BASIC CORROSION TECHNOLOGY FOR SCIENTISTS AND ENGINEERS pdf

1: Basic corrosion technology for scientists and engineers by Einar Mattson PDF - HD CHORUS E-books

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A perfect companion to the Fi A perfect companion to the First Edition, Volume Two uses the same format while providing new material and current developments with an international influence. Some of the topics covered include: The role microorganisms play in corrosion reactions, the occurrence of MIC in varying industries, advice on how to identify whether or not corrosion problems are related to MIC, and MIC treatment and prevention tips. The topics listed above are illustrated through numerous charts, graphs, and photographs. Each chapter is authored by a recognized expert in the field of MIC. The opening section includes two keynote papers on: The further 45 papers cover carbon and low alloy steels, martensitic stainless steels, corrosion resistant alloys, galvanic corrosion, corrosion inhibitors and other materials. Maximising amine unit reliability, together with improvin More The corrosion of carbon steels in amine units used for gas treatment in refining operations is a major problem for the petrochemical industry. Maximising amine unit reliability, together with improving throughput, circulation and treatment capacity, requires more effective ways of measuring and predicting corrosion rates. However, there has been a lack of data on corrosion. This valuable report helps to remedy this lack of information by summarising findings from over 30 plants. This book deals with the important field of anticorrosive rubber lining and its applications in various industries, including oil and gas, nuclear, aerospace, maritime, and many more, highlighting many of the technological aspects involved. The author offers a unique perspective due to the exclusiveness of the case histories presented, including many industrial rubber lining practices which are mostly kept within the industry. Less Aspects of Microbially Induced Corrosion: Much attention is given to the currently important subject of biofilms, particularly on stainless steel in seawater. There are descriptions of the characterisation of biofilms and their effects. The volume concludes with an account of biological effects in power stations, the economic implications and prevention methods. In the past, the first step to In the past, the first step to locating this data was an expensive and time consuming search through the technical literature. Now, many of the important and frequently referenced curves are presented together in this volume. The curves are arranged by standard alloy designations and accompanied by a textual explanation of test procedures and interpretation of results. In each case the individual curve is referenced to the original source. The major alloy groups covered in this book include aluminum, copper, nickel, titanium, and other nonferrous alloys. Major sections are devoted to carbon, alloy, stainless and pressure vessel steels, as well as to superalloys. The effect of variables, such as grain size, cooling rate, stress intensity, and temperature, are presented, along with numerous environments. Is an invaluable resource for corrosion scientists, corrosion engineers, and More Presents a comprehensive look at atmospheric corrosion, combining expertise in corrosion science and atmospheric chemistry: Is an invaluable resource for corrosion scientists, corrosion engineers, and anyone interested in the theory and application of Atmospheric Corrosion; Updates and expands topics covered to include, international exposure programs and the environmental effects of atmospheric corrosion; Covers basic principles and theory of atmospheric corrosion chemistry as well as corrosion mechanisms in controlled and uncontrolled environments; Details degradation of materials in architectural and structural applications, electronic devices, and cultural artifacts; Includes appendices with data on specific materials, experimental techniques, atmospheric species. More This user-friendly survey of the corrosion of metals does not require a deep knowledge of chemistry, but acts as an invaluable compendium of accessible information on the different types of corrosion, electrochemical concepts, environments and methods of protection and prevention, as well as recommendations for further information. It is an inclusive summary of cathodic protection includingâ€¦ Electrochemistry More This book explains how to prevent and control metallic corrosion through modest premiums paid for cathodic protection. More This book provides a detailed step-by-step procedure for onshore cathodic protection tests including rectifier inspections and troubleshooting, structure-to-electrolyte pipe-to-soil potential measurements, direct current measurement, diagnostic testing troubleshooting cathodic protection systems , adjustive surveys, commissioning of cathodic protection systems, close interval potential surveys, DC stray current testing, electrical isolation tests, road casing isolation testing, AC hazardous voltages on pipelines, and soil resistivity measurements. Each of these test procedures were prepared as modules that can be used independent of each other. The text will be especially useful to cathodic protection technicians in assisting with their field tests, to cathodic protection technologists or specialists in the analysis of the tests data and for persons involved in the training of cathodic protection personnel.

