CHAPTER III

Method and material

This study was carried out on carbon steel material at exposed surface to under water using digital camera and fractal dimension to study the structural morphological. There are certain stages in which the way should be shown So, section 1 is regarding corrosion experiment, section 2 for image acquisition and preprocessing, section 3 to explain how fractal analysis a through the box counting method.

3.1 Corrosion Experiment

1. About 0.3cm thickness is 20 x 20 area carbon steel in the form of plates of 20cm from hardware shop.

2. Samples of cut form as a plate and polished to smooth surfaces. 10cm x 10cm.

3. The samples were placed in a glass dish containing water (mineral water with pH 6.8) and kept for different length of time.

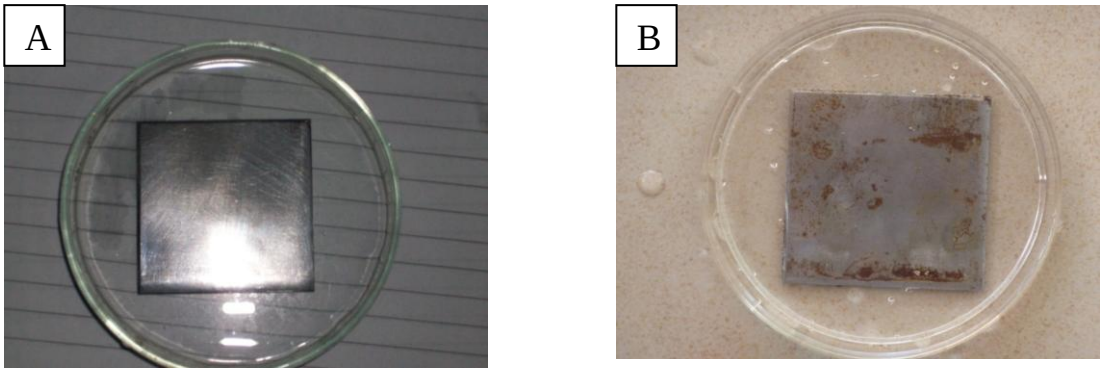
4. Images of the surfaces are taken by using digital camera at a fixed resolution.

5. Five images were taken of the sample at any particular time.

In this experiment the material used are metal carbon steel, water PH 6.8, and using digital camera was used to take pictures in different sets, and five images of the same sample are taken

3. 2.1 Image Acquisition and Preprocessing

We can see the pictures before and after pouring water (a) Picture metal before exposed to water; (b) Picture surface carbon steel after exposed to water .Digital camera used takes the picture to select a set of five times difference. Water under going corrosion shown in Figure 3.1.



(a) Polished steel before corrosion (b) Corroded steel in water environment

Figure 3.1 (a-b) JPEG Digital camera shown before and after exposure to water

3.2.2 Image format conversion

Image analysis process was carried out by image J software to (see Figure 3.5) used to analysis the carbon steel corroded surface membrane in term of surface roughness and surface carbon steel.

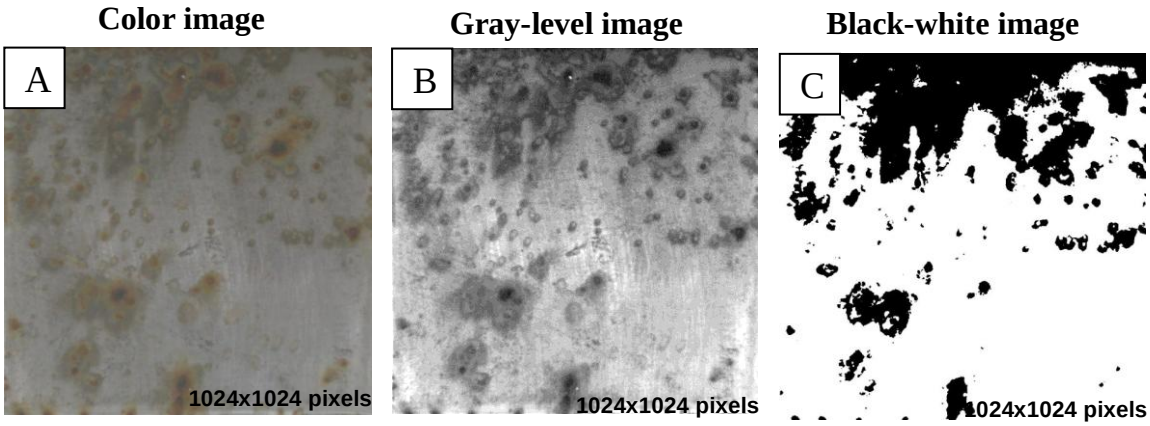


Figure 3.2 (a) Color image and (b) Gray-level image and (c) Black- white image

3.3.1 Fractal analysis

A fractal is "a rough or fragmented geometric shape that can be split into parts. The term fractal was coined by Benoît Mandelbrot in 1975 and was derived from the Latin *fractus* meaning *broken* or *fractured*. A fractal often has the following features: Too irregular to be easily described in traditional Euclidean geometric language. It has a simple and recursive definition, Its geometrical properties can be characterized by **fractal dimension, *D*.** Scaling factors are characteristic for the decomposition of fractals into self similar parts. The fractal dimensions of the pores were estimated by equation show 3.1.

