STRESS CORROSION CRACKING PERFORMANCE OF AUSTENITIC STAINLESS STEELS MATERIALS IN SODIUM CHLORIDE

Samir Milad Elsariti
School Of Materials Engineering, Kompleks Pusat Pengajian Jejawi 2,
Universiti Malaysia Perlis (Unimap), Taman Muhibbah, 02600 Jejawi, Arau, Perlis
Email: samir.elsariti@gmail.com, Tel: 017-6057157

Mohd Nazree
School Of Materials Engineering, Kompleks Pusat Pengajian Jejawi 2,
Universiti Malaysia Perlis (Unimap), Taman Muhibbah, 02600 Jejawi, Arau, Perlis

ABSTRACT

The effects of differences in austenitic stainless steel materials content on the structure and its properties of high strength weld metals have been studied. Based on the environment was conducted using sodium chloride solutions are with 3.5 or 9.5 wt% NaCl. From mechanical testing, it was confirmed that a large improvement in impact toughness could be achieved by increasing the nickel content. Based on dynamic calculations and observed separation conduct it was determined that the stainless steel materials set as austenite. The austenitic stainless steel materials structures were categorized using scanning electron microscopy. At some areas mainly stress corrosion cracking was found.

Keywords: stress corrosion cracking, austenitic stainless steel, sodium chloride.

Introduction

Stainless steel is often perceived as the backbone of current industry. Stainless steel has achieved extensive applications in a wide range of industries and has been in use as a reliable substitute for carbon steel in corrosive environments ever since. Stainless steel was generally recognized as being an expensive, high-technology alloy. As material manufacturing and fabrication technology advanced, large-scale production of stainless steel components occurred (Caig, 1989). This made stainless steel more cost-effective and affordable. All of these mentioned factors, including cost of corrosion, economical feasibility, and the need to operate in more severe environments, have encouraged the wide-spread use of stainless steel.

Stress Corrosion Cracking (SCC) is a form of failure of material having specific characteristics. This is a represent able cause of dominant damage at one particular component or material structure, so that it is considered in design at a construction industry. Stress Corrosion Cracking behavior in austenitic stainless steels in solution has been extensively investigated using a constant load method.

Stress Corrosion Cracking refers to the environmentally assisted cracking process as a result of the conjoint, simultaneous interaction of tensile stress and corrosion. Stress Corrosion Cracking is material environment specific, its occurrence requires the exposure of a susceptible material to its specific Stress Corrosion Cracking causing substances with the presence of tensile stress (Alloy Digest Source book, 2000). The amount of this tensile stress is relatively low, and failure can be in some cases induced by a small amount of residual stress remaining as a result of the manufacturing process.

Not all stress corrosion cracking susceptible environments and material combinations are known, and the list of specific environments that cause Stress Corrosion Cracking continues to expand. Detection of Stress Corrosion Cracking at its initial stage for in-service equipment is very difficult, and its incubation period is unpredictable. In practice, Stress Corrosion Cracking failures are often unannounced and can be disastrous. Engineering designs are mostly based on the yield strength criteria, for example, Working-Stress Approach, except for specific applications where a Reliability-Base Approach may be justified to maximize the utilization of materials (ASTM G36-94).

Scope Of Study

Experimental results are presented from a study of the effects of pre-cracked specimen configuration and initial starting on crack growth rate and, for both onset of cracking and crack detain. Attention is given to Austenitic Stainless Steels 304, 310 and 316 steel in a 3.5wt% and 9.35wt% NaCl solutions, for configurations of a pre-cracked specimen tested under constant load, and a modified notched specimen loaded to a fixture. The threshold crack growth value determined was independent of experiment time, where the crack growth and weight lost compared and explained in curves. It is been described that the main problem associated with the effective utilization of stress corrosion cracking which is a significant problem in notch side of each specimen (ASME B31.8S, 2004).

Statistics show that the Stress Corrosion Cracking unpredictable because of its initiation occurred time and it can be happened in short or long term in few days, months or years. And in this research, we have investigated the problems which occurred by

Stress Corrosion Cracking of austenitic stainless steels in NaCl solutions similar to sea water (3.5wt% NaCl) & Sabkha (salt-flat) (9.35wt% NaCl).

The discussion in the previous paragraphs shows the importance of conducting Stress Corrosion Cracking tests and giving some ideas for life prediction of engineered components for both engineering design and for integrity management purposes. This research will apply the Stress Corrosion Cracking of Austenitic Stainless Steels types which will particularly in Natrium Chloride Solutions (3.5wt% & 9.35wt%) approximately equal to NaCl concentration in sea water and Sabkha (salt-flat) .

