EFFECTS OF CHEMISTRY AND OTHER VARIABLES ON CORROSION AND STRESS CORROSION CRACKING IN HANFORD DOUBLE-SHELL TANKS

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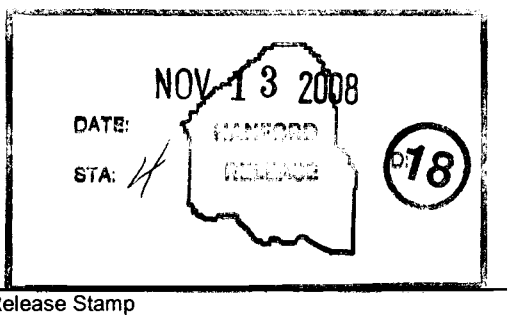
Abstract: Laboratory testing was performed to develop a comprehensive understanding of the corrosivity of the tank wastes stored in Double-Shell Tanks using simulants primarily from Tanks 241-AP-105, 241-SY-103 and 241-AW-105. Additional tests were conducted using simulants of the waste stored in 241-AZ-102, 241-SY-101, 241-AN-107, and 241-AY-101. This test program placed particular emphasis on defining the range of tank waste chemistries that do not induce the onset of localized forms of corrosion, particularly pitting and stress corrosion cracking. This document summarizes the key findings of the research program.



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EXECUTIVE SUMMARY

The Hanford reservation contains approximately 50-million gallons of liquid legacy radioactive waste from cold war weapons production that is stored in 177 underground storage tanks. Current plans call for vitrification of the waste and final disposal in a geologic repository at Yucca Mountain. The double-shelled carbon steel tanks presently used for storage will continue in operation until a vitrification plant is constructed and waste processing operations are completed. Due to various chemical reactions taking place inside the tanks, the waste chemistries will tend to change over time. Although the changes occur slowly, the waste compositions will be altered because of the current estimate for storage of waste, which goes beyond 2035.

In addition, the present chemistries for some of the tank waste types are no longer in specification with respect to corrosion mitigation (e.g., maintaining pH levels above 12). Thus, there is concern within the U.S. Department of Energy (DOE), oversight groups, and regulatory bodies that tank integrity may have been or may become compromised given these changes in chemistry. Furthermore, if tank integrity is potentially compromised, there is a need to define mitigation strategies. Additional resources would be required to mitigate potential leaks and conduct repairs. The objective of this work was to finalize the range of conditions where the tank steel is susceptible to localized corrosion and stress corrosion cracking (SCC) in the Double-Shell Tanks (DSTs) using primarily simulants of wastes stored in various tanks, in particular Tanks 241-AP-105, 241-SY-103 and 241-AW-105. The chemistries in these tanks cover a broad range of waste chemistries in the tank farm including low nitrate concentration wastes, low nitrite to nitrate ratio wastes, and wastes containing high halide concentrations. These tanks were specifically selected because they provide bounding compositions of aggressive ions. In addition, testing was conducted in simulants of wastes from Tank 241-AZ-102 and 241-SY-101 to test the impact of specific aggressive ions. Tank 241-AN-107 and Tank 241-AY-101 simulants were tested to complement results from previous corrosion studies with respect to carbonate SCC and pH impact on corrosion susceptibility, respectively. The work involved a series of cyclic potentiodynamic polarization (CPP), slow strain rate tests (SSRTs) and crack growth rate (CGR) tests in the waste simulants on a plate of American Association of Railways Tank Car (AAR TC) 128 Grade B steel, which is believed to have similar properties to the waste tanks.

Based on the work conducted, the key findings of the research are listed below.

- The SCC potency of the waste simulants for the three tanks studied followed the trends previously established for nitrate-based simulants. SCC only occurred at relatively high applied potentials (e.g., 0 mV vs. SCE) or at low nitrite/nitrate concentrations ratios.

- Limited CGR testing performed in AY-101 simulants indicated that stress intensity factors above 45 ksi$\sqrt{in}$ were necessary for crack propagation to occur in the waste simulants tested.

- Though at current tank conditions the Present Supernate Composition (PSC) simulant for tank 241-AP-105 (AP-105-PSC) showed a low propensity for corrosion, the tank steel exposed to the Tank AP-105-PSC simulant at elevated temperatures and under anodically

polarizing conditions demonstrated a susceptibility to SCC and localized corrosion at the liquid/vapor interface. Long-term immersion tests indicated that the steel was susceptible to corrosion at the liquid/vapor interface even at open circuit potential (OCP), but the extent at room temperature was not as severe as at elevated temperatures (e.g., 50°C). The AP-105-PSC is the only simulant in which SCC was observed in a SSRT performed at OCP. Local chemistry changes (nitrite depletion or pH drop) may be responsible for the interfacial attack, though the precise mechanism is unclear at this time. The liquid/vapor interface attack indicates that localized corrosion is possible in simulants with high pH, and this should be considered in any future corrosion mitigation strategies.

- The Present Interstitial Liquid (PIL) for Tank 241-SY-103 (SY-103-PIL) simulant, which has the upper limit of chloride concentration of the DSTs, appears to be benign with respect to corrosion and SCC relative to the AP-105-PSC and previously tested Tank 241-AN-107 simulants and the PIL for Tank 241-AY-102 (AY-102PIL) simulant. Any possible corrosion liability associated with the high chloride content, appears to be offset by the relatively high nitrite content.

- The PIL for Tank 241-AW-105 (AW-105-PIL) simulant, which has the upper limit of fluoride concentration, also appears to be benign with respect to tank steel SCC. However, some localized corrosion has been observed at the liquid/vapor interface.

- The AZ-102 simulant, tested at the higher temperature of 77°C, appears to be benign with respect to SCC, confirming the inhibitory nature of nitrite. The AZ-102 simulant has a high nitrite/nitrate ratio of 8.4.

TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF FIGURES

LIST OF TABLES

LIST OF TERMS

Abbreviations and Acronyms

AAR TC	American Association of Railways Tank Car
ASTM	American Society for Testing and Materials
CGR	Crack Growth Rate
CPP	Cyclic Potentiodynamic Polarization
CT	Compact Tension
DCPD	Direct Current Potential Drop
DI	Deionized
DOE	U.S. Department of Energy
K_{ISCC}	Stress intensity factor for stress corrosion cracking
K_{th}	Threshold stress intensity factor
K_{thSCC}	Threshold stress intensity factor for stress corrosion cracking
OCP	Open Circuit Potential
PIL	Present Interstitial Liquid
PSC	Present Supernate Composition
SCC	Stress Corrosion Cracking
SCE	Saturated Calomel Electrode
SEM	Scanning Electron Microscope
SSR	Slow Strain Rate
SSRT	Slow Strain Rate Test
TIC	Total Inorganic Carbon

Units

°C	degrees Celsius
°F	degrees Fahrenheit
h	hour
in.	inch
ksi	kilopounds per square inch
ksi$\sqrt{in}$	ksi square root inch
M	molarity
mM	milli-molar
mV	millivolt
sec	second

1.0 INTRODUCTION AND BACKGROUND

The Hanford tank reservation contains approximately 50 million gallons of liquid legacy radioactive waste from cold war weapons production that is stored in 177 underground storage tanks. Current plans call for vitrification of the waste and final disposal in a geologic repository at Yucca Mountain. The carbon steel DSTs presently used for storage will continue in operation until a vitrification plant is constructed and waste processing operations are completed.

The waste chemistries in the storage tanks are grouped according to their main constituents, such as nitrite/nitrate-based and carbonate-based chemistries. Most of the wastes are highly alkaline in nature, typically with pH values between 12 and 14. Under alkaline conditions, carbon steels will tend to be passive and undergo relatively slow rates of uniform corrosion. However, carbon steels can become susceptible to localized corrosion (e.g., pitting) and SCC in the presence of certain aggressive constituents, such as chloride and nitrate, even in these passive conditions[1]. The original Single-Shell Tanks (SSTs) at Hanford experienced some SCC failures because of the presence of high concentrations of nitrate in the waste and high residual stresses near the welds in the tanks. Research at Hanford and Savannah River Laboratories demonstrated that cracking could be prevented by post weld heat treating the tanks and maintaining the waste at a high pH (>13), which were practices incorporated into construction and operation of the tanks respectively. Although most wastes stored in the DSTs are currently within specification and will remain within specification for the next 20 years, there will be cases in which the chemistry will be out of specification (i.e., pH levels below 12). This transformation is a result of waste chemistries changing over time due to various chemical reactions taking place inside the tanks. These out of specification conditions could also develop during waste transfer and mixing operations. Thus, there is concern within DOE, oversight groups, and regulatory bodies that tank integrity could be compromised given these chemistry changes. If tank integrity is threatened, there is a need to define mitigation strategies. Additional resources would be required to mitigate potential leaks as well as conduct repairs.