2: Basic Corrosion Technology for Scientists and Engineers - CRC Press Book

This user-friendly survey of the corrosion of metals does not require a deep knowledge of chemistry, but acts as an invaluable compendium of accessible information on the different types of corrosion, electrochemical concepts, environments and methods of protection and prevention, as well as recommendations for further information.

Reza Javaherdashti August 23, Source: An improved communication system between corrosion engineers and managers based on Corrosion Knowledge Management CKM principles can help reduce the cost and consequences of existing and future corrosion problems. Email Newsletter Join thousands receiving the latest developments in corrosion technology industry. Abstract Corrosion management CM is a relatively well-known term to address technicalities involved in the prevention and mitigation of corrosion. This organizational culture or as we call it, corrosion knowledge management CKM , mainly relies on managerial techniques for better communication between corrosion engineers and other engineers and between corrosion engineers and their managers who may have little background in corrosion. This technique first focuses on the available sources and then proposes a feasible way of dealing with corrosion through these available sources by using the following principles: Definition of a corrosion system corrosion in the system CINS or corrosion of the system COFS Use of information Transparency Modelling It is proposed that based on this model for dealing with corrosion, a better understanding of corrosion and its seriousness is created and that via a feasible communication system based on CKM principles can help reduce the cost and consequences of both existing and future corrosion problems. Introduction to Corrosion Management The approach of corrosion management CM to the problem of corrosion is a set of techniques that are applied to prevent or mitigate corrosion. Despite having rather different applications and principles, what is common among all the CM techniques is that, with the exception of a limited group of corrosion technologists, the literature and the associated language sound like jargon to non-corrosionists. Even a corrosionist who has been dealing with cathodic protection would behave quite carefully. The degree of conservativeness increases when this CP specialist deals with coating application or biocide selection. When it comes to corrosion, this lack of communication must be improved. Corrosion science and technology is in essence different from all other disciplines of science and engineering in that while corrosion deals with degradation and failure mechanisms, all other branches of science and technology consider new technologies for manufacturing and production. Therefore, any non-corrosionist who is dealing with using materials must consider their service life based not only on assumptions and expectations but on real conditions of service. Metallic loss, wear and tear, and depreciation are handicapped references to what corrosion is and can become. Routine financial formats, in which a certain rate of physical depreciation is taken, are based on assumptions that under real life conditions may not always be met. To get a more realistic understanding about financial risks associated with corrosion, a more active and feasible dialogue between corrosionists and non-corrosionists is quite necessary. Multi-dimensional features of corrosion disasters are reflected in their serious impacts on a range of factors such as environmental, economic and community health. Some examples of such impacts of corrosion are given later in this paper. They are not the responsibility of only a few. The lack of communication between corrosionists and non-corrosionists not only increases labor and expenses in many cases, but also results in environmental changes impacts on both nature and society. In particular, if the non-corrosionists are managers who have had no official training in engineering and especially in corrosion engineering, then the lack of communication becomes even more important. Figure 1 schematically shows the impact. The bright line shows that as management levels increase, the technical knowledge is likely not to follow. The dark line shows that it may be the low echelon engineer who can lecture about the technicalities of corrosion and not necessarily the CEO. The methodology can also offer a way to overcome the environmental impacts of corrosion. During extractive processes to obtain metals out of their ores or mineral compounds, reductive processes are applied. In these processes, by giving more electrons to metallic compounds in the ore, thermodynamically stable metal in the ore is brought into a thermodynamically unstable state by the reducing processes of extractive metallurgy. In other words, by investing energy to convert the ore to metal, chemical bonds are broken; oxygen, water and other anions are removed and the pure metal is arranged in an ordered lattice whose formation requires a certain amount of excess energy, different for each metal, to be stored. It is the dissipation of this stored energy that drives the corrosion reaction. As a result, metals are always expected to reach a stable energy level by giving off the additional electrons they have received during extractive metallurgical processes. This leads to the thermodynamic basis of oxidation , or more generally termed, corrosion, in metals. See our video, The Basics of Corrosion and Protection , for an introduction to the corrosion process.