Purposes

The main objective of this research is to identify Stress Corrosion Cracking of austenitic stainless steels (304, 310 & 316) in natrium chloride solutions (3.5wt% & 9.35wt% NaCl) at room temperature under constant stress including:
To investigate four stages of Stress Corrosion Cracking behavior related to austenitic stainless steels such as types of 304, 310 & 316.
To analysis the Stress Corrosion Cracking of austenitic stainless steels in two different concentrations of 3.5wt% & 9.35wt% NaCl equivalent to (Sea water & Sabkha).
To record and analysis the stress corrosion cracking initiations in each specimen of the three types austenitic stainless steels such as types 304, 310 & 316.

Experimental Method

The experiment utilized types 304, 310 & 316 austenitic stainless steels materials ordered at the time of this program. Specimen's austenitic stainless steel with a thickness of 3.2 mm was used. The yield and ultimate strengths of the material are summarized in Table 1. Most constant load Stress Corrosion Cracking tests were conducted at a stress level of 0.9 yield. The chemical composition for this material is as listed in Table 2.

Table 1: Mechanical Properties.

Materials	Yield strength 0.2% offset MPa	Ultimate Tensile Strength MPa
SS304	442	674
SS310	316	632
SS316	205	515

Table 2: Chemical Composition wt%.

Materials	C	Mn	P	S	Si	Cr	Ni	Mo
SS304	0.058	1.10	0.041	0.012	0.423	14.07	11.69	-
SS310	0.056	1.40	0.031	0.007	0.455	20.29	14.16	-
SS316	0.081	1.23	0.038	0.008	0.520	15.31	8.975	0.042

Other than verification of the equipment setup and plan, this study designed to obtain the connection between the constant initial stress levels to the time to initiation of crack and, the time to failure of the specimen, in stressed stainless steels (types 304, 310 & 316) specimens absorbed in 3.5wt% & 9.35wt% NaCl solutions at room temperature. Should sufficient data can be gathered that warrant the generation of a stress time plot on a log basis, statistical analysis of data would also be conducted, however, as indicated previously, reproduction of Stress Corrosion Cracking in a lab environment remains the biggest challenge in research related to Stress Corrosion Cracking (Nishimura, 2004). This same problem was experienced in this test program. Observation and results are included in next chapter of this thesis.

Specimens for tension tests can be called notched specimen. For the purpose of this experiment, smooth and notched specimens were used. Notched and standard specimens are beneficial because of size also which easy to conduct the dimensions changes, and ultimate failure of the specimen is more probable than for larger specimens. In addition, shorter failure time generally results with notched standard specimens compared to sub-sized specimens. The specimen has a notch along the center. The specimens were machined from a 3.2 mm thick sheet (Cheng, 2006). The specimen surface and shallow notch to observation crack initiation. The surface and shallow notch were ground with grade 1200 emery paper and then were polish finished. Number of specimens for each material was five. This produces a greater stress upon application of load along the notch ligament due to the reduced cross sectional area at the center. This configuration ensures that the initiation of the crack occurs within the notch area of the specimen. Other than constraining the crack initiation location, the threaded shape of the ends outside the shoulder section of the specimen are extended to permit proper alignment and connection to the constant load fixture, allowing axial application of load, and providing space for the test chambers.

The resistance to Stress Corrosion Cracking is strongly dependent on the grain shape and orientation with respect to the stressing direction. It is often observed that the Stress Corrosion Cracking resistances in transverse and longitudinal directions are quite different, such that when tensile stress is applied in a transverse direction, the resistance to Stress Corrosion Cracking is decreased.

Consequently, it is very important to define the orientation of the specimen and the relationship between the direction of stress application and grain flow. Specimens can be cut from different forms of wrought materials that are rolled or extruded, which produce elongated grains in the direction of metal flow. In this series of experiments, the specimens were prepared such that applied stress is cross to the notch. The surface conditions of specimens have significant influence on the results of Stress Corrosion Cracking tests, because Stress Corrosion Cracking certainly involves initial surface reactions. During an experiment, the total amount of tensile stresses that a specimen sees is the sum of the stresses applied by the loading fixture and the residual stresses in the specimen.

Most industry machines components are made without much extra preparation of a component's internal surface where it is in contact with chloride solution in cooling systems, such surfaces include inner surfaces of tubes, containers, and vessels. To reproduce as created status, extra surface preparation was not performed aforementioned to actual Stress Corrosion Cracking tests (Gutman, 2007).

To restrict the specimen area exposed to the test solution, the notch section is well-polished. Since specimens should be free of oil, grease, and dirt, preceding to inserting the specimen into test chamber, the load fixtures preparation concluded with thorough washing and cleaning by corrosive cleaner.

Austenitic stainless steel has a inclination to crack at stress points when exposed to certain corrosive environments, such as those involving chloride ions. Chloride ions can concentrate at stress locations and catalyze the formation of a crack. In this test, 3.5wt% & 9.35wt% NaCl solutions were used. The test solution was prepared by dissolving some of NaCl in sufficient amount of tap water to make about ten liters of test solution.