$$n = \frac{1}{s^D} \quad D = \frac{\log n}{\log 1/s} \qquad 3.1$$

N number of self similar pieces

S scaling factor

D self similarity dimension

A digital image a [x,y] is a box counting described in 2D discrete space defined by the x- axis representing the possible gray values and y-axis representing the number of pixels for each gray value. The value is assigned to the integer coordinates [x,y] with x = 0,1,2, x-1 and y = 0,1,2 ,y-1. So we get various dimension of sample image of [1024x 1024]

The rough subdivided roughly into five digital images of [45x 45] pixels, to cover the sample completely, which gave a raw image space so that distribution of sample could be observed on the surface as show in Chapter 4.

3.3.2 Box Counting Method

Counts the number of boxes of an increasing size needed to cover a one pixel binary object boundary. The box size and the number of boxes necessary to cover the boundary are plotted on a log-log plot and the fractal dimension determined from the slope, i.e. D= -slope.

Step 1: Count number of boxes $N(L)$ of different side length L to cover the object.

Step 2: Plot log N versus log l since fractal curve follows $N \sim L - D$

Step 3: Slope gives the fractal dimension D

How the box-counting fractal dimension can be determined.

Log N (L) number of boxes to cover the set of magnification factor MF versus log L box size of self –similar corrosion particles SSCP. L = box size, $N(L)$ = number of boxes to cover the set.

Reduce the box size and count

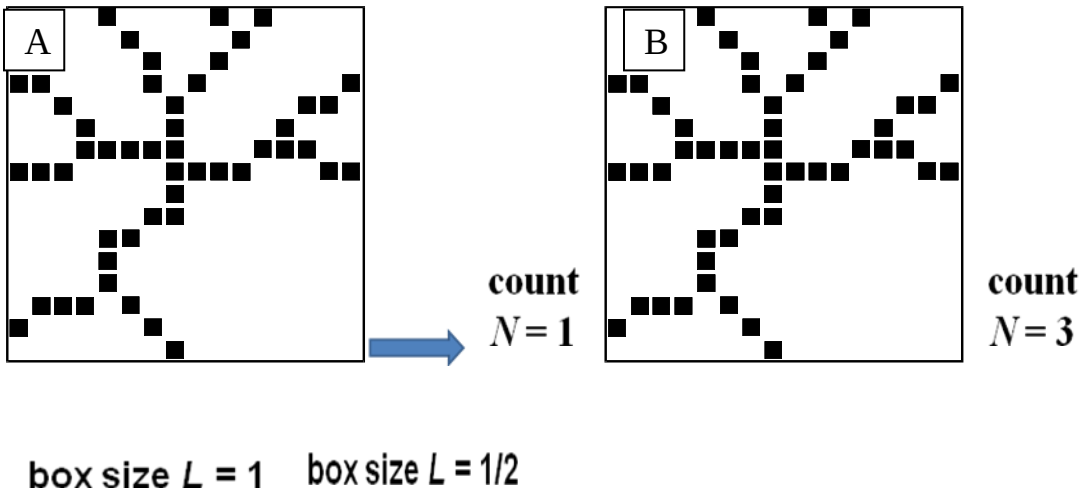


Figure 3.3 (a-d)

Box-counting fractal dimensions with determined, reduce the box size and count

Estimation of Box-Counting Fractal Dimension, *D.* these L of box size, *N* (*L*) of number of boxes to cover the set.

Table 3.1 Estimation of box-counting fractal dimension, *D* , box count N(L) to box size L

Box size, ***L***	**Box Count, *N*(*L*)**
1	**1**
1/2	**3**
1/4	**11**
1/8	**26**

The fractal dimension of the pores were estimated by equation this show 3.2

$$D = \frac{\Delta \log N(L)}{\Delta \log(1/L)} = 1.60$$

Here talk about Fast Box Counting Algorithms: Liebovitch & Toth 1989 Phys. A141: 386 – 390, Hou et al.There number a round about 1.60 for all samples with different time. Plots the logarithm of the number of self- similar carbon steel corrosion surface particle log (L) SSCP) versus the logarithm of the magnification factor of self- similar pores log NL (MF) show Figure 3.4.