Thus far, research has been conducted with waste simulants for Tanks 241-AN-107 (AN-107), 241-AN-102 (AN-102), 241-AY-101 (AY-101) and 241-AY-102 (AY-102) using the simulants developed for the wastes in these tanks. The AN-107, AN-102, and AY-101 simulants have nitrate-based chemistries with high concentrations of nitrite and nitrate (typically > 1.3M nitrate). The AY-102 stimulant has a carbonate-based chemistry as the carbonate concentration is considerably higher than the nitrite and nitrate concentrations (typically in the order of 1 M carbonate, vs. mM nitrate concentration).

Research conducted at CC Technologies in AN-107[2] simulants revealed that a nitrite concentration above 1M considerably reduced the susceptibility of carbon steel to pitting corrosion and SCC. Although the current pH value of the interstitial liquid in the salt cake/sludge in AN-107 is out of specifications (pH 11 rather than 13), the laboratory testing demonstrated that the pH did not have a significant impact on either localized corrosion or SCC

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[1] R. N. Parkins, and R. Usher, *The Effect of Nitrate Solutions in Producing Stress Corrosion Cracking in Mild Steel*, Proceedings Frist International Congress on Metallic Corrosion. London, U.K.: Butterworths (1962): 296-302.

[2] Hanford Tanks 241-AN-107 and 241-AN-102: *Effect of Chemistry and Other Variables on Corrosion and Stress Corrosion Cracking*, CC Technologies Inc, September 8, 2006.

of carbon steel in the range of 10 to 13.5. SCC was commonly observed at an applied potential of -100 mV (vs. SCE) or above. This potential range is more positive than the OCP of the steel in the simulants. Furthermore, the concentration of the corrosion and SCC inhibitor nitrite is gradually increasing in the AN-107 waste from the initial concentration of 1.2M to 2.3M in the predicted endpoint chemistry. Thus, the tank chemistry in AN-107 is self-inhibiting owing to the increasing nitrite concentration with time. The implication of this research is that adjustments to the pH of the interstitial liquid in the salt cake/sludge to high levels is unnecessary (specifications stipulate pH between 12 and 14). Applications of these findings to interstitial liquid was immediate, but changes to control of the supernate liquid will only be possible if it can be shown that corrosion at the liquid/air interface and vapor space will be unaffected.

The work in AY-101[3] and AY-102[4] simulants indicated that these chemistries were largely benign with respect to localized corrosion. As with the AN-107 simulants, nitrite is a potent inhibitor to localized corrosion for these simulants. In nitrate-based AY-101, SCC was observed only at relatively high applied potentials (e.g., 0 mV vs. SCE). In carbonate-based AY-102, however, SCC was observed both at high potentials (0 mV vs. SCE) and at potentials near -800 mV vs. SCE where an active-passive transition was noted on CPP curves. Fortunately, corrosion potential monitoring of steel in the carbonate-based simulants suggested that the OCP of the steel will be far more positive than -800 mV vs. SCE. These results indicated the necessity to monitor the corrosion potential of the tank wall.

In the present work, the localized and SCC corrosion behavior of steel in waste simulants for Tanks 241-AP-105 (AP-105), 241-SY-103 (SY-103), 241-AW-105 (AW-105), 241-AZ-102 (AZ-102), 241-SY-101 (SY-101), AN-107 and AY-101 were investigated. The AP-105- PSC contains high nitrate (3.58 M) and low nitrite (0.27 M) concentrations. It has the lowest nitrite–to-nitrate concentration ratio among all simulants that have been investigated thus far. The SY-103 and AW-105 PILs (SY-103-PIL and AW-105-PIL) represent wastes with bounding chloride (0.5 M) and fluoride (0.58 M) levels, respectively. Chloride is known to contribute to pitting behavior in steels. Fluoride is expected to be detrimental to the tank steel as well. The AW-105 simulant has low nitrite (0.12 M) and nitrate (0.42 M) concentrations, whereas the SY-103 simulant is high in both nitrite (2.91 M) and nitrate (1.97 M). These differences are expected to have a significant influence on the corrosion and SCC behavior of the tank steel. The various chemistries of simulants investigated in this work are listed in Table 1 and compared with other chemistries studied previously.

The SY-101 simulant also has a low nitrite-to-nitrate concentration ratio and raised a concern for the susceptibility of the tank steel to localized corrosion and SCC. The AN-107 simulant was previously studied to examine its propensity for corrosion. The simulant was investigated to test susceptibility to carbonate SCC because of the high carbonate concentration of 1.4 M. The AZ-102 simulant represents a tank chemistry at the other extreme: the nitrite-to-nitrate ratio is a relatively high 8.4, with a nitrate content of 0.105 M and a nitrite content of 0.883 M. The

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[3] Hanford Tank AY-101: *Effect of Chemistry and Other variables on Corrosion and Stress Corrosion Cracking*, CC Technologies Inc, January 2008.

[4] Hanford Tanks AY-102 and AP101: *Effect of Chemistry and Other Variable on Corrosion and Stress Corrosion Cracking*, CC Technologies, September 7th 2007.

supernate and interstitial liquid in Tank 241-AY-101 was investigated in previous programs. In this work, the condensate surface layer (CSL) in Tank AY-101 (AY-101-CSL), which has a relatively low nitrite-to-nitrate ratio (0.2), was studied.

This report summarizes the results obtained for the chemistries described above. The scope of the test program includes a series of CPP, SSRTs, and CGR tests on a plate of AAR TC 128 Grade B steel. AAR TC128 Grade B steel has similar properties to the steels used in constructing the DSTs.

The results from this work in conjunction with those obtained in other previous research programs for other tanks will help expand understanding of the roles of nitrite and nitrate (both absolute concentrations and ratio), and the roles of high chloride and fluoride in the corrosion process. Based on these results, strategies may be formulated about possible mitigation schemes.

Table 1. A List of the Concentrations of the Main Constituents in Different Simulants.

Acronym	Simulant	AlO_2^-	SO_4^{2-}	NO_2^-	NO_3^-	TIC	Cl^-	F^-	OH^-	pH
AY-102-PIL	Present Interstitial Liquid	0.002	0.018	0.001	0.002	1.021	0.004	0.003	0.001	11
AP101-TSC	Transferred Supernatant Composition	0.31	0.029	0.98	2.13	0.47	0.05	0.09	2.61	14+
AY-102-CSC	Combined Supernatant Composition	0.29	0.028	0.938	1.967	0.477	0.046	0.084	2.42	14+
AY-102-ACS	Aged Combined Supernatant	0.29	0.028	1.27	1.635	1.118	0.046	0.084	1.24	14+
AY-102-AIL	Aged Interstitial Liquid	0.002	0.009	0.001	0.002	0.935	0.004	0.003	0.001	11
AY-102-ATL	Aged Total Liquid	0.37	0.027	1.20	1.532	1.242	0.043	0.079	0.96	14+
AY-101-PIL	Present Interstitial Liquid	-	0.305	0.847	0.057	1.842	0.011	0.068	0.001	11
AY-101-PSC	Present Supernatant Composition	0.107	0.020	0.205	1.33	0.201	0.018	0.014	0.71	13+
AP-105-PSC	Present Supernatant Composition	0.15	0.047	0.270	3.58	0.326	0.03	0.009	0.18	13+
SY-103-PIL	Present Interstitial Liquid	2.06	0.017	2.91	1.97	0.123	0.50	-	2.43	14
AW-105-PIL	Present Interstitial Liquid	0.02	0.014	0.12	0.42	0.097	0.01	0.58	0.45	13+
AP-105-Mixed	Mixed Simulant	0.195	0.04	0.413	2.857	0.274	0.039	0.026	0.95	13+
AP-105-Evaporated	Evaporated Simulant	0.347	0.072	0.736	5.087	0.489	0.069	0.047	1.67	14
AZ-102	AZ-102 Simulant	0.007	0.186	0.883	0.105	0.619	-	0.0520	-	12+
AW-105-PSC	Present Supernate Composition	0.0065	0.005	0.064	0.44	0.108	0.008	0.156	0.26	13+
SY-101	SY-101 Simulant	0.1407	0.02	0.203	0.931	0.133	0.023	0.028	0.66	13+
AY-101-CSL	Condensate Surface Layer	0.0153	0.002	0.037	0.181	0.147	0.006	0.002	0.005	11.82