NaCl solution was used in this of other type of chloride solutions as NaCl is everywhere such as sea water and Sabkha (salt-flat) (Bruce, 2009). Other commonly used test solutions, such as MgCl, are generally viewed as more severe. A more thorough environment was not selected to replicate a condition as close to in-service condition as possible. The use of a higher concentration solution to produce cracks in a lab environment comparable to those in accelerated tests was not preferred in this test program. Two different percentages NaCl solutions were used as it is a reasonable amount and fall within the range of most actual service condition.

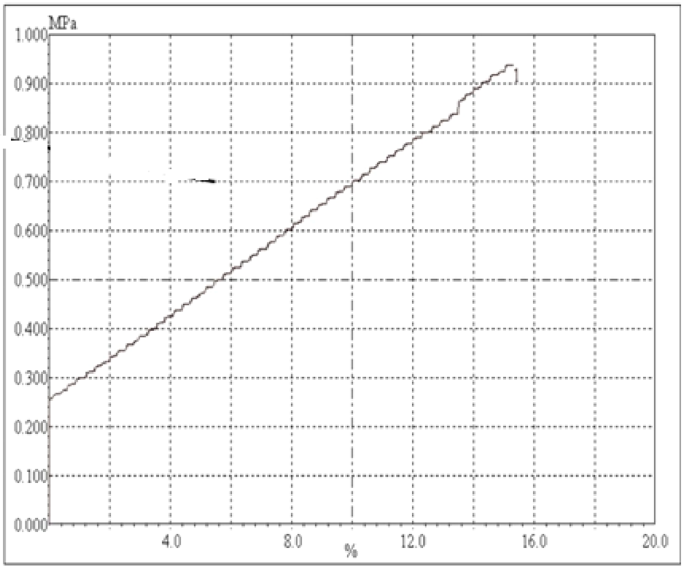
Figure 1: Natrium Chloride.

Constant load test of Stress Corrosion Cracking was chosen as the test method due to the need to measure the producing time required for generating Stress Corrosion Cracking. This selection was based on close absorption of actual condition without unnecessarily increasing the severity of the test condition (Fielder, 2010). Accelerated methods such as SSRT are known to be unrealistic when compared to actual field data regarding time-to-cracking, thus, SSRT was not deemed suitable for this test. As for the constant strain test that typically utilizes C ring, U-bend, or other form of curved beams as test specimens, technical problems in preventing sensors from being in contact with the test solution, but yet capable to detect crack initiation and propagation precluded the use of this methodology. Fascination tests are sometimes performed by periodic short term removal of test pieces from the test environment, where identification of Stress Corrosion Cracking is done by careful illustration examination and time to cracking recorded when indication of cracks are seen, this may be practicable for accelerated tests where test time is limited to less than a day, but for the test duration involved with the current test program, it was not practical to do frequent examinations for an predictable term of more than two months test period for each test conducted.

One of the advantages of a constant-load test is that the applied stress is increased as the crack grows due to the reduced load bearing area by the crack, and fracture of the specimen can eventually occur. Detail descriptions of each part of the equipments are discussed in the following sub-sections. A photographic of the chambers is shown in Figure 2.

Figure 2: Constant-Load Stress Corrosion Cracking Test Chamber

Figure 3: Spring & UTM Test Result.



Before the 304, 310 & 316 Austenitic stainless steels to be tested for Stress Corrosion Cracking, tensile test was performed on the material. With the experience gained from tensile tests as shown in Figures. 4, 5 & 6 tensile test stage of the material was explained in next sub-section.

Figure 4: Tensile Test Graph for SS304.

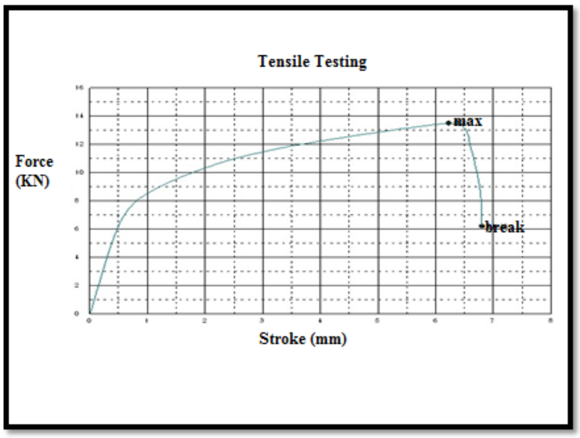


Figure 5: Tensile Test Graph for SS310.

