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REPAIR, MAINTENANCE AND PROCEDURES TO PREVENT DEFECTS AND FAULT DETECTION TESTS - A LITERATURE REVIEW STUDY

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Abstract:
A reliable technical method is required to analyze the present defects in the pipe. Technical inspections aiming at detecting technical points concerning the defects begins from scientific explanations from the damaged parts. Then, an analysis is made in view of materials and their engineering so that it is detected how these damages have occurred [1]. Production of reasonable technical results requires several items including expertise, experience and identification of required equipment and above all, well-disciplined material experts and engineers [2]. The procedure for technical survey of defects is performed as per following stages.

- ***Collection of initial data***
- ***Determination of mechanism of the defects***
- ***Determination of sequence of defects***
- ***Testing the assumptions***
- ***Determination of reasons for facture and its cause***
- ***Reporting the results.***

Keywords: Pipe Defects; Inspections; Identifications; Technical Surveys.

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1. Introduction

It is appropriate to use the learned items to avoid repetition of similar occurrences in the future by recommendation of changes in the respective system. In practice, implementation of all these works will be followed by common aspects; however, they help us review each one independently [2]. At the beginning of each survey, we need to collect data. History of service providing and procedure of work performance should be compared with the performance of failed parts. This survey may show the reason of failure. Then, the record of the caused defect should be determined. By reviewing the work environment, testing and photographing the equipment in place we can highly assist in this way. Accurate consideration of details and use of exact records are essential in determining failure mechanisms. After a primary survey, prototypes of the material should be made available laboratory tests, chemical analyses and mechanical tests as well as magnification by microscopes for scanning electron and light. Of course, selection of the correct method that completely identifies the defect is also very important and one cannot use just one method for all

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pieces of equipment [3 & 4]. Almost major defects are caused as the result of one occurrence. We usually experience sequence in the caused faults due to the following reason: Poor design of welding may result in defects caused by soft failure or fatigue which in turn result in other defects thanks to overloading. Analysis of equipment performance history is a guide to sequence of occurrences. Moreover, we can take observations from microstructure tests of the failed surfaces. Appearance and thickness of oxidation, paint or marine organics on the fractured surface can almost give us a history of damage [5].

2. Materials and Methods

In the stage of testing the hypotheses, the existing hypotheses are accurately analyzed and quantified. Verification tests may be required at this stage which usually include corrosion test of suspicious substances, fatigue tests or failure mechanics tests so that one of two similar hypotheses can be selected. Sometimes new information changes a theory or introduces a new element including Charpi test in the manner that for the bended stainless steel, upon observation of any leakage, it can be attributed to failure mechanism but by this test we may understand that it has become so as the result of hydrogen induction from cathode protection [6 & 7]. Finally, the part which is often ignored is the report of findings. Introduction of documents and design of results are the most important parts of a survey. The reports related to survey of failure and defects should be accurate, brief and useful and should be technically complete and understandable by non-expert individuals. A good report should not ignore any point related to the survey. At the same time, the provided text should be free from being judged or compromised. It may be used one day in the court; therefore, it should be documented and reliable [8]. An effective managerial plan in the field of piping and protection of its stability can maximize access to the pipes with the least cost without endangering the standards related to stability. Development of such a plan is conducted in a complicated environment in which several factors contribute. One of the components in development of such a plan is RBI. Here, risk is defined as a combination of probability of failure and its consequences [9]. In this strategy, the wise resources are divided between different failure options accompanied by risks. Risk analysis may be conducted both quantitatively and qualitatively. In the qualitative sections, analyses of different sections are considered by giving scores to different sections on which failure affects. This method is usually very subjective and it is not accurate. In quantitative risk analysis, the probability of leakage its consequences are calculated based on strict inspection and modeling results. This method gives more reliable results. Unfortunately, quantitative calculation of risk is almost impossible thanks to difficulty in calculating the probability of failure and the effects of its consequences. Therefore, a combination of these two methods provides a balanced state between accuracy and feasibility.