2.0 EXPERIMENTAL APPROACH

2.1 MATERIALS AND SPECIMENS

All test specimens were fabricated from a 2'×2'×1" as-supplied plate of AAR TC Grade B steel. This is similar in composition and mechanical properties to the A515 Grade 60 steel used in the Hanford AY-101 double-shelled underground storage tank construction. The plate was supplied to CC Technologies by ARES Corporation. Chemical and mechanical specifications for AAR TC 128 Grade B tank car steel are shown in Table 2 and Table 3, respectively; however, no efforts were made to confirm these values. Figure 1 (a) shows a photomicrograph of the AAR TC128 Grade B Tank Car Steel used in this investigation. This steel was also used in previous AY-102, AP101, and AY-101 work. For comparison, Figure 1 (b) shows the microstructure of the American Society for Testing and Materials (ASTM) A537 Class 2 steel used previously for Tank 241-AN-105 and AN-107 work. The most significant difference between the two microstructures is the presence of pearlite bands in the tank car steel which is commonly observed in hot rolled steels.

Table 2. Chemical Specifications for AAR TC128 Grade B Tank Car Steel.

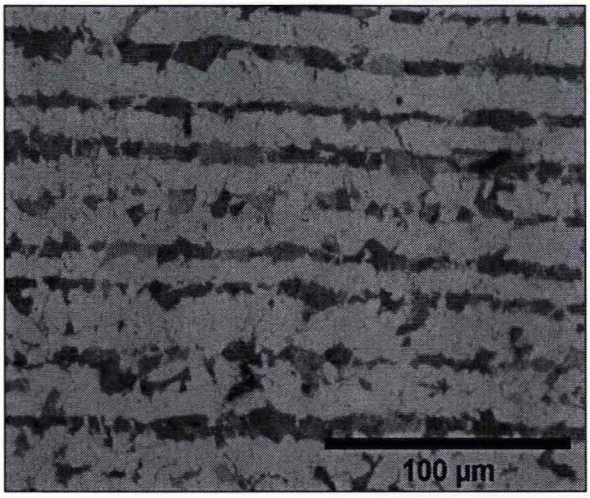
	Element						
	C	**Mn**	**P**	**S**	**Si**	**Cu**	**Fe**
Max.	0.50	1.35	0.040	0.05	0.30	0.35	balance
Min.	--	--	--	--	--	--	--

Table 3. Mechanical Specifications for AAR TC128 Grade B Tank Car Steel.

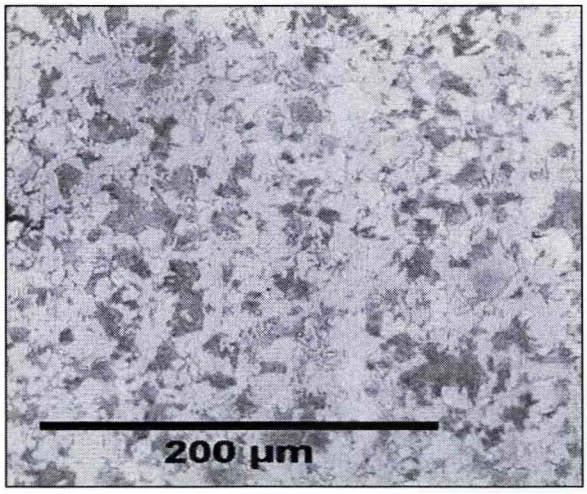
	Ultimate Tensile Strength (psi)	**0.2% Offset Yield Strength (psi)**	**Elongation in 2" (%)**
Max.	101,000	--	--
Min.	81,000	50,000	21.0

Figure 1. Photomicrographs of (a) the Microstructure of the AAR TC 128 Grade B Tank Car Steel Used for the Current Work and Previous AY-102 and AP101 Work, and (b) the Microstructure of the ASTM A537 Class 2 Steel used for Previous AN-105 and AN-107 Work.

(a)



(b)



Three main specimen geometries were utilized in this work. A schematic representation of the CPP specimens, SSRT specimens, and CGR specimens are shown in Figure 2 , Figure 3, and Figure 4, respectively. The specimens were fabricated by Metal Samples Company in Munford, AL and Metcut Research, Inc., in Cincinnati, Ohio. Material close to the flame cuts at the edges of the plates was avoided for specimen fabrication to ensure consistent microstructures. SSRT specimens were fabricated such that the longitudinal axis was aligned with the plate rolling direction (i.e., longitudinal orientation). Compact tension (CT) specimens were fabricated such that the pre-crack was in the plate rolling direction (i.e., transverse-longitudinal orientation).

Figure 2. Engineering Drawing of the Cyclic Potentiodynamic Polarization (CPP) Specimen (Units in Inches).

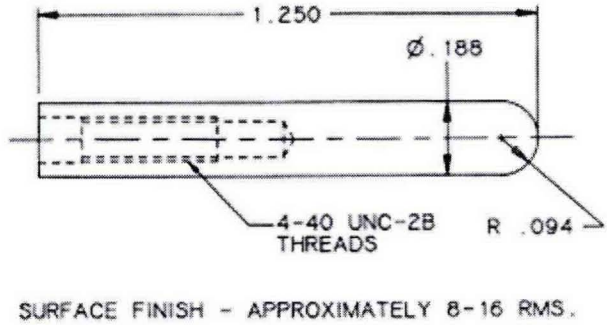


Figure 3. Engineering Drawing of the Slow Strain Rate Test Specimen (Units in Inches).

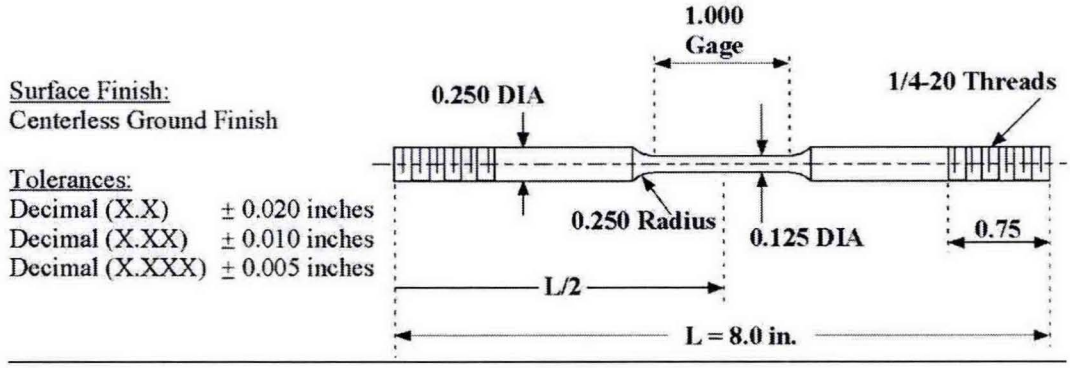
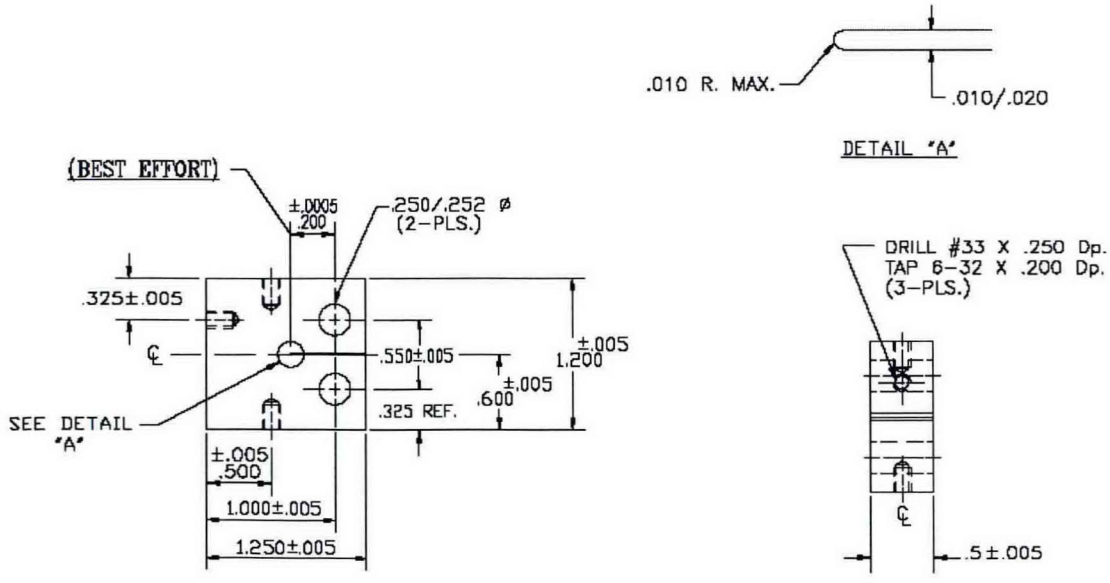
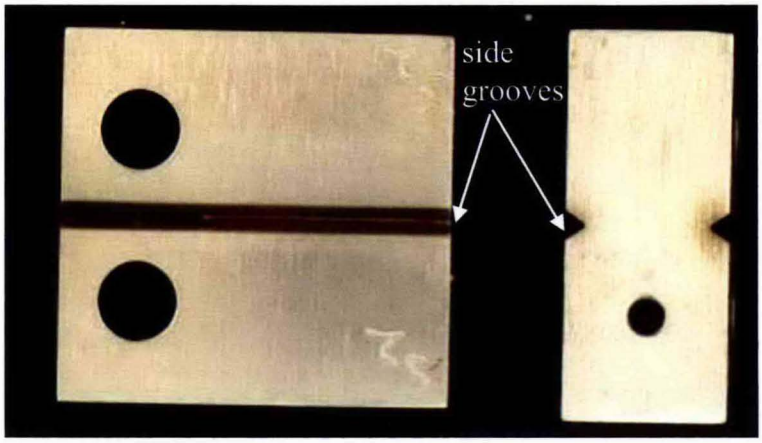