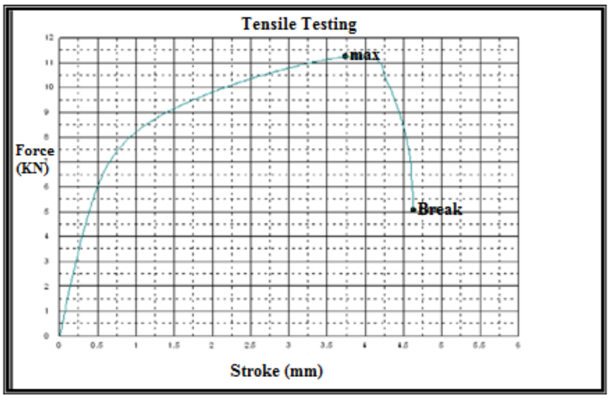
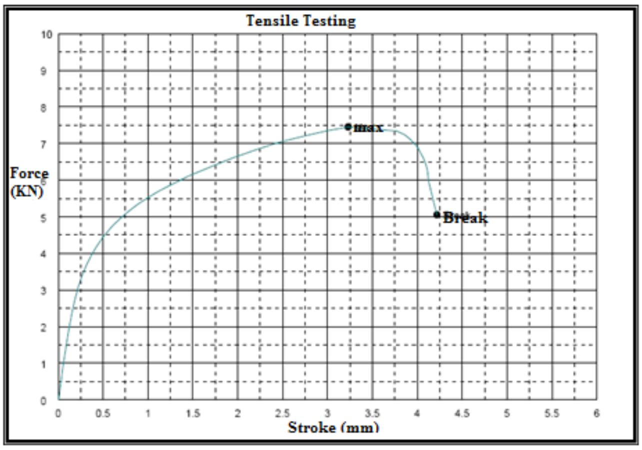


Figure 6: Tensile Test Graph for SS316.



Results

Crack Growth

In 3.5wt% NaCl solution, Stress Corrosion Cracking cracks were not achievable in the constant load Stress Corrosion Cracking tests performed for all specimens at time of 404 hours. When the tests were setup and eventually initiated, though it was not totally expected, difficulties in reproducing cracks were not a surprise when actually confronted. The test of the all types in first stage (404 hrs) has demonstrated that the materials were quite resistant to surface attack and indicated that this material was highly corrosion resistant. It is this material that was used in the test program. Longer time recommended in the literature.

As previously commented, more than one reason could have led to the unsuccessful production of cracks at first stage, and many may have worked cooperatively. The following sections discuss possible explanation of the results obtained.

Probable Reasons For Absence Of Cracks

One of the main reasons is suspected to be the use of a low concentration test environment for the series of Stress Corrosion Cracking constant load tests conducted.

One of the objectives set in this test program was to investigate the time required for crack initiation and the time for fracture of the specimen. A lower concentration test medium at a room temperature was purposely selected to enable data gathering of the time required to generate a localized aggressive environment of Stress Corrosion Cracking incubation period that closely resembles that of actual service conditions (sea water). Though ironic to one of the original intentions of the test program, this room temperature test condition is probably one of the principle causes of failure in crack induction within the period of 404 hours experimentation (Arnold, 2008).

The test environment was set as it is generally accepted that stress corrosion cracking is a threat to Austenitic stainless steel in NaCl at a room temperature, even though in-service failure at elevated temperature has infrequently occurred. stress corrosion cracking does not nucleate immediately after the material is brought into contact with the environment, and certain duration for producing generally leads the beginning of crack initiation. Cracking was not observed in the first stage of this test program likely because it takes more than two weeks for Stress Corrosion Cracking to nucleate (ASTM E8-04). This may be a logical supposition as failure statistics showed that those failures that occurred within two weeks or more either involved a more complex chemistry in the contacting environment. Several references have included a general note suggesting that the use of a less severe test medium requires longer Stress Corrosion Cracking induction time in a laboratory environment. Khatak also noted that generation of Stress Corrosion Cracking when testing below 80°C demands sufficient patience from the investigator. However, an explanation or a definition as to how long of an actual incubation duration needed was not indicated in literature reviewed. The solution (3.5wt% NaCl solution prepared with normal water) used in this test program can be classified as non-aggressive, where the condition of 3.5wt% NaCl at room temperature for Austenitic stainless steel types 304, 310 & 316 is adjoining near to the boundary of the risky region producing pitting and Stress Corrosion Cracking. The test solution used was near-neutral and this further confirmed the "moderate" classification of this test solution.