BASIC CORROSION TECHNOLOGY FOR SCIENTISTS AND ENGINEERS pdf

3: Stress Corrosion | Degradation and Surface Engineering

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Introduction This NACE Basic Corrosion Course has been prepared under the direction of the National Association of Corrosion Engineers to help provide a broader program for corrosion education for its membership and the industries which have corrosion problems. Munger, Amercoat Corporation; W. Burton, Allied Chemical Corporation; E. Greco, Consultant; and Aaron Wachter, Consultant. This committee has served for two years under the Chairmanship of Professor Anton deS. Brasunas of the University of Missouri-Rolla. They secured the services of numerous NACE members who contributed time and effort in preparing this seventeen-chapter text on corrosion which is intended to be used by individuals throughout the world as a correspondence course. For that reason, the writing and preparation was so patterned as to maximize the clarity of the discussion and minimize the need for any additional instruction. This text is liberally illustrated to help clarify various situations and the language which was used throughout the text has been made as nonmathematical and nontechnical as possible to discuss this very technical subject in a relatively easy-to-understand manner. As corrosion technology develops and as the need for additional, new, and more detailed information becomes necessary, NACE will then consider the preparation of a more advanced text, as well as preparing up-to-date and supplementary data for this basic course. NACE gratefully acknowledges the assistance of the various authors and editorial committee who helped make this course possible and we trust that their arduous efforts will be amply rewarded by the realization that this course will be of considerable benefit to the nation, to numerous industries, and to individuals all over the world who will take advantage of the opportunity afforded them by this educational effort. Brasunas and Norman E. Hamner When a study of corrosion is undertaken, it may be natural to think that corrosion is a simple single reaction and that when understood, it can be turned off like a spigot. If cost and availability were not factors, we could select the very best materials and come close to doing just that. But let us dismiss consideration of materials like gold or platinum and think in terms of practical substances that we can afford to use in our homes, industries, automobiles, etc. Practical materials like iron and steel, aluminum and copper alloys, plastics, ceramics, wood, refractory metals, stainless steels and many other modern alloys and superalloys, all have certain advantages as well as disadvantages. A selection of one of these alloys or classes of alloy can be a "best choice" for a certain application. Learning when to choose which, comes with experience and knowledge. This is a part of what we hope you can learn from this course. LaQue Ordinarily, people become engaged in controlling or preventing corrosion by appointment rather than as the final step in a process of formal education having this as its original goal. This course is designed to be helpful to that segment of such a group entering this field without the benefit of any extensive training in the basic sciences related to corrosion, but who may be called upon from time to time to take at least the first steps in anticipating, diagnosing and otherwise dealing with corrosion problems, either on their own or in collaboration with others. Economic Importance While corrosion processes form an interesting basis for scientific studies which are frequently undertaken as exercises in chemistry, and particularly electrochemistry, by far the greatest interest in, and concern for corrosion stems from its practical effects and how they may be avoided. Various estimates have been made of the annual economic loss resulting from corrosion. There is no general agreement as to just what should be included in calculating this loss, for example, should we include the coating on tin cans which would not be needed if the contents were not corrosive to steel. It is, therefore, fruitless to argue about the figure that should be used. Greene Corrosion as a Chemical Reaction Although at first sight the corrosion of metals may appear to be a rather complex process, the general reaction can be readily understood by considering elementary chemical principles. Almost all of these have been discussed in your high school chemistry courses and therefore their application to the phenomenon of corrosion should be relatively simple. In this chapter, the principles of chemistry and chemical reactions important to the understanding of corrosion are discussed. Since space limitations prevent a complete review of basic chemistry, it is suggested that if necessary, a high school chemistry text or review book be utilized for additional study