Figure 4. Engineering Drawing of the Crack Growth Rate Specimen (Units in Inches).



The dimensions of the CT specimens shown in the figure below are a standard size, and consistent with the dimensions used for CT samples in previous constant load experiments. Constant displacement rate tests previously used were again employed to determine the CGR and the threshold stress intensity for SCC (K_{thSCC}). All specimens were side-grooved (Figure 5) following the guidelines provided in ASTM E1820-06e1[5] to ensure crack growth did not diverge significantly from the pre-crack direction and to promote plane strain conditions. This standard recommends a total reduction in cross-section of the crack plane of 20% of the width of the test sample, with an included angle of 90° or less, and a root radius of <= 0.02 ±0.01 in. Figure 5 shows a digital photograph of the CT sample machined with side-grooves.

Figure 5. A Photograph of One of the CGR Specimens Following Side-Grooving.



2.2 CHEMICALS AND SOLUTIONS

The chemistries used in this work with AP-105, SY-103 and AW-105 were "present" chemistries. The aged chemistries for the tanks studied are not expected to be significantly different from the present chemistries due to the small concentration of organic carbon compounds (0.05M). That is, the oxidation of organic carbon compounds, when present at such low quantities, will not significantly alter the carbonate, hydroxide, nitrate, or nitrite concentrations. The presence and concentration of these species are believed to play critical roles in the corrosivity of the simulants.

As stated previously, the simulants that were chosen for evaluation were selected to bind the effects of various tank chemistry compositions, such as the effects of chloride, fluoride, and nitrite/nitrate ratio. All of the simulants are considered chemically stable and did not require continuous agitation prior to being used. The pH of each simulant was adjusted after initial mixing using either sodium hydroxide (Noah), or nitric acid (HNO_3) or acetic acid (CH_3COOH). If the difference between the measured pH and the target pH was large, nitric acid was favored over acetic acid; however, acetic acid was most commonly used because of the small adjustments that were typically required.

[5] ASTM E1820-06e1, 2006, *Standard Test Method for Measurement of Fracture Toughness*, American Society for Testing and Materials, ASTM International, West Conshohocken, PA.

For each simulant a standard chemistry and several modified chemistries were often investigated. The standard chemistry was used to establish the baseline localized corrosion and SCC behavior. The modified chemistries were used to explore the role of certain species, such as nitrite, nitrate, and sulfate, on the localized corrosion and SCC behavior of the material. The chemicals used to mix the baseline simulants (i.e., without modifications) as well as the concentrations used are listed in Table 4. The rows containing some of the key species of interest are shaded. Note that in some cases simulants were mixed using the baseline chemistry, and then pH balanced. The pH balance will change the hydroxide concentration, and influence the proportions of carbonate and bicarbonate present in the solution.

3.0 OPEN CIRCUIT POTENTIAL MONITORING, POTENTIOSTATIC AND CYCLIC POTENTIODYNAMIC POLARIZATION TESTING

CPP testing was performed according to the guidelines set forth in ASTM G61-86e1.[6] Samples were either fully immersed or partially immersed in the simulants. When the samples were partially immersed, a liquid/vapor interface was created so that the corrosion phenomena at the interface could be investigated.

Prior to testing, the specimens were prepared to a 600 grit surface finish, ultrasonically cleaned with isopropanol for five minutes, rinsed with DI water, and then dried with nitrogen. Prior to introducing the specimen to the test cell, the test solution was added. In cases where testing above room temperature was conducted, the solution was then heated to the desired temperature (50°C [122°F] or 77°C [170°F]). The test solution was then purged with the desired test gas for approximately one hour prior to specimen introduction and testing unless the test was conducted under quiescent conditions. A saturated calomel electrode (SCE) was usually used as the reference electrode with a salt bridge to separate the reference electrode from the testing environment. This was done so that the reference electrode could be maintained at room temperature. In a few limited cases, a Ag/AgCl wire reference electrode was used. For tests where polarization was required, a platinized niobium wire was used as the counter electrode.

The OCP, CPP, and potentiostatic tests were performed under two different conditions – (1) quiescent in air conditions (i.e., no gas purging and the cell was open), (2) gas purging conditions (nitrogen, high purity Ar or compressed "zero" air containing no CO_2). In a set of long-term immersion tests to investigate the susceptibility of the steel to interfacial corrosion in the AP-105-PSC simulants, the head space of the cell was blanketed with compressed "zero" air (no CO_2), nitrogen or argon so that the mixing of the interface chemistry with the bulk solution could be minimized. The quiescent conditions and compressed air purging aimed to provide oxygen to the simulants, and in many cases were used to investigate the role of oxygen in both CPP and corrosion at the liquid/vapor interface. Nitrogen and argon purging were used to maintain deaerated conditions (i.e., the oxygen reduction reaction was minimized or eliminated). For the deaerated experiments the cathodic reactions were dominated either by other reducible species in the solution (i.e., nitrite or nitrate) or water reduction (assuming the potential was sufficiently negative).

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[6] ASTM G61-86e1, 2003, *Standard Test Method for Conducting Cyclic Potentiodynamic Polarization Measurements for Localized Corrosion Susceptibility of Iron-, Nickel-, or Cobalt-Based Alloys*, American Society for Testing and Materials, ASTM International, West Conshohocken, PA.

Table 4. The Concentrations of Chemicals Used in Preparation of the Simulants.