The parameters used in the current test program, including the selection of test environment, material used, as well as certain equipment design criteria, which only used a test duration of about 70 days in total. In the current test paper in 3.5wt% NaCl solution at room temperature, neither pitting nor Stress Corrosion Cracking was observed at the first stage about 404 hours in all types. This discrepancy may be attributed to one or conjoint action of several factors. First, surface preparation of the specimens was different. Since Stress Corrosion Cracking is highly sensitive to the surface condition, this probably resulted in dissimilar susceptibility of Stress Corrosion Cracking. Stress Corrosion Cracking specimens used in reference has dimples marked for generation of residual tensile stresses. It was noted in that the strength of tensile stresses generated by the notches is probably much lower than specimens stressed under constant load, however, these dimples in the specimens may have provided a sheltering effect to promote the formation of a local aggressive environment, which encouraged localized attack. The indentations may also have broken the passive layer on the specimens and exposed fresh metal to the test environment. The stress on the specimen have been relatively large as they were mostly tested at 0.9 of the material's yield strength, but the pounding stress on the surface was likely compressive of tension as that of reference. Compressive residual stress resulting from machining of the measurement section may have a similar influence which is sometimes used to prevent surface defects. Even though the degree of effectiveness of surface compressive stress layer in the prevention of surface flaws is still controversial, it is uncertain here as to how much this surface condition may prohibit the induction of Stress Corrosion Cracking within the test duration. Stress Corrosion Cracking is generally less sensitive to stress level but more sensitive to environmental condition such as concentration of harmful species and temperature. Note that though pitting was noticed, Stress Corrosion Cracking was also absent in the same test condition (ASTM G30-97).

Another concern was that the corrosion reaction of the test chamber material may have resulted in interfering with the Stress Corrosion Cracking process that was aimed in this test program.

The test chamber was used not totally coated. Some studies used Teflon covering in its autoclave design, yet since the autoclave was made using stainless steel grade equivalent to UNS N08904, the Teflon liner was probably used for reduction in metal surface exposed to the test environment (if it was in contact with test medium). In the current test program, the situation is different. The chamber was made with mild steel and any coating deficiencies such as cracks can result in corrosion preference in the test chamber rather than corroding the stainless steel specimen.

The lack of Stress Corrosion Cracking in the constant load tests conducted may also due to the use of Austenitic Stainless Steels for testing. For example, 316 Austenitic Stainless Steel has addition of molybdenum which is accountable for the superior Stress Corrosion Cracking resistance and may lead to the long drawn out production period required. Materials that were made in more recent years may have better Stress Corrosion Cracking resistance due to the advancement in metal making process. Also, the potential during Stress Corrosion Cracking tests may not encourage pitting for the Austenitic Stainless Steels tested. Note that even though Stress Corrosion Cracking was not produced at first stage of 404 hours, this result is not in difference with other published results. From published results, cracks were observed only at a much elevated temperature than that used in the current test program which is room temperature, many of the tests where cracks were produced and conducted with a stress level higher than the yield strength of the Austenitic Stainless Steels tested (Canadian Regulated Pipelines, 2007).

The tensile tests conducted for obtaining the mechanical properties of the specimens did not reveal a lower strength probably due to the slightly higher nitrogen content that assisted in increasing the strength of the material as a result of give up carbon for weld ability. Typical nitrogen content in straight grade austenitic stainless steel is approximately 0.02wt%.

Recent discussion with suppliers of stainless steel components for the oil and gas industry has showed that only dual rated stainless steel materials that have the strength of the straight grade material and weld ability of the lower carbon grade are stocked. This additional nitrogen content in the dual-rated material may have helped in improving the Stress Corrosion Cracking resistance as nitrogen has a beneficial effect on pitting resistance, even though the extent of the benefit against Stress Corrosion Cracking from alloying such a small incremental amount of nitrogen is unknown. On the other hand, it is interesting to note that the nickel content of the materials, both the ones tested and those specified in ASTM A276, falls within the range of high susceptibility of chloride Stress Corrosion Cracking in the test environments used for generating. Note that the composition analysis for the materials used for the tests were done by SES, and results were shown in Table 2 completed.

Since all constant load tests conducted in 3.5wt% NaCl solution at room temperature did not generate Stress Corrosion Cracking at 404 hours, in order to verify that the equipment specifically designed can produce Stress Corrosion Cracking, more time was conducted as described later on.

Stress Corrosion Cracking of the specimen 304 notch area's surface was detected on the second stage (838 hours) of the 3.5wt% NaCl test despite of the 310 & 316 where no cracks appeared and at the same time, they cracks occurred in all specimens in 9.35wt% NaCl solution. Crack growth of the specimen 304 crack time to crack length on Figure 7 showed that a longer time-to-failure was recorded in this test comparing to the other test data in 9.35wt% NaCl solution. This longer failure time may be due to the following reasons:

As noted Stress Corrosion Cracking is highly sensitive to concentration of NaCl. The test conducted was carried out at a NaCl lower than the concentration of the other test solution. Different specimen configuration, surface preparation and other differences in test conditions may result in diffusion of data. Time-to-failure data was for straight grade 304 Austenitic Stainless Steel.