purposes. Compton Corrosion in the atmosphere usually occupies a minor position in the writings of scientists and corrosion engineers dealing with the basic subject. The corrosion phenomena in chemical plants, underground structures and, to a lesser degree, in sea water or at elevated temperatures seem to offer more glamour and to be more spectacular. Actually, most of the destructive damage to equipment and structures caused by corrosion occurs in the atmosphere. The large segment of the vast paint industry concerned with the manufacture and application of its products for the protection of metals and the large scale operations of the galvanizing industry attest to the -importance of controlling atmospheric corrosion. Most of the broad forms of corrosion occur in the atmosphere and some appear to be largely restricted to it. Since the corroding metal is not bathed in large quantities of electrolyte, most atmospheric corrosion operates in highly localized corrosion cells. Calculation of the electrode potentials on the basis of ion concentration, the determination of polarization characteristics and other electrochemical operations are not possible as contrasted to the situation in liquid immersion types of corrosion. Yet, all of the electrochemical factors significant in corrosion processes operate in the atmosphere, so their comprehension is vital to an understanding of its operation. Peabody The purpose of this chapter is to introduce the student to cathodic protection, one of the widely used "tools" for the control of electrochemical corrosion throughout industry. After a brief description of the meaning of cathodic protection and how it works, the balance of the chapter will consist of a discussion of the practical aspects of cathodic protection systems as well as various factors that may influence cathodic protection designs. As a first step, it is necessary to agree on a definition for "cathodic protection" so that a basis will be established on which can be built a better knowledge of the manner in which it functions and of its practical use. Cathodic protection is defined as: Reduction or elimination of corrosion by making the metal a cathode by means of an impressed direct current or attachment to a sacrificial anode usually magnesium, aluminum, or zinc. A cathode is the electrode where reduction and practically no corrosion occurs. Prior to applying cathodic protection, most corroding structures will have both cathodic areas and anodic areas those areas where corrosion is occurring, see glossary. It follows, then, that if all anodic areas can be converted to cathodic areas, the entire structure will become a cathode and corrosion will be eliminated. The second step is to show how application of direct current electricity to a corroding metallic structure can cause it to become a cathode throughout its area. To begin with, direct current electricity is associated with the corrosion process on a buried or submerged metallic structure. As was mentioned in previous chapters, various metals have varying tendencies to corrode as illustrated by their relative positions on the Galvanic or Emf Series. Since this chapter will center largely around iron, it is well to note that iron is intermediate in these lists. Furthermore, it has been shown that pure iron, wrought iron, or mild steel behave just about the same in underground situations. It has been observed that iron pipe buried in bone dry soil suffers little or no corrosion. However, because of rain, natural springs, rivers, etc. Even if we considered the simple case of moisture from natural rain, we would soon be dealing with the complex solutions similar to well water, river water, etc. All soils contain a variety of mineral matter, some of which is soluble to a greater or lesser degree and we must deal with these "solutions". Had there been no minerals to dissolve in rainwater, corrosion by soils would be almost nil. Iron in pure water does not corrode, but when there is oxygen dissolved in it the situation is very different. Furthermore, when other substances dissolve in it the situation becomes even more complex. An explanation of corrosion behavior under a variety of conditions is not easy to give, but one important factor is the electrical conductivity of the medium which surrounds the metal being corroded. Pure water is a very poor electrical conductor but as substances dissolve in it, particularly those which ionize, conductivity rises sharply. As it will be seen later, the relationship between conductivity and corrosion is a very logical one. Berry A major use of water in industry is the transfer of heat and the production of steam. There is extensive use of cooling water in almost every manufacturing process, in commercial air conditioning, and even a fair percentage of domestic air conditioning. Fossil and nuclear-fueled steam plants and attendant steam generation dominate the power generating field. Water is