Chemical	Formula	AP-105-PSC	AP-105-Mixed	AP-105-Evaporated	SY-103-PIL	SY-101	AW-105-PIL	AW-105-PSC	AZ-102	AY-101-CSL
		Molarity (M)	Molarity (M)	Molarity (M)	Molarity (M)	Molarity (M)	Molarity (M)	Molarity (M)	Molarity (M)	Molarity (M)
Sodium Aluminate	$NaAlO_2.2H_2O$	0.15	0.195	0.3470	2.06	0.1407	0.0160	0.0065	0.0070	0.0153
Sodium Chloride	NaCl	0.0308	0.039	0.0690	0.4960	0.0228	0.0102	0.0083	-	0.0064
Sodium Fluoride	NaF	0.0091	0.026	0.0470	-	0.0277	0.5810	0.156	0.0520	0.0015
Sodium Chromate	Na_2CrO_4	0.0106	0.008	0.0140	0.0010	0.0021	0.0002	0.00004	0.0130	0.0003
Sodium Phosphate, 12-Hydrate	$Na_3PO_4.12H_2O$	0.0301	0.03	0.0530	0.0275	0.0984	0.0032	0.0045	-	0.0059
Potassium Nitrate	KNO_3	0.0133	0.13	0.23	0.1280	0.0069	0.2180	0.1444	0.0710	-
Sodium Sulfate	Na_2SO_4	0.0472	0.04	0.072	0.0167	0.0196	0.0139	0.0053	0.1860	0.0021
Sodium Formate	NaHCOO	0.0100	0.0115	0.016	0.1880	-	0.0033	0.0021	-	-
Sodium Acetate Trihydrate	$NaCH_3COO.3H_2O$	0.0075	0.0105	-	0.0439	-	0.0062	0.0023	-	-
Sodium Oxalate	$Na_2C_2O_4$	0.0075	0.0115	0.016	0.0044	0.0244	0.0032	0.0017	0.0170	0.0014
Sodium Nitrate	$NaNO_3$	3.5644	2.727	4.857	1.8400	0.9244	0.2010	0.2956	0.0340	0.1810
Sodium Nitrite	$NaNO_2$	0.2700	0.413	0.736	2.9100	0.2027	0.1240	0.0638	0.8830	0.0368
Sodium Carbonate	Na_2CO_3	0.3260	0.274	0.489	0.1230	0.1328	0.0966	0.1076	0.6070	0.147
Glycolic Acid	$C_2H_4O_3$	0.0075	0.0115	-	0.0334	-	-	0.0010	-	-
Sodium Hydroxide	NaOH	0.1761	0.952	1.67	2.43	0.6555	0.4502	0.2630	-	0.0051
Cobaltous Nitrate	$Co(NO_3)_2$	-	-	-	-	-	0.0000242	-	-	-
Nickel Nitrate	$Ni(NO_3)_2$	-	-	-	-	-	0.00007	-	-	-
Boric Acid	H_3BO_3	-	-	-	-	0.0008	0.0006	0.0003	-	-
Potassium Molybdate	K_2MoO_4	-	-	-	-	-	0.00003	0.00001	0.0005	-
Zirconyl Nitrate	$ZrO(NO_3)_2$	-	-	-	-	-	0.0000049	-	-	-
Tributyl phosphate	$C_{12}H_{27}O_4P$	-	-	-	-	-	0.0049	-	-	-
1-Butanol	C_4H_9OH	-	-	-	-	-	0.0125	-	-	-
Dibutyl Phosphate	$C_8H_{19}O_4P$	-	-	-	-	-	0.0125	-	-	-
Ammonium Acetate	NH_4CH_3COO	-	0.0040	0.008	-	-	-	-	-	-
Iron Nitrate, 9-Hydrate	$Fe(NO_3)_2.9H_2O$	-	-	0.00002	-	-	-	-	-	-
Zinc Nitrate, 6-Hydrate	$Zn(NO_3)_2.6H_2O$	-	-	0.00007	-	-	-	0.00003	-	-
Sodium Bicarbonate	$NaHCO_3$	-	-	-	-	-	-	-	0.0120	-

Prior to CPP and potentiostatic testing, the OCP was monitored for 18 hours. The start potential for the CPP tests was -100 mV vs. OCP. The scan was reversed at 1V vs. SCE or if the current reached $1mA/cm^2$. A scan rate of 0.17mV/s (0.6 V/h) was used. For the potentiostatic testing, the sample was polarized to an anodic potential for the desired amount of time.

When a test was completed, the specimen was removed from the test solution, rinsed with deionized (DI) water, and then dried with nitrogen gas. If visible corrosion products were present on the specimen surface, the specimen was ultrasonically cleaned in acetone for five minutes, rinsed with DI water, and dried with nitrogen. The post-test appearance of the specimen was photographically documented to show any evidence of corrosion attack. In some cases, the test specimen was examined using a scanning electron microscope (SEM) in addition to examination using optical stereomicroscopy. Finally, the tested specimens were stored in separate specimen bags in a desiccator for possible further analysis.

3.1 SLOW STRAIN RATE TESTING

All SSRTs were performed according to the guidelines provided in ASTM G129-00[7] using cylindrical tensile specimens at a constant extension rate of 10^{-6} in/in-s (unless otherwise noted). To perform the tests, the specimen was placed in a Teflon®[8] test cell and the load was applied using grips that entered the cell through sliding seals. This assembly was then inserted into the load frame, after which the solution of interest was introduced and heated to 50 °C. Tests were conducted at open circuit or at an applied potential against a SCE reference electrode that was maintained at room temperature using a Luggin probe/salt bridge filled with the test solution. A platinum flag was used as a counter electrode. All of the SSRTs were performed under quiescent air conditions; i.e., exposed to air with no gas sparging.

The test specimens were pulled to failure. The stress-strain curves provided in the following results sections are for reference purposes. However, the time-to-failure and the strain-at-failure of the specimens did not always clearly indicate the presence of SCC. Also, the degree of SCC was not easily established from these parameters. Therefore, the occurrence of SCC was always confirmed by both visual inspection and SEM examination. Examination of the specimens after failure consisted of examination in a stereographic optical microscope at 10 – 63x, and a SEM. The fracture surface of each of the test samples was examined using the SEM to identify regions of intergranular fracture, indicative of high pH SCC.

3.2 K_{thSCC} AND CRACK GROWTH RATE TESTING USING COMPACT TENSION SPECIMENS

K_{thSCC} and CGR tests were performed using pre-cracked ½-T (0.5 inch wide) CT specimens (Figure 5). The objective of these tests was to determine the K_{thSCC} for the steel in various

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[7] ASTM G129-00, 2006, *Standard Practice for Slow Strain Rate Testing to Evaluate the Susceptibility of Metallic Materials to Environmentally Assisted Cracking*, American Society for Testing and Materials, ASTM International, West Conshohocken, PA.

[8] Teflon® is a registered trademark of DuPont in the United States and other countries.

simulants. The K_{thSCC} could then be related to the maximum K_I expected for a variety of flaw sizes in the tank. This would aid in the determination as to whether or not there is an integrity concern for the tank. The CGRs estimated in these tests can also be used to approximate the time for any growing flaw to go through-wall. The term K_{thSCC} refers to a "threshold." The term K_{ISCC} is not used because the test procedure utilized for this investigation does not satisfy the requirements of ASTM E1820. In particular, samples were not wide enough to ensure plane strain conditions, which are necessary for a valid K_{ISCC} determination.

Previous tank chemistry studies had been performed using a constant tensile load. Constant tensile load testing was not performed in the current investigation because of the difficulties associated with the determination of K_{thSCC} in tank waste simulants with this technique. Results from previous testing showed some inconsistencies in estimated K_{thSCC} from the different tests. In some cases, direct current potential drop (DCPD) indicated negative crack growth due to build up of corrosion product in the crack mouth. To avoid the difficulties, the approach was modified to a "dynamic-K" test. The dynamic K-tests were initiated with a constant displacement rate rather than a constant load. At the onset of cracking or a predefined K, the displacement was held constant for several weeks or months. Tests were concluded when evidence of crack growth and a declining K were observed or a sufficient length of time had elapsed (~5 months) to imply no cracking in the test sample. The advantage of the technique is that both K_{thSCC} and CGR can be estimated from the same test data, provided that some crack growth occurs during the test.

The dynamic-K tests were performed using the same loading frames as those used in the SSRTs. The dynamic-K tests were run at approximately 5×10^{-8} in/s, which was substantially slower than the nominal extension rate of 10^{-6} in/s used for SSRTs. The time frame for the dynamic load experiments ranged from several weeks to several months because of the slow loading rate to a specified K value and longer hold time. Comparatively, the constant load tests typically concluded within 30 days.

Dynamic-K experiments were conducted at 50°C in Teflon cells that contained the desired solutions. Tests were carried out either at open circuit or an applied potential. The OCPs were continuously monitored with a high impedance voltmeter and a reference electrode (SCE). The reference electrode was maintained at room temperature in a separate container that was connected to the test cell by means of a Luggin probe/salt bridge filled with the test solution. For the tests at applied potential, a platinum flag counter electrode was included in the test cell while a potentiostat was used to maintain the potential at the desired value.