Nevertheless, the test conducted has proven that the equipment is capable of producing Stress Corrosion Cracking given a susceptible material-environment combination along with an exposure time that is long enough for crack to nucleate. Morphology by SEM of the cracked specimen from the 3.5wt% NaCl test illustrated typical Stress Corrosion Cracking characteristics indicating breakable behavior were observed on the notch surface, and yielding behavior was evidenced on the overload region. It is well known that hydrogen is closely related to Stress Corrosion Cracking. Hydrogen evolved during the process of Stress Corrosion Cracking can enter the specimen and cause brittle.

Such hydrogen embrittle may have occurred in this specimen as SEM examination showed cracks in region of the notch area. This shown that hydrogen brittle may have occurred, and that the metal may have been brittle as a result of hydrogen egress.
At the time of 1244 & 1678 hours, there were appearance of cracks on all specimens of Austenitic Stainless Steels 304, 310 & 316 on the notch surface area and were investigated by SEM as well in both NaCl solutions. Stress Corrosion Cracking growth, Weight Lost & their Morphology by SEM were obtained from all specimens in total time in both concentration 3.5wt% & 9.35wt% NaCl solutions.

Figure 7: Crack Growth of 304 Austenitic Stainless Steel in 3.5wt% & 9.35wt% NaCl Solutions.

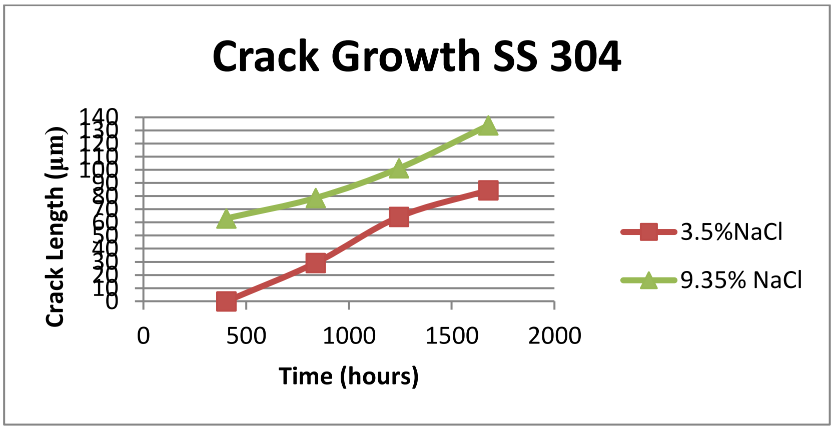


Figure 8: Crack Growth of 310 Austenitic Stainless Steel in 3.5wt% & 9.35wt% NaCl solutions.

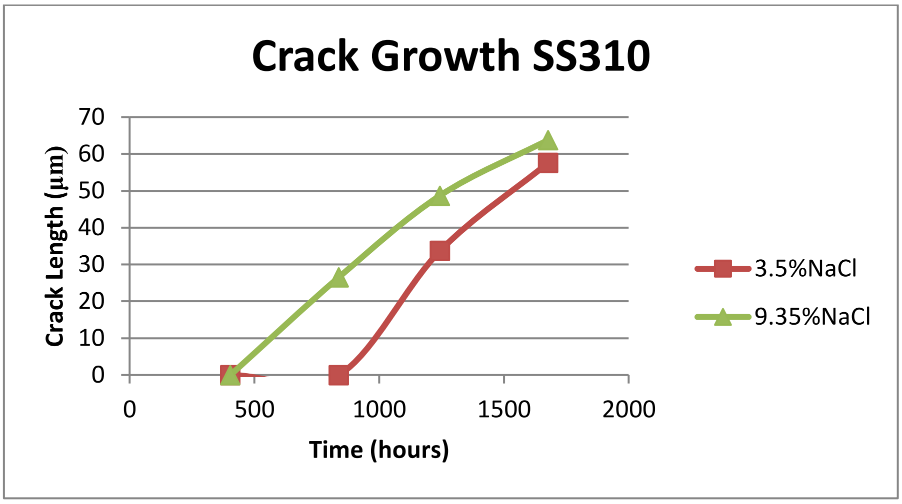
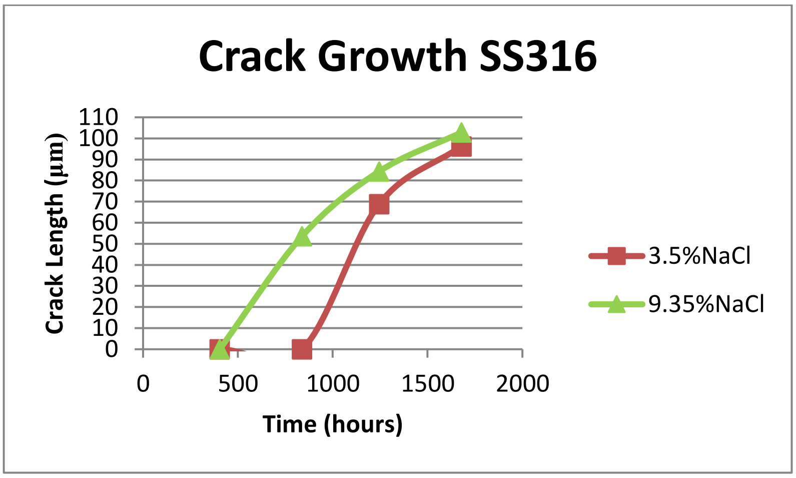


Figure 9: Crack Growth of 316 Austenitic Stainless Steel in 3.5wt% & 9.35wt% NaCl solutions.