corrosive to most metals. Pure water without dissolved gases as O2, CO2, SO2 in it does not cause undue corrosion attack of most metals and alloys at temperatures up to the boiling point of water. Even at temperatures of about F C almost all the common structural metals, except the light metals aluminum and magnesium, possess adequate corrosion resistance to highpurity water and steam. Naturally-occurring or man-made contaminants make water corrosive. The most significant of these contaminants is oxygen from the air that is dissolved in the water. As described in Chapter 3, oxygen is a cathodic depolarizer that reacts with and removes reaction products from the cathode during electrochemical corrosion, thereby permitting the attack to continue. Other contaminants that are often found in water and which contribute to corrosion include chloride salts usually sodium chloride-common table salt from the sea, wells, or industrial sources; sulfides from wells, mining wastes, or sewage; and carbon dioxide from combustion-products in the air or certain water treatment practices. Of course, many other man-made contaminants can be found in local areas where industries discharge their wastes into streams. This chapter will discuss the corrosion problems associated with natural and treated waters at temperatures ranging from room temperature up to to F to C ; the means of preventing or slowing down corrosion; and the best choice of materials for each environment. Godard Localized corrosion can be defined as selective removal of metal by corrosion at small special areas or zones on a metal surface in contact with a liquid environment. Note that this discussion is limited to corrosion in liquids, whereas pitting and other forms of localized corrosion can also occur in other environments. It usually occurs under conditions where the largest part of the original surface either is not attacked or is attacked to a much smaller degree than at the local sites. The most common type of localized corrosion is pitting, in which small volumes of metal are removed by corrosion from certain areas on the surface to produce craters or pits. Pitting corrosion may occur on a metal surface in a stagnant or slow moving liquid. It also may be caused by crevice corrosion, poultice corrosion, deposition corrosion, cavitation, impingement and fretting corrosion. Another common type is intergranular corrosion sometimes called "intercrystalline corrosion". In this form, a small volume of metal is preferentially removed along paths that follow the grain boundaries to produce what might appear to be fissures or cracks. The same kind of subsurface fissures can be produced by transgranular corrosion sometimes called "transcrystalline corrosion". In this, a small volume of metal is removed in preferential paths that proceed across or through the grains. This occurs only under certain conditions and with certain alloys. Intergranular and transgranular corrosion sometimes are accelerated by tensile stress. In extreme cases, the cracks proceed entirely through the metal, causing rupture or perforation. This condition is known as "stress corrosion cracking", a subject that will be dealt with in Chapter Intergranular and transgranular subsurface cracks also can be produced by hydrogen. Caustic embrittlement and corrosion fatigue are two other mechanisms of metal deterioration which form fissures at or beneath the surface. In a completely different type of corrosion which may become localized one of the metals in an alloy may be selectively leached out without producing visible pits or cracks, and without changing the dimensions of the metal. At a casual glance the metal may appear to be intact. Under a microscope it can be seen to be porous. The mechanical properties of the alloy are greatly reduced by the selective attack. The most common example of this type is dezincification of brass in which the zinc is selectively dissolved out of the alloy. Another case is "graphitic corrosion" of cast iron, in which the iron is selectively dissolved or leached away leaving a porous mass apparently intact but in reality consisting largely of graphite. Snavely Definition of Corrosion Inhibitor An inhibitor is a substance which retards or slows down a chemical reaction. Thus, a corrosion inhibitor is a substance which, when added to an environment, decreases the rate of attack by the environment on a metal. Corrosion inhibitors are commonly added in small amounts to acids, cooling waters, steam and other environments, either continuously or intermittently to prevent serious corrosion. It would be awkward to include mechanisms of inhibition in the definition of a corrosion inhibitor because inhibition is accomplished by one or more of several mechanisms. Some inhibitors retard corrosion by adsorption to form an invisibly thin film only a few molecules thick; others form visible bulky precipitates which coat the metal and protect it from attack.