The applied load and displacement for the test samples were monitored and recorded continuously throughout the experiments. Additionally, the DCPD was monitored as a means to estimate crack growth *in situ*. The DCPD technique involves the application of a constant current (in this case 20A) through the specimen while the potential drop across the two sides of the crack is recorded. Any crack propagation during the test will increase the resistance across the sample and this will be reflected by a change in potential drop. The increase in crack length is calculated from the potential drop and sample geometry using the Johnson equation[9].

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[9] Johnson, H. H. "Calibrating the Electric Potential Method for Studying Slow Crack Growth," Materials Research and Standards, Volume 5, No 9, September 1965, pp 442-445.

To monitor crack propagation and growth, both the DCPD measurements and load measurements were used. A significant DCPD (beyond the noise in the data) was interpreted as crack growth. A reduction in the loading rate during loading or a reduction in load during the hold time was also interpreted as crack growth, as it indicates an increase in specimen compliance. Tests were carried out until cracking was detected by load and/or DCPD measurements or until a predefined limit of K was reached.

Following testing, the samples were sectioned longitudinally. Half of the sample was mounted and prepared for metallographic examination, while the other half of the sample was cooled in liquid nitrogen, and then overloaded to failure. The fracture surfaces were examined using the SEM for evidence of intergranular fracture features, which are indicative of SCC as described above for the SSRT specimens.

The morphology of the fracture surfaces observed in the SEM reveals whether crack growth has occurred. In particular, facture surfaces were examined for intergranular features, which are indicative of high pH SCC. Four types of fracture surfaces are expected during examination of the samples: transgranular fatigue (pre-crack), transgranular ductile (tearing during the test), intergranular (SCC), and transgranular brittle overload (fracture of the specimen in liquid nitrogen). From the inspection of the fracture surfaces, the known test conditions, and the load and DCPD data, estimates of both K_{thSCC} and CGRs are generated provided there was some crack propagation. If no crack propagation is observed, then it is known that K_{thSCC} is higher than the K applied in the test.

4.0 RESULTS AND DISCUSSION

4.1 ELECTROCHEMICAL POLARIZATION BEHAVIOR IN TANK 241-AP-105 BASED SIMULANTS

Table 5 summarizes the results of the electrochemical tests conducted in FY2008 AP-105-PSC based simulants, including standard AP-105-PSC simulants, AP-105-Evaporated simulants, and AP-105-Mixed simulants as well as their modified versions.

4.1.1 Cyclic Potentiodynamic Polarization Behavior

Figure 6 (a) is the CPP curve obtained with a fully immersed specimen in deaerated AP-105-PSC at 50°C and at pH above 13. This simulant contains 0.27 M nitrite ion and 3.58 M nitrate ion (nitrite-to-nitrate concentration ratio of 0.075). As shown in Figure 6 (a), the polarization curve showed a wide passive region before the increase in the current. This area of increased current is shown with more detail in Figure 6 (b). A small positive hysteresis loop was observed but no pitting corrosion was noted on the post-test sample. This implied that the increase in current at approximately 500 mV (vs. SCE) was not associated with localized corrosion but the oxidation of electro-active species in this simulant.

Table 5. A Summary of Electrochemical Tests Performed in AP-105-PSC Based Simulants. (2 sheets)

Base Chemistry	pH	NO_2^- (M)	NO_3^- (M)	TIC (M)	OH^- (M)*	Cl^- (M)	F^- (M)	T (°C)	Aeration condition	Testing type	Visual	Sample ID (#EL1196-)
AP-105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	N_2 purging	CPP Full immersion	No pitting	54
AP-105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	N_2 purging	CPP Full immersion	No pitting	60
AP-105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	N_2 purging	Potentiostatic at 0 mV	No pitting	63
AP-105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	N_2 purging	CPP Full immersion	Crevice corrosion	64
AP-105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	N_2 purging	Potentiostatic at 0 mV	Crevice corrosion	65
AP-105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	Quiescent Air	Potentiostatic at 0 mV, half immersion	Severe attack at liquid/vapor interface	66
AP-105-PSC	>13	0.6	3.58	0.326	0.176	0.03	0.009	50	Quiescent Air	Potentiostatic at 0 mV, half immersion	Corrosion	72
AP-105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	N_2 purging	Potentiostatic at 0 mV, half immersion	Corrosion	73
AP-105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	Quiescent Air	CPP Half immersion	Corrosion	75
AP-105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	Room	Quiescent Air	Potentiostatic at 0 mV, half immersion	Corrosion	76
AP-105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	Quiescent Air	Potentiostatic at 100 mV vs. OCP, half immersion	Corrosion	77
AP-105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	Room	Quiescent Air	CPP Full immersion	No pitting	81
AP-105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	Quiescent air	Potentiostatic at 0 mV Half immersion	Minor corrosion	91
AP-105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	Zero air purging	OCP Half immersion	Corrosion	84
AP-105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	High Purity Ar purging	OCP Half immersion	Corrosion	85
AP-105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	N_2 purging	OCP Half immersion	Corrosion	86
AP-105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	Quiescent air	OCP Half immersion	Interface attack	83

* This reflects the concentration prior to pH adjustment.

Table 5. A Summary of Electrochemical Tests Performed in AP-105-PSC Based Simulants. (2 sheets)

Base Chemistry	pH	NO_2^- (M)	NO_3^- (M)	TIC (M)	OH^- (M)*	Cl^- (M)	F^- (M)	T (°C)	Aeration condition	Testing type	Visual	Sample ID (#EL1196-)
AP-105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	Room	Quiescent air	Potentiostatic at 50 mV vs. OCP Half immersion	Corrosion	92
AP-105-PSC	>13	0	3.85	0.326	0.176	0.03	0.009	50	N_2 purging	CPP Full immersion	Pitting	93
AP-105-Mixed	>13	0.413	2.857	0.274	0.952	0.039	0.026	50	N_2 purging	CPP Full Immersion	No pitting	98
AP-105-Evaporated	14	0.736	5.087	0.489	1.67	0.069	0.047	50	N_2 purging	CPP	No pitting	99
AP-105-Evaporated (Nitrite/Nitrate=0.1)	14	0.51	5.087	0.489	1.67	0.069	0.047	50	N_2 purging	CPP Full immersion	No pitting	105
AP-105-Mixed (Nitrite/Nitrate=0.1)	>13	0.28	2.857	0.274	0.952	0.039	0.026	50	N_2 purging	CPP Full immersion	No pitting	106
AP-105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	Zero air Blanket	OCP Half immersion	Minor corrosion	94
AP-105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	High Purity Ar blanket	OCP Half immersion	Minor corrosion	95
AP-105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	N_2 blanket	OCP Half immersion	Minor corrosion	96
AP-105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	Room	Quiescent air	OCP Half immersion	Interface attack	97
AP-105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	Quiescent air	CPP Full immersion	Pitting	102

* This reflects the concentration prior to pH adjustment.

Figure 6. The CPP Curve in Nitrogen Deaerated AP-105-PSC Simulant (T= 50°C and pH>13).

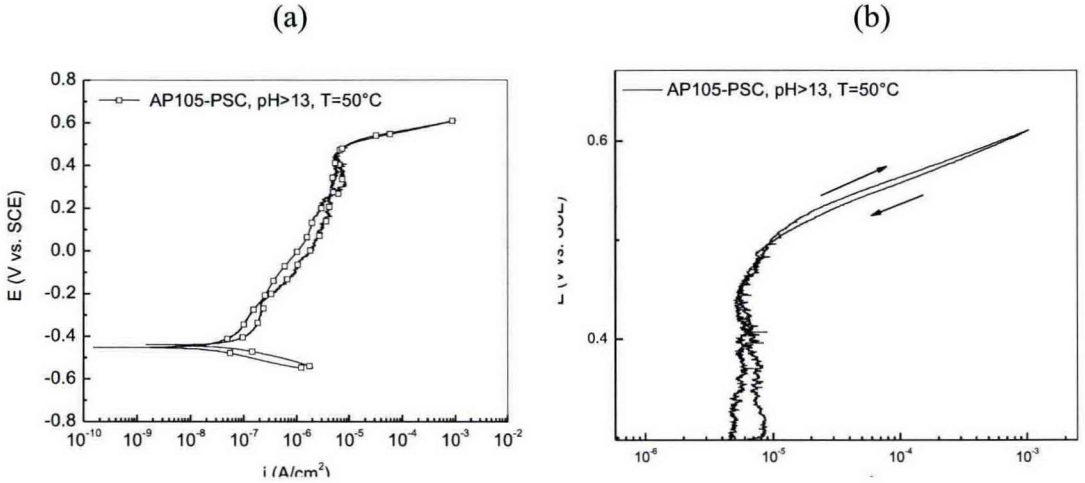


Figure 7 shows a comparison of the CPP curves obtained in deaerated AP-105 mixed and evaporated simulants at 50°C. These simulants have a higher nitrite-to-nitrate ratio (0.14) than the standard AP-105 simulant (0.075). The CPP curves showed a tiny hysteresis loop. No pitting corrosion was observed on the sample after CPP testing. Similar to the observation in AP-105-PSC, therefore, the hysteresis loop was not associated with localized corrosion but most likely with the electrochemical oxidation and reduction of other electro-active species in the simulants.