3. Results and Discussions

As a result, most models are accurate in prediction to a limited extent. Engineers consider the required security margin in this developed plan [9]. In the coverage and paint technology, development is one of the effective methods in preserving the stability of equipment and components. For this purpose, there are different types of cover and paint in organic, non-organic and compound groups. Especially, temperature and different sols are among the most important factors affecting stability of performance of cover, paint and pipe [10]. The best method to protect severe corrosion of steel pipes which are exposed to seawater and the most economical way is a

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combination of protective paint and cover and cathode protection which is fulfilled depending on the management of time stages of fabrication cycle, selection of type and specification of cover. It should be noted that if only the cathode protection system is selected in coordination with coverage, the protection will be effective [11]. One of the challenges in the oil and gas industry includes prevention from fracture due to HE under CP. Selection of materials for joints and fixtures is necessarily based on mechanical features, corrosion resistance (general, local galvanic, pit and cracking) beside EAC which includes SCC and SLC [12]. Although steel alloys have a good application in cathode protection systems in view of corrosion, their cracking resistance is an important subject especially for highly stable steels [13 & 14]. The best provided solution which is currently available for evaluation of pipe defects is the use of guide books available in PDAM because they provide a solution for different defects [15, 16, 17 and 18]. Another method is GVI method which is usually conducted by ROV [18]. It is required to provide procedures for inspection and assurance of pipe stability, minimized risk of the pits and consequently removing environmental damages and risks. For several years, non-destructive tests have been effectively used in the inspection of oil industry pipes. They have been studied for several times. They have been used in the evaluation of engineering structures and systems in the course of installation of these structures and also during their shelf lives. Special consideration has been given to these researches in oil industry the main reason of which was the serious consequences of risks which could occur such as failure of equipment, environmental disasters and mortality. Use of POD curves is one of the parameters which are considered in choosing the most complete selected technique in non-destructive test [19]. Several studies and much effort have been made in preparation of a criterion [20] and extensive numerical and laboratory analyses have been used for permissible evaluation of this criterion [21, 22, 23, 24, 25, 26, 27, 28 and 29]. One of the applications of this criterion is the testing of corroded pipes which are under internal pressure.

Unfortunately, few activities have been made in Iran on corrosion statistics and there is no official statistics in this field. Based on the evidence however, it can be said that corrosion costs in Iran will be very high because firstly, corrosion is quite unknown in most industries and secondly, if it is recognized in an industry, old and costly methods are used to confront that. Therefore, estimations for corrosion cost can be more than 5% of gross national income in the country. Considering the above statistics and figures, we found that corrosion costs in the countries cover high volume national capitals. With a short view to the experiences of other countries, it can be found that most of the countries currently make and apply appropriate arrangements to confront the damages caused by corrosion. In 2001 for example, US army announced by extensive propagandas that corrosion costs in the army had decreased from 10 billion dollars in 2000 down to 8 billion dollars in 2001. A fundamental requirement considered by US corrosion experts was to conduct systematic studies to estimate steel corrosion costs in the US economy and to formulae a strategy to decrease corrosion costs. In this way, based on the negotiations made between Corrosion Engineers Society of America and members of congress and US department of transportation, a corrective plan for corrosion cost in transportation in the 21st century was offered which was agreed by the congress in 1998. In 2001, the project for corrosion costs in United States was presented. In that report, direct cost of corrosion was estimated by analyzing 26 sectors of industry which had full information of corrosion. The extracted information was generalized for total sectors of the country by extrapolation of results. Finally, total estimated direct cost of corrosion was 276 billion dollars per year which was equal to 3.1% of total national gross income of the US. Moreover, indirect costs of corrosion were conservatively included equal to the direct

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costs. Therefore, it can be said that total corrosion cost imposed on the US will be more than 6% of total percentage national gross income.