Discussion

Morphology By Scan Electronic Microscopy (Sem)

SEM, it has the main rule to detect the cracks where available or observed on the notch surface area and this section, we will explain by the images the cracked or corrosive surfaces from each types of Austenitic Stainless Steels 304, 310 & 316.

In this section, we discuss SEM results based on Figures shown next for each specimen's morphology, showing which stages of experiment were no cracks or any SCC observed. Also some figures show pitting corrosion appearance in different stages of the experiment with no cracks or with cracks which give clue that crack might occur at any time according to the general mechanism of SCC. All those results has been summarized in results section as shown in Table 4.1 and a comparison between crack growth of 304, 310 & 316 Austenitic Stainless Steels in two different concentrations (3.5wt% & 9.35wt% NaCl) solutions as shown in Fig. 4.6 & Fig. 4.7.

Morphology of 304 Austenitic Stainless Steel in 3.5wt% & 9.35wt% NaCl solution

From the experimental part, we have observed cracks on the notch area surface of 304 Austenitic Stainless Steel in different stages in both NaCl solutions. At 404 hours in 3.5wt%NaCl, there was no crack and the crack initiated only in the second stage at the notch side of specimen in 3.5wt% NaCl solution.

On the other hand, cracks were observed from first stage in 9.35wt% NaCl solution and the initial crack length on the notch surface of SS304. It determined the final experimental stage at 1678 hours in 9.35wt% NaCl solution with the crack length at that stage and how rapidly increased comparing to the initial stage and we can notice also some pitting corrosion on the surface which explained the environment affect on the surface which is NaCl solution.

Figure 10: The crack length in initial stage SCC of SS304 in 9.35wt% NaCl in 404 hours.

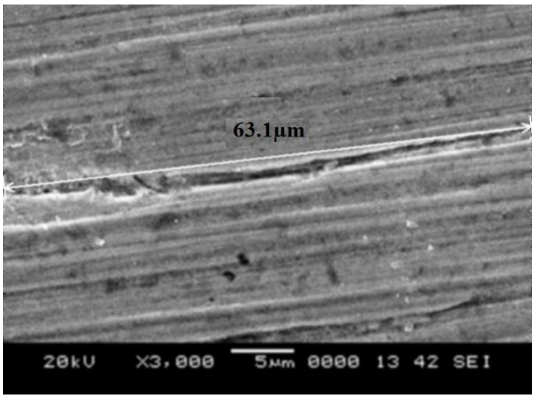


Figure 11: The crack length in 1678 hours SCC of SS304 in 9.35wt% NaCl solution.

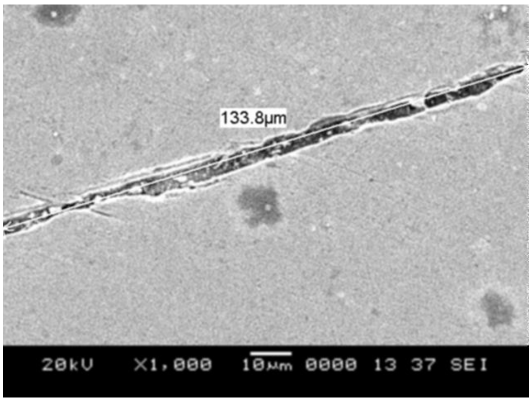
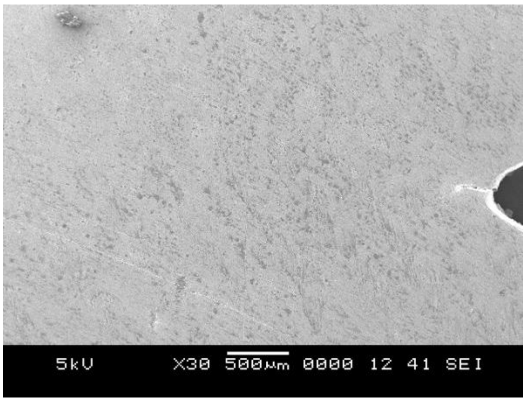
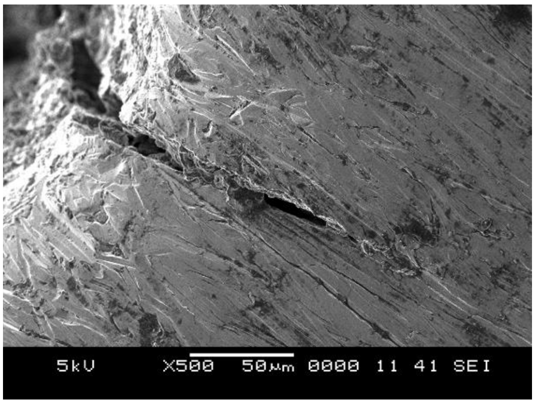


Figure 12: SCC appears on the notch side of SS304 in 838 hours 3.5wt% NaCl Solution.