Figure 8 is a comparison of the CPP curves obtained in the AP-105 evaporated and mixed simulants with nitrite-to-nitrate concentration ratio of 0.1. No clear positive hysteresis loops were noted in either CPP curves and the samples tested in both simulants did not show any indication of localized corrosion.

Figure 7. CPP Curves in Nitrogen Deaerated AP-105 Mixed and Evaporated Simulants at pH 14 and 50°C.

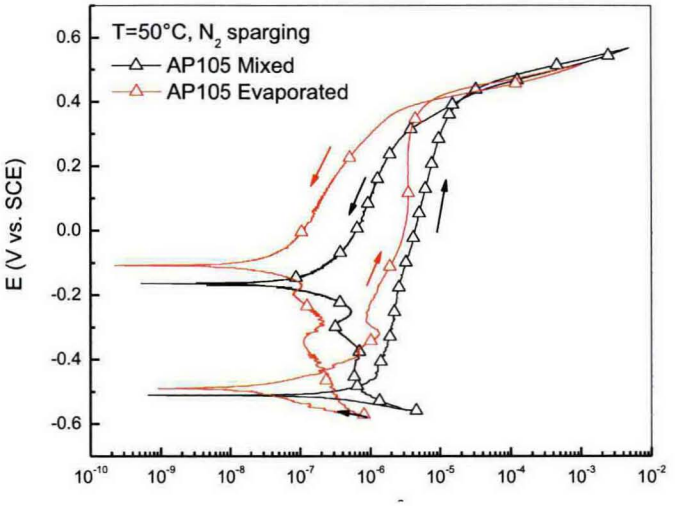
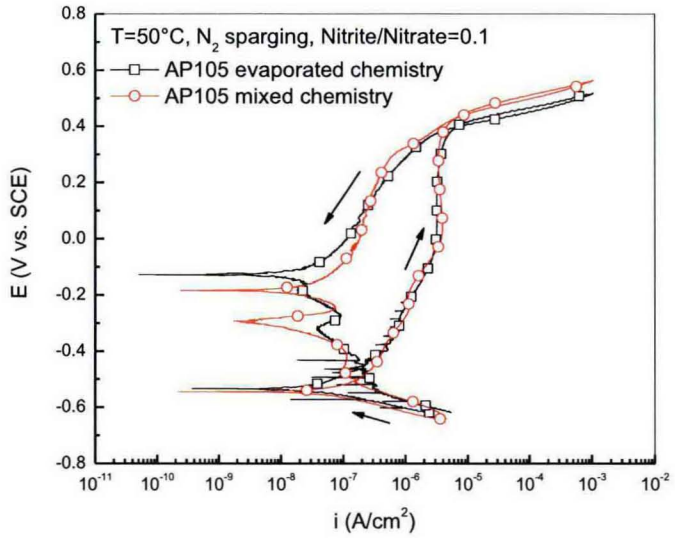


Figure 8. CPP Curves Obtained in Nitrogen Deaerated AP-105 Evaporated and Mixed with Nitrite-to-nitrate Concentration Ratio of 0.1 (pH 12+ and T=50°C).



The lack of localized attack on the samples tested in the AP-105 based simulants was likely a result of relatively high hydroxide concentration and the combined inhibition from both nitrite and other inhibitory species. In the previous AN-107 program, at nitrite/nitrate ratio of 0.095, a value slightly higher than that in AP-105-PSC, severe pitting was noted and the repassivation potential was more negative than OCP. Although the nitrite/nitrate concentration ratio in the AP-105-PSC is lower than 0.095, the pH was significantly higher than the AN-107 simulant. Furthermore, other inhibitory species, such as aluminate, were present in the AP-105 simulant but not in the AN-107 simulants. The combined effect from all these differences very possibly caused the difference in the observed polarization behavior (i.e., different repassivation potential and the extent of localized attack). Similarly, although the nitrate concentration in the evaporated simulant is 5.087 M, a significantly higher value than other simulants investigated to date, no pitting corrosion was noted on the CPP specimen. Thus, it appears that nitrite, combined with other inhibitory species (e.g., hydroxide, aluminate), efficiently inhibited localized corrosion in the evaporated simulant.

4.1.2 Liquid/Vapor Interfacial Corrosion in AP-105-PSC

Figure 9 is a comparison of the CPP curves obtained in AP-105-PSC simulant when the specimen was partially immersed in quiescent air conditions and fully immersed in deaerated conditions. The sample was partially immersed to create a liquid/vapor interface that simulated the sample configuration in the SSRTs. In the SSRTs, which were all performed in quiescent air conditions, a liquid/vapor interface was present and severe attack at the interface was observed after polarizing to 0 mV vs. SCE at 50°C for approximately 60 hours in the AP-105-PSC simulant. Details of the SSRT results are discussed in the following section. Also, the investigation of corrosion at the interface could provide insight into the integrity evaluation of the waste storage tanks because a liquid/vapor interface will be present at the supernate level in the tank. As

mentioned above, a slightly positive hysteresis loop was observed when the sample was fully immersed in the deaerated simulant. However, the CPP curve for the partially immersed specimen in quiescent conditions exhibited a large hysteresis. The post-test inspection of the partially immersed sample revealed corrosion at the bottom of the sample, near the liquid/vapor interface, and the portion exposed to the vapor phase (Figure 10). The attack at the liquid/vapor interface was further investigated in a set of potentiostatic tests, as will be discussed below.

Figure 9. A Comparison of CPP Curves in Nitrogen Deaerated AP-105-PSC Simulant at Different Nitrite and Nitrate Concentrations (pH=13+, T=50°C).

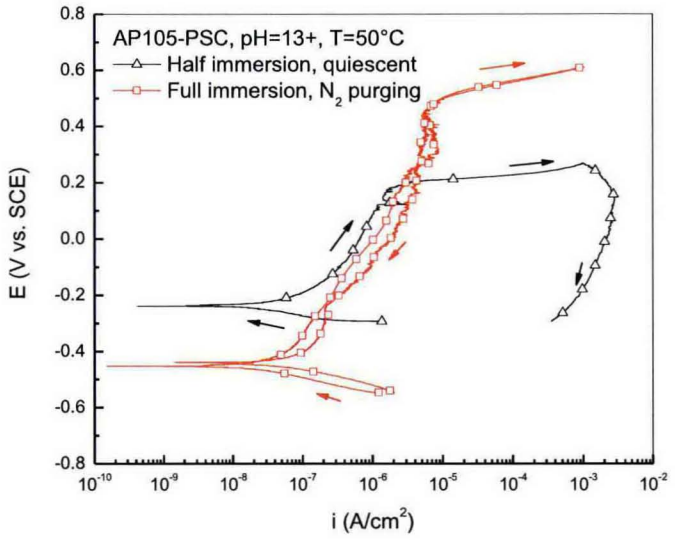


Figure 10. Sample Appearance after CPP Testing in AP-105-PSC Simulant under Quiescent Air Conditions (pH=13+, T=50°C).

