Study on corrosion features analysis for visual inspection & monitoring system: A NDT Technique

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ABSTRACT – These days, utilization of camera as inspection tools has been expanded. The flexibility functions of camera fit to get different kind of information. This research work is focusing on developing a robust visual inspection system for NDT corrosion detection that able to detect corrosion in any environment, and the corrosion detection will be using visual data as principal data inspection.

1. INTRODUCTION

Corrosion can cause major losses to industry. One of the industry that has high impact due to the corrosion is oil and gas. This is because, oil and gas use pipeline to transfer goods between places. In a case study, a deteriorated Bar Wrapped Pipe (BWP) due to corrosion was detected by Pure Technology during schedule inspection [1]. However due to the pipe useful life is nearer to the end, the pipes section were replaced. Yet, by replacing BWP earlier then its expiry, the cost compare to the usage is increasing.

Corrosion inspection and monitoring are key activities in ensuring asset integrity and control of corrosion. Management choices on gear condition, expectation of leftover life and necessities for synthetic treating are just in the same class as the information input provided from field experience. Corrosion inspection and monitoring includes assessment of [2]:

a. In-line systems - corrosion coupons, bio-studs
b. On-line monitoring techniques
c. Off-line monitoring - Non-Destructive Testing

Non-destructive testing (NDT) techniques are used extensively to monitor corrosion. One of the advantages is that equipment usually need not be taken out of service. In Cawley review on NDT that presented in 2001, radiography, ultrasonic, eddy current, magnetic particle, and penetrant testing were top five techniques dominating the NDT market [3] yet visual inspection is the most widely applied in NDT technique, but due to the accuracy issues, it is often used together with others method. Meanwhile, this research is discussing the application of visual inspection system to be used as primary equipment for NDT corrosion inspection.

This paper is organized as follow. Section 2 present the current NDT corrosion inspection and monitoring process. In section 3, visual corrosion inspection is introduced, and analyze between other methods of NDT corrosion inspection. In section 4, the corrosion features based on the characterization of corrosion is discussed to identify the profile of each corrosion types. Finally, discussion is concluded in section 5.

2. CORROSION INSPECTION & MONITORING

In the petroleum industry, the internal corrosion in oil and gas production operation is often monitored with hydrogen probes. Hydrogen probes measure hydrogen permeation and provide information on the rate of corrosion [4]. Other on-stream corrosion-monitoring techniques that are used in petroleum and chemical industries include the following:

a. Electrical resistance and linear polarization methods.
b. Ultrasonic thickness measurement.

The costs of corrosion vary considerably from one industry to another industry. However, substantial savings are achievable in most industries. The first step in any cost reduction program is to identify and quantify the present costs of corrosion [5]. Based on this analysis and a review of the present status of corrosion control in the industry, priorities can be determined and the most rewarding cost-reduction projects pursued [6]. Corrosion can be classify based on one of the following three factors [7]:

a. Nature of corrode: either as “wet” or “dry”.
b. Mechanism of corrosion: This involves either electrochemical or direct chemical reactions.
c. Appearance of the corroded metal: either uniform or it is localized

With the ability to classify the corrosion type based on visual, the inspection system able to make suitable decision based on expert system database. Corrosion is either uniform and the metal corrodes at the same rate over the entire surface, or it is localized, in which case only small areas are affected. The detection of the corrosion “areas” will be detected by means of visual sensor, using camera or video that able to determine and analyze the sensed areas. Thus the corrosion detection on the inspection system using visual proves to be validated.

3. VISUAL CORROSION CLASSIFICATION

Classification by appearance, which is particularly useful in failure analysis, is based on identifying forms of

corrosion by visual observation with either naked eye or magnification. The morphology of attack is the basis for classification. Nine forms of wet (or aqueous) corrosion can be identified based on appearance of the corroded metal [5] is shown in Figure 1. However in NDT visual inspection system, macroscopic localized corrosion type is suitable for classification as macroscopic size defect is large enough to be detected in ordinary visible sense.

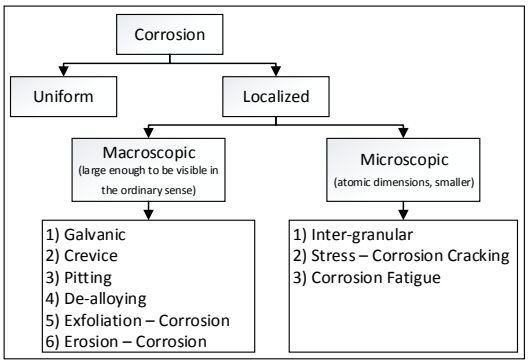

Figure 1 Characterization based on appearance

4. CORROSION FEATURES

In visual inspection, the corrosion level identification requires expert who can clearly determine the corrosion based on experience as well as types of corrosion, with red rust as a common experience. Usually, the corrosion process produces rough surfaces, and image analysis based on textural features can be used for quantification and discrimination of corrosion extent [8]. Additionally, color progression of metallic surfaces is also used for the detection of corrosion because of different metal oxides and other corrosion products [9].

Figure 2 shows the corrosion image features profile identified for localized macroscopic corrosion that able to differentiate various classes of corrosion. Each type has different features that can be differentiate with either texture, color or shape. By enhancing the image capture, the limitation of inspection environment can be lifted and increase the accuracy of the inspection.

5. CONCLUSIONS

This paper discussed the potential of vision system to be used for primary equipment on NDT corrosion inspection. The visual inspection system is to be conducted during monitoring stage in the preliminary inspection. Visual inspection system would be able to gather data and at the same time processed and analyzed the collected data. With the result, the analyzed data is able to classify the corrosion type and by identify the type of corrosion one can understand the pattern of attack, thus early prevention can be done. Using image as inspection data, issue on analogue signal loss due to the communication interference can be eliminated, as the image data able to recover required feature based on other features. Furthermore, the ability of the system, able to adapt the unrefined environment make the proposed system robust and able to use in others application.

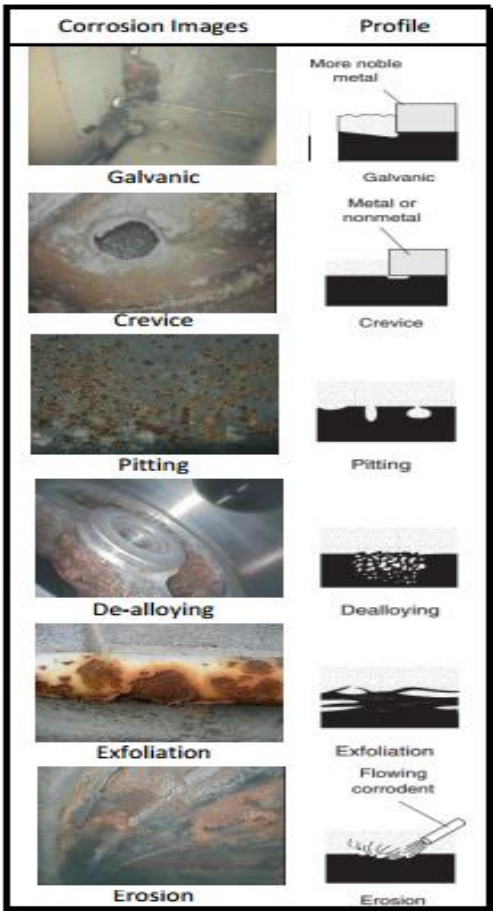

Figure 2 Corrosion image with profile

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