in **Fig 8**.

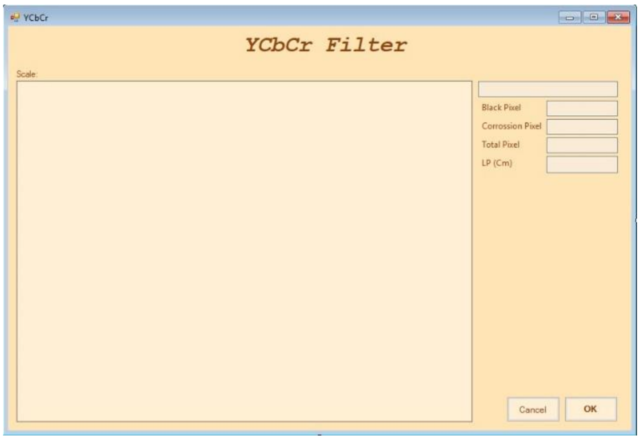

Fig 7. YCbCr Filtering

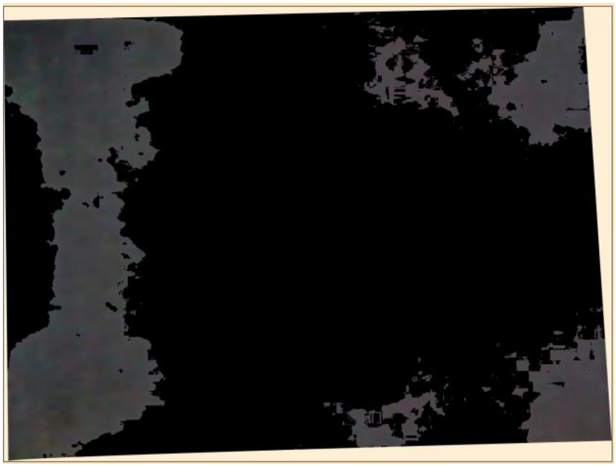

Fig 8. YCbCr Process

YCbCr filter is a color filter consisting of Y (luminance), Cb (chrominance blue), and Cr (chrominance red). The Y component is obtained from the sum of the weights of RGB, while the chrominance component (Cb and Cr) is the reduction of a luminance component to B and R. In this YCbCr filter method, the minimum value data parameter and the maximum value data parameter YCbCr used to detect the presence of corrosion in the material are as shown **Table 1**. The parameter data value of YCbCr was obtained after testing the corrosion rate on several images of corroded material.

Table 1. YCbCr value data

Value of Y		Value of Cb		Value of Cr	
Min	**Max**	**Min**	**Max**	**Min**	**Max**
0	0.29	-0.5	0.02	-0.5	0.5

By pressing the YCbCr button in the application, corroded and uncorroded objects will be detected. After filtering, the program will calculate the number of pixels in the corroded color. Next, the pixel will be calculated with a set scale value (size calibration) so that the corroded surface area is obtained in cm units. To calculate the corrosion rate of the material, enter the duration of immersion of the material in hours and press the corrosion rate button to find out the value of the corrosion rate of the material. The corrosion rate of the material can be seen in **Fig 9.**

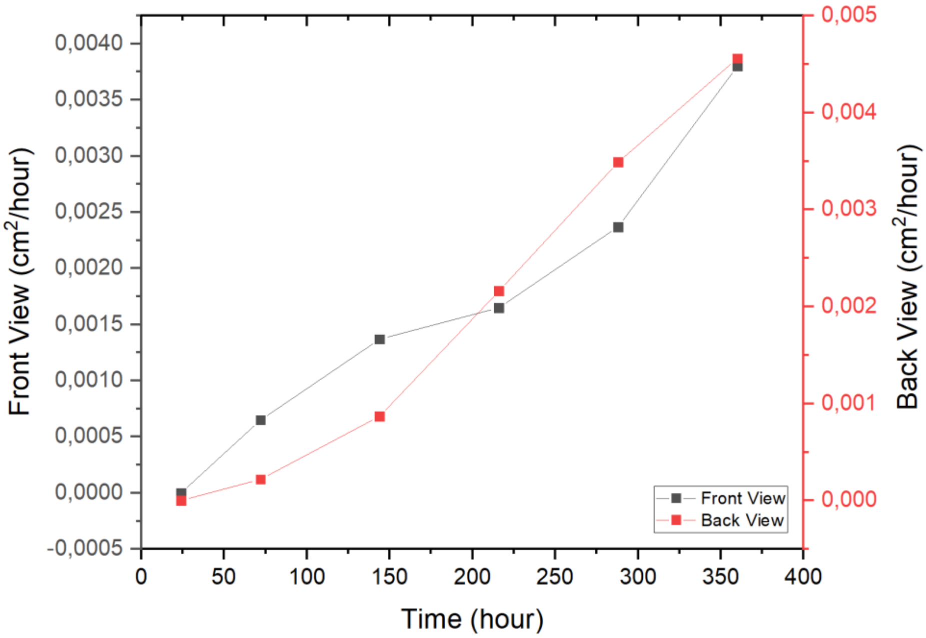

Fig 9. Corrosion rate for aluminum duralumin

Based on **Fig. 9**, it can be seen that the corrosion rate of the material between the front and back is different. It can be caused by the different surface roughness of aluminum duralumin [13]. Other things that also cause differences in the corrosion rate are NaCl solubility, water pH, and the presence of impurities [14].

4 Conclusion

Based on the research that has been done, it can be concluded that the corrosion phenomenon of aluminum duralumin surfaces can be identified using the YCbCr method. The corrosion rate on the surface of aluminum duralumin increases with the length of time immersion in 2.5 M NaCl solution.

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