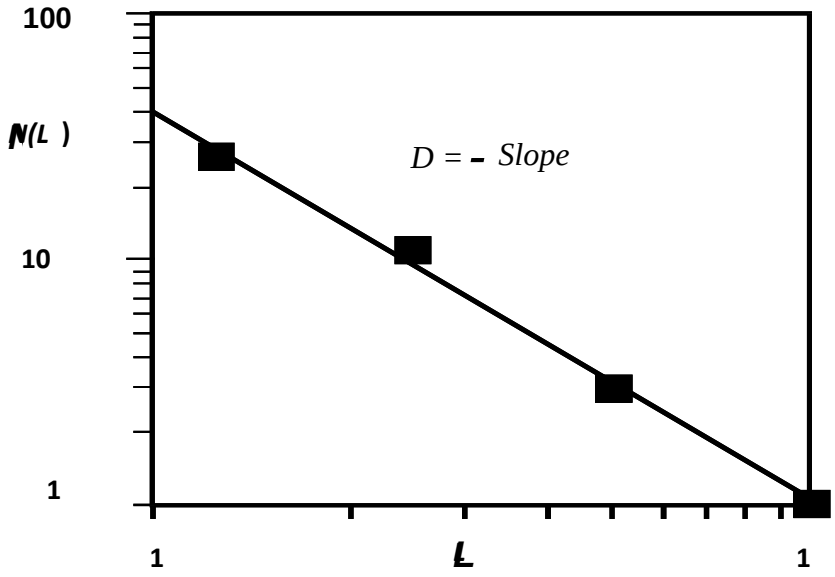


Figure 3.4 Log (N (L)) versus log (L)

Fractal box-counting dimension will be determined using ImageJ Image Processing and Analysis Software. Linear regression of Log(N(L)) versus Log (L) can also be done in MS Excel in order to estimate the slope, hence the fractal dimension.

3.3. 3 Image Processing and Analysis Software (Image J)

Image J is a public domain Java image processing program inspired by the NIH Image for the Macintosh. It runs, either as an online applet or as a downloadable application, on any computer with a Java 1.4 It can display, edit, analyze, process, save and print 8-bit, 16-bit and 32-bit images. It can read many image formats including TIFF, It can calculate area and pixel value statistics of user-defined selections. It can measure distances and angles. It can create density histograms and line profile plots. It supports standard image processing functions such as contrast manipulation, sharpening, smoothing, edge detection and median filtering. It does geometric transformations such as scaling, rotation and flips. Image can be zoomed up to 32:1 and down to 1:32. All analysis and processing functions are available at any magnification factor. The program supports any number of windows (images) simultaneously, limited only by available memory. **We used program image j analysis and processing in some of the tasks and orders, including.**

- Icon image where this tool automatically or interactively set lower and upper threshold values, segmenting the image into features of interest and background. The thresholded features are displayed in red and background is displayed in grayscale. Use Analyze>Measure (with "Limit to Threshold" in Analyze>Set measurements checked) to measure the aggregate of the selected features. Use Analyze>Analyze Particles to measure features individually. Use the wand tool to outline a single feature. Use the drop down menu on the right to select one of three display

modes. Red displays the threshold values in red. B&W switches to a mode where features are displayed in black and background in white. Over/Under displays pixels below the lower threshold value in blue, thresholded pixels in grayscale, and pixels above the upper threshold value in green and used size Scales the active image or selection to a specified width and height in pixels.

- Icon process also there some icons Smooth, in this icon Blurs the active image or selection. This filter replaces each pixel with the average of its 3x3 neighborhood**.** Icons sharpen increases contrast and accentuates detail in the image or selection, but may also accentuate noise. This filter uses the following weighting factors to replace each pixel with a weighted average of the 3x3 neighborhood.
- Icon analyzes use Counts the number of boxes of an increasing size needed to cover a one pixel binary object boundary. The box size and the number of boxes necessary to cover the boundary are plotted on a log-log plot and the fractal dimension determined from the slope, i.e. D=-slope in this icon used get to plot and result as fractal and box counter fractal. this figure shows program image,

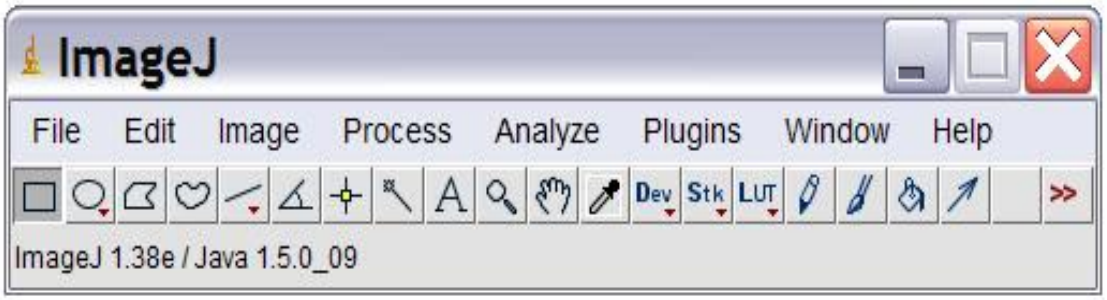


Figure 3.5 Image J Image processing and analysis Software