Most of the national experts believe that we first need a fundamental movement in preparing an official statistic on corrosion so that corrosion aspects can be completely specified in all industries. In the next step, we can formulate a strategy for prevention from corrosion with the assistance of Islamic Consultative Assembly to require the industries to include a series of minimums in the field of corrosion in their management. Prevention strategies can include the followings:

- Increased knowledge of high costs of corrosion and cost decrease potentials
- Change of this incorrect attitude that nothing can be done to minimize corrosion costs
- Change of policies, rules, standards and practicing management to the extent that we can reduce corrosion costs through effective management of corrosion
- Increased training and qualification of employees in order to understand and identify corrosion control procedures
- Reviewing the design process of products in parallel with preventing from increased corrosion costs
- Design and formulation of advanced anticipation methods during the life of product and detection in the course of process
- Establishment of advanced technologies for corrosion control which is fulfilled by researches [30].

4. Conclusions and Recommendations

The effect of corrosion costs is important in marine structures and especially oil and gas transmission pipes in two ways:

- The cost of corrosion engineering and additives for prevention of corrosion in manufacturing a pipe and/or a new structure. These costs include corrosion resistant materials, covers and installation of cathode protection systems during fabrication.
- The costs for repair, maintenance and laying a pipe and/or a structure due to corrosion. These costs include the costs for replacing body steel and other parts with much corrosion, removing the corroded coverage, application of a new coverage and installation of additional cathode protection equipment.

Corrosion is considered as a problem only when the protective structure fails. There are two main choices to avoid corrosion. The first choice is to protect the structures against corrosion by a series of covers. In applying this solution, the user should consider the number and type of layers which are to cover the surroundings of structure. The second type of protective structure is the cathode structure. Cathode protection systems are developed with the help of an electrical current around the surface of the object that requires protection. The corrodible object (node) is placed in the connecting point to cathode system and when the current is established, corrosion which usually occurs on the sheet is transferred to the corrodible object. This action occurs in the form of galvanic corrosion and a chemical reaction is made between two different conductors immersed in electrolyte liquid. In the system in which there are two metals, the one which is more negative is corroded while the more positive metal is protected. System acts until the two metals are in contact with each other. The contact between them should not be in terms of a long wife, but the most important point is that both of them should have similar potentials. More than two metals can be

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used in this system. Protection is made on the metals which are more positive while all other metals are emptied (Dunedin Marine Systems). Dunedin Marine Systems tested several different metals for cathode protection. Zinc was used more thanks to its cheapness. The results showed that it is very important to avoid overprotection because it may lead to gas corrosion and may affect the painted surfaces. When this protective structure fails, periodical inspections should be kept and maintained. Some of the choices for keeping and maintenance are listed in table 2.1 [31].

Table 1.1: Repair options (Ship Structure Committee 1995)

Corrosion severity	**Corrosion type**	**Corrosion repair options**
Low decomposition and failure of coverage	General corrosion	1) No need to repair and control 2) Blasting and cover repair 3) Addition/maintenance of anode
	Pitting corrosion, shallow pits less than 50% thickness of the sheet	1) No need to repair and control 2) Blasting, filling the pit with epoxy and repair of cover 3) Addition/maintenance of anode
High decomposition and failure of coverage	General corrosion	1) No need to repair and control 2) Blasting, filling the pit with epoxy and repair of cover 3) General blasting and replacement of cover 4) Addition/maintenance of anode
	Pitting corrosion, shallow pits higher than 50% thickness of the sheet and few numbers	1) No need to repair and control 2) Blasting, filling the pit by welding and coverage repair 3) Addition/maintenance of anode
	Pitting corrosion, few shallow pits higher than 50% thickness of the sheet and high numbers	1) No need to repair and control 2) Blasting, filling the pit by welding and coverage repair 3) Cutting, welding the new sheet and cover repair 4) Addition/maintenance of anode

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