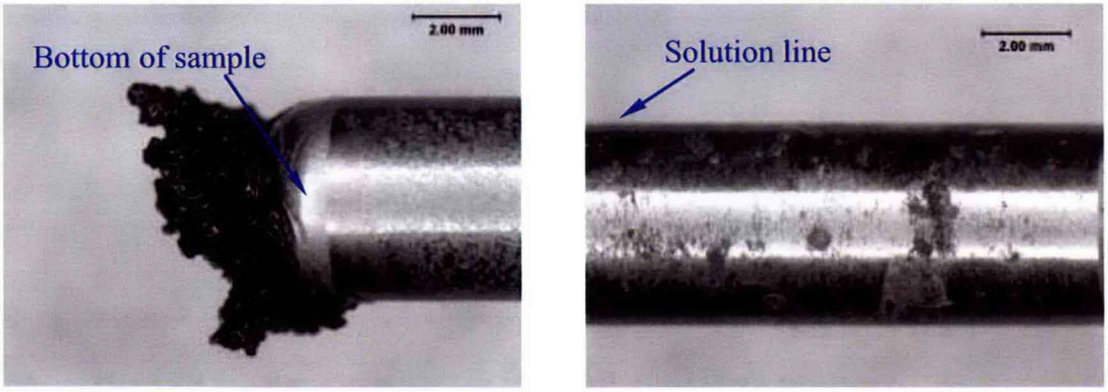


Figure 11 shows the current change as a function of time when a partially immersed sample was polarized at 0 mV vs. SCE for 50 hours (pH>13, T=50°C) in an AP-105-PSC simulant under quiescent conditions. The current measured in the potentiostatic test showed a sharp increase shortly after the potentiostatic test began. Severe corrosion attack was noted on the sample at the liquid/vapor interface, as shown in Figure 12 (a). Corrosion attack was also observed on the specimen areas that were above the liquid/vapor interface (Figure 12 (b)). The observed corrosion attack was similar to that observed on the SSRT sample when exposed to the same simulant under quiescent air conditions. In contrast, no corrosion was noted on a fully immersed sample in the same environment and conditions. The measured current density remained low indicating passive conditions throughout the test, as shown in Figure 13.

Figure 11. The Change in the Current as a Function of Time when the Partially Immersed Sample Was Held at 0 mV vs. SCE (AP-105-PSC, pH>13, T=50°C, Quiescent Air Conditions).

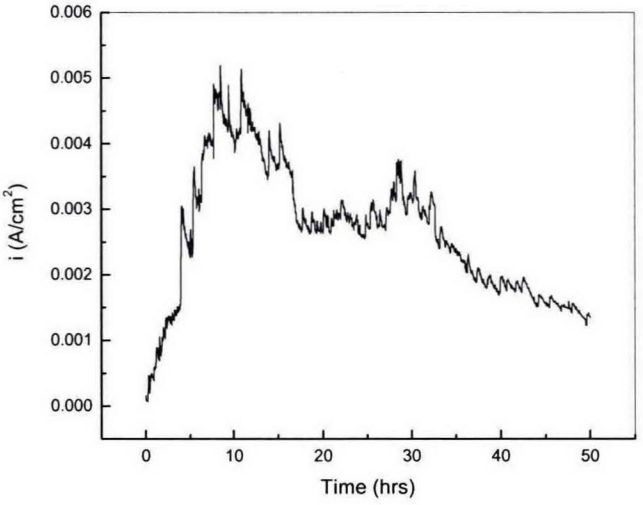


Figure 12. The Sample Appearance after 50 Hours of Potentiostatic Testing at 0 mV vs. SCE in the AP-105-PSC Simulant (pH>13, T=50°C, Quiescent Air Conditions).

(a) Corrosion at Liquid/vapor Interface; (b) Corrosion on the Portion above the Liquid/vapor Interface.

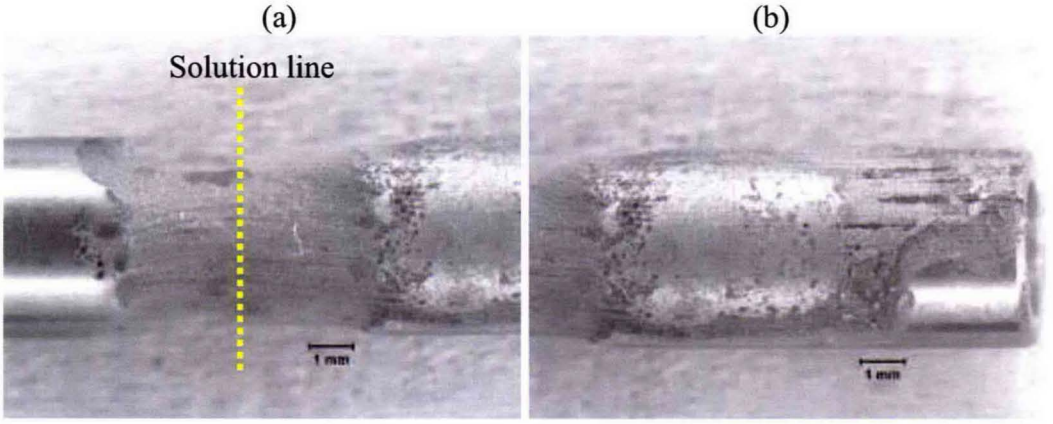
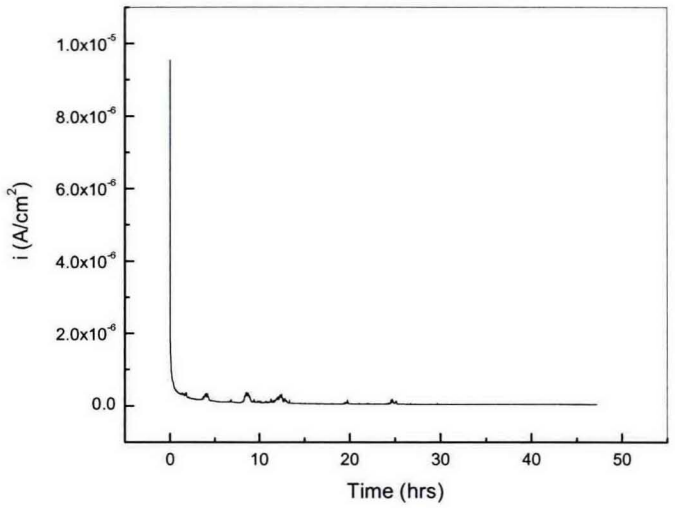


Figure 13. Current as a Function of Time for Fully Immersed Sample Polarized at 0 mV vs. SCE in AP-105-PSC Simulant (T=50°C, pH>13) Under Quiescent Air Conditions.



The contrasting results of severe corrosion attack for the partially immersed specimen and no corrosion attack for the fully immersed specimen are likely related to chemical reactions occurring at the interface. Typically, materials corrode more readily (at a higher rate) at a liquid/vapor interface than in the bulk in an aggressive environment. This is because oxygen is more readily available at the interface than in the bulk solution, allowing oxygen to contribute more significantly to the cathodic reaction (assuming oxygen reduction dominates the cathodic kinetics). However, when a sample is polarized to a noble potential (e.g., 0 mV vs. SCE as it was in these experiments), it is expected that all the cathodic reactions would be displaced to the counter electrode. This indicates that the fully immersed and partially immersed specimen should have similar cathodic reactions (as well as similar anodic reactions). Therefore, it is possible that some unknown reactions at the interface created a locally aggressive environment that resulted in severe corrosion attack of the partially immersed specimen.

While corrosion attack was noted at the liquid/vapor interface in quiescent air, the extent of corrosion attack was greatly decreased when the nitrite concentration was increased to 0.6M. The observed decrease in current density with the higher nitrite concentration is shown in Figure 14. Minimal corrosion attack was observed for this condition as shown in Figure 15.

Similarly, the current densities under deaerated conditions were lower than under quiescent conditions for the AP-105-PSC simulant with 0.27 M nitrite, as shown in Figure 16. The corrosion attack on the samples tested in deaerated simulants was also less severe than that observed under quiescent air conditions (see Figure 17). Additionally, the corrosion attack was noted to be less severe when the solution was actively sparged with nitrogen (Figure 16 and Figure 17). Note that in the test for the sample shown in Figure 17, though, the interface was actively disturbed and mixed with the bulk solution under the gas purging.

Figure 14. A Comparison of the Change in the Current as a Function of Time in the Potentiostatic Tests Conducted in AP-105-PSC Simulants with Different Nitrite Concentrations at 50°C and Quiescent Air Conditions.