4: NACE Basic Corrosion Course

Basic Corrosion Technology for Scientists and Engineers (2nd Edition) Details This user-friendly survey of the corrosion of metals does not require a deep knowledge of chemistry, but acts as an invaluable compendium of accessible information on the different types of corrosion, electrochemical concepts, environments and methods of protection.

Eclipse Scientific Products Inc. These factors affect a wide range of materials and bridge many industries including: This paper is the first in a series of papers that present the types of defects encountered in the pipeline industry and the sizing methods that can be used for assessment of the defects. This paper has been prepared to present examples of corrosion and cracking in pipeline metals and to demonstrate appropriate calibration blocks, which include representative targets, that should be used to calibrate ultrasonic equipment prior to same side sizing applications. Although the focus of these papers has been on pipeline applications the technology can be used for many applications, including the inspection of stainless steel and aluminum. Ultrasonic, External Corrosion, Stress Corrosion Cracking, SCC, Calibration Background Degradation of pipelines is the result of the persistent attack by the environment on pipeline materials coatings, welds, pipe, etc. Buried pipelines are located within ever changing environmental conditions that may lead to a corrosive environment. Factors that may prevent or contribute to the initiation and attack on buried pipelines include the following. Pipe Coatings Buried pipe is coated to offer protection from the surrounding environment. A breakdown in the coating will result in pipeline metal being exposed. The material used for coating pipes varied over the years as technology evolved. Cathodic protection The introduction of an electrical current on a buried pipe such that the electrode potential of the buried pipe is lowered creates an environment where metal loss is reduced. Soil conditions, such as moisture content and mineralogy influence the effectiveness of the cathodic protection, as does the type of coating on the pipe. For example, pipe coated with polyethylene material is shielded from cathodic protection more than pipes coated with asphalts. Soil conditions Soil structure and conditions will not only impact the effectiveness of the cathodic protection but also may contribute to the creation of a corrosive environment. Factors such as soil type, drainage, temperature, CO2 concentration, and electrical conductivity all contribute to the environment surrounding the pipe. Temperature The temperature of the soil as well as the temperature of the pipe may create favorable conditions for attack on pipeline materials. Liquid and gas lines have slightly different operating temperature characteristics but both are still susceptible. For example, with gas pipelines both the pipe and surrounding ground can vary from a high of 40oC upon leaving the compressor station down to 5oC at distances from the station. Stresses residual and others Stresses in the pipe may lead to premature degradation of the pipeline strength. Stresses acting on the pipe include: Pipe pressure Corrosion, in particular cracking, is related to the pressures exerted on the pipe. As the pressures within the pipe are increased, the growth rates for cracks also increase. The circumferential stress hoop stress generated by the pipeline operating pressure is usually the highest stress component that exists. Cyclic loading effects Conditions where the pipe is under cyclic loads may result in increased crack growth rates. Operating pressures for large diameter pipe can measure up to kPa psi. The pipeline pressure continually fluctuates due to loading and unloading of product and is influenced by pump activity. This applies to both gas and liquid lines but has greater influence in liquid systems. Types of Corrosion Corrosion is the breakdown of the parent material due primarily to electrochemical methods where there is an exchange of electrons between two materials. The rates of attack and severity of corrosion will vary depending on the influencing factors mentioned above. The type of corrosion that is experienced may vary as well Mattson, Typical corrosion types found on pipelines include: Uniform or general corrosion proceeds at approximately the same rate over the whole surface being corroded and the extent can be measured as mass loss per unit area. Pitting results in pits in the metal surface due to localized corrosion. Crevice corrosion occurs in or immediately around a break in the material. Intergranular corrosion results in corrosion at or near the grain boundaries of the metal. Erosion Corrosion involves conjoint erosion and corrosion that typically occurs in fast flowing liquids that have a high level of turbulence. Environment-induced cracking results from the joint action of mechanical stresses and corrosion. Corrosion The various corrosion types produce distinct corrosion patterns. However, whether the corrosion is a result of low level and pitting corrosion that effects large areas or it is a more aggressive galvanic or microbiologically influenced corrosion MIC , the result is metal loss that could compromise the integrity of the pipe. The corrosion patterns produced include uniform defects, pitted surfaces, striations, and channel defects. Figures 1 to 4 present examples of some corrosion patterns observed on pipeline metal. An example of general deep pitting corrosion with some pits joining to form larger pits and interconnected pitting. Image presenting the trend towards channel style corrosion. The channels were initially small pits that joined together and continued to grow. This type of corrosion pattern can result in defects with significant depth and length. Examples of corrosion striations. This style of corrosion looks like scratch marks and requires special consideration when being inspected using ultrasonic methods, since the striated corrosion surface profile affects the reflected ultrasound signal. General corrosion patterns range from the image on the left with little or no good wall to the image on the right with only minor corrosion throughout the surface. Calibration Blocks for Sizing Corrosion Calibration blocks for sizing corrosion are typically quite simple and have one primary requirement, to assist an operator with calibrating the ultrasonic equipment to allow accurate assessment of the material being inspected. Depending on the inspection format, manual or automated, the blocks used for calibration may vary. In manual inspections a standard step wedge is commonly used for remaining wall or opposite wall measurements. The step wedge should be constructed of material representative of the material being inspected and contain at least three different thickness measurement locations. Figure 5 contains an example of a typical step wedge that could be used for calibration. Example of a typical step wedge and SDH. Calibration for automated inspection formats allows for the calibration sample to be more indicative of the corrosion being inspected. Although Flat bottom holes FBH are commonly used, the utilization of more intricate calibration blocks is beneficial. The benefits of using more representative calibration blocks is that the operators have a range of signal responses that can be used to mock-up the inspection and test the calibration. This allows confirmation of the various components of the signal being extracted from the data sets. Figures 6 to 8 show samples of calibration blocks that include FBH and corrosion patterns. Items to consider when completing corrosion mapping include: Both of these items are required to provide accurate measurements of remaining wall thickness and allowances for any out-of-round issues that may be encountered. Flat bottom holes of various depths and diameters are useful for identifying transducer limitations. Additional fixed known angle hole targets cone shaped can also be used. Actual pipe corrosion sample and the associated machined replica pattern in a calibration sample. Calibration sample showing three replicas of the same corrosion feature. Each corrosion replica has been machined to a different predefined depth to provide TOF measurement variation. Cracking Many forms of cracking exist in the various industries that utilize material and equipment susceptible to cracking. Four types of mechanically and chemically assisted cracking that may occur in industrial equipment include: In this paper the discussion is limited to the pipeline industry and stress corrosion cracking. The term EAC is used to describe all types of cracking in pipeline that is influenced by the environment and stress. In a pipeline environment when water comes in contact with steel there is potential for the minerals and gases to create an initial corrosion site that is acted on by stresses that result in crack growth. Contributing factors to crack growth are residual stresses, temperature, load stress, bending, and local stresses. If there is no stress then crack growth will not occur and the result will be general wall thinning or pitting through corrosion. The conditions that are present during crack growth dictate the type of SCC that may occur. For example, electrolyte pH will determine if the cracking is intergranular or transgranular. High pH conditions cause intergranular cracks while low pH conditions create non-classical SCC that result in transgranular cracks with mixed modes at the crack tip. The crack faces in low pH cracks also show evidence of secondary corrosion and appear wider than high pH SCC. Crack Profiles Crack characteristics can vary greatly depending on the cause of the crack, the materials being cracked, and the environment causing the cracking CEPA SCC working Group, Figures 9 to 11 show examples of crack profiles. Figure 9 shows a cross section of two SCC cracks that were located in pipeline steel within the body of the pipe. Cracks may have a single main branch or be composed of several smaller branch tips. In addition, the proximity of a crack to adjacent cracks may vary significantly as shown in Figure 9 and Figure 9 shows two cracks located at a significant distance from one another while Figure 10 shows two co-parallel cracks close together located within the weld cap. Figure 11 shows a crack occurring at the fusion line of the weld and the parent material. Fusion line cracks are commonly known as toe cracks. Photomicrograph of a SCC crack in pipeline steel. Photograph of a SCC crack at the weld fusion line toe crack. Branching nature that may occur at the crack tip can clearly be seen in this profile. Photomicrograph of a SCC in a weld. The two indications shown are located adjacent to one another and both occur within the weld material. An example of an isolated crack is shown in Figure 12 with an example of a limited colony shown in Figure Cracking within colonies may result in the cracks on the periphery of the colony being deeper then the cracks at the center of the colony. This may be observed because the effect of cracking within a colony environment may act as a stress relieving mechanism causing reduced crack growth for cracks located in the center of the colony while the cracks on the periphery continue to grow. Example of an isolated SCC. Example of a SCC colony. Fusion Line Toe Cracks Cracking located at the weld edge or fusion line is due to stress concentration that occurs at these locations. The potential for the coating to tent along the weld cap and the higher stress factor present at weld areas can produce significant indications. Figure 14 shows an example of a toe crack with an adjacent SCC colony.

5: Basic Corrosion Technology for Scientists and Engineers (2nd Edition) - Knovel

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6: Corrosion - Metals & Metallurgy - Knovel

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