The crack appearances of the austenitic stainless steels were observed by scanning electron microscopy. Figure 9 shows the crack appearances of type 304 austenitic stainless steel in the notch surface area at 3.5wt% NaCl solution. The crack was observed over the notch side. Type 304 austenitic stainless steel in notch surface area at 838 hours demonstrated the same crack appearance as those in Figure 10.

Figure 13: SCC of SS304 at the notch side in 838 hours in 3.5wt% NaCl Solution.



Conclusions

Extensive research has been conducted by many researchers, committed to exploring the occurrence of Stress Corrosion Cracking. The initiation mechanism for Stress Corrosion Cracking remains as an on-going research area. Stress Corrosion Cracking propagation mechanisms are available, yet no one mechanism can explain all observed characteristics of Stress Corrosion Cracking. Even though un-preferred, history has confirmed that manufacturing are often unaware of the existence of Stress Corrosion Cracking in their operating environment until the first failure occurs, and acknowledgment is gained from shocking experience. As equipment ages and provides sufficient time for production of unanticipated Stress Corrosion Cracking incidents, failures of equipment by Stress Corrosion Cracking may occur in all parts of the world (Natchitoches Pipeline Disaster, 2006).

A Stress Corrosion Cracking constant load test method was used. Two different tests were conducted related to chloride Stress Corrosion Cracking of 304, 310 & 316 Austenitic Stainless Steels in 3.5wt% & 9.35wt% NaCl solution in a room temperature environment. Though cracks were not produced during the first stage of the first experiment in 3.5wt% NaCl solution, this "no crack" result is still consistent in regards to some literatures and published data collected. The outcome of this test series does not mean that Stress Corrosion Cracking is resistant in the test condition used, instead, it demonstrated the difficulty in conducting Stress Corrosion Cracking research as testing under constant conditions can provide reproduction more closely associated to the actual environment (sea water & salt-flat) encountered in practice while enough patience and time is required to collect crack data for analysis. Keeping in mind that environmental cracks are usually accompanied with a large degree of distribution and variation in data, which calls for numerous specimens to be tested under the same condition to increase the certainties of the measurement achieved, it only further confirms the problems that researchers see every day in dealing with Stress Corrosion Cracking in general. The following conclusions could be drawn on the studies undertaken on the SCC of austenitic stainless steels immersed in 3.5wt% NaCl and 9.35wt% NaCl solutions.

All types of austenitic stainless steels' specimens are susceptible to stress corrosion cracking in both 3.5wt% & 9.35wt% natrium chloride solutions. Type 310 austenitic stainless steel is more resistance to SCC than 304 & 316 austenitic stainless steels in both natrium chloride concentrations throughout the experiment period studied. The susceptibility of these austenitic stainless steels to SCC is attributed to the aggressive constituents present in these solutions.

Crack length in type 316 austenitic stainless steel was longer than the other two types in the final stage of the test in 3.5wt% NaCl solution by about (96.2µm), despite of type 304 austenitic stainless steel crack length was the longest conducted at the final stage of 1678 hours in 9.35wt% NaCl solution by about (133.8µm).

The lowest crack growth was observed in type 310 austenitic stainless steel in both 3.5wt% & 9.35wt% NaCl solutions, and the type 316 austenitic stainless steel had the fastest crack growth in low test solution concentration of 3.5wt% NaCl between the second and final stages of the total time. On the other hand, the fastest crack growth was observed in high concentration of 9.35wt% NaCl solution in the type 304 austenitic stainless steel from the initial stage up to final stage of the total time.

Type 310 austenitic stainless steel is more susceptible to weight lost than the other two types (304 & 316) austenitic stainless steels in 3.5wt% NaCl solution. The susceptibility of 310 austenitic stainless steel to weight lost is mainly attributed to the presence of oxidization and dissolving of its elements such as Chromium and Nickel in 3.5wt% NaCl solution.

And those the objectives which were achieved such the investigation of Stress Corrosion Cracking and to analysis failure data on the incubation period and the total time to fracture of austenitic stainless steels types flooded in 3.5% and 9.35% NaCl solutions at room temperature. And conducting stress corrosion cracking tests to observe its initiation in each specimen of the three types of austenitic stainless Steels 304, 310 and 316 in both natrium chloride solutions.

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