# MORPHOLOGICAL STUDY OF SURFACE CORROSIO IN CARBON STEEL USING FRACTAL METHODS

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*SURFACE CORROSION IN CARBON STEEL*

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## Abstract

Corrosion can be defined as the disintegration of a material into its constituent atoms due to chemical reactions with its surroundings. There are various chemical and physical factors that affect the rate and mechanisms of corrosion processes. In this study, we focus on the corrosion of carbon steel in mineral water at room temperature. The morphologies of corroded surface are characterized using fractal analysis. The steel plates of 10cmx10cmx0.2cm are first polished using abrasive papers of different coarseness until smooth surfaces are obtained. The samples are placed in glass dish filled with mineral water and a simple imaging procedure using digital camera is setup. The surface corrosion is monitored and surface images at fixed resolutions and ambient conditions are taken at different time. Fall live the images are to be taken, the steel plate is taken out of the water and the surface is cleaned without scrubbing using mineral water, air dried and images are taken. The plate is returned to the dish with replenished water. For image analysis, a set of five images of different location are taken from the same steel sample. The color images are converted to gray-level images and homogenized for light illumination. The gray-level images are then converted to black and white binary images for fractal box counting analysis. For simplicity, we used the standard threshold technique based on visual inspection of information retention upon binary conversion. Despite being subjective, the technique is reasonably accurate provided there exists clear distinction between the corrosed areas in the gray-level images.

The fractal box-counting analysis is carried out using ImageJ image analysis software. The fractal dimension is determined from slope of linear plot of log box counts versus log box sizes. Average fractal dimensions for the five samples at any particular time of observation are calculated. The variation of average fractal dimension as the surface corrosion progresses is determined. It is found that the fractal dimension increases as the corrosion evolves in time. The spot corrosion related to initial pitting mechanism has lower fractal dimension and as the corrosion progresses around these spots, larger areas are affected thus the fractal dimension increases. The fractal dimension can be interpreted as an index of surface damage. As the fractal dimension approaches the topological dimension 2, the whole areas would have been corroded. In conclusion, we have shown that fractal dimension can be a useful quantity to characterize surface corrosion. The general trend in the variation of the fractal dimensions as the corrosion progresses is consistent with what is visually observed of the surface damage. Thus, fractal analysis with digital image inspection can be a useful technique for an automated corrosion monitoring system to be used in remote inspection of water or oil and gas pipelines.

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| Scanning Electron Microscope | SEM |
| Electrical Resistance | ER |
| Linear Polarization Resistance | LPR |
| Magnification factor | MF |
| Similar- Self Corrosion Particles | SSCP |
| Kennedy Space Center | KSC |
| Network for the Atmospheric Corrosion Survey of Materials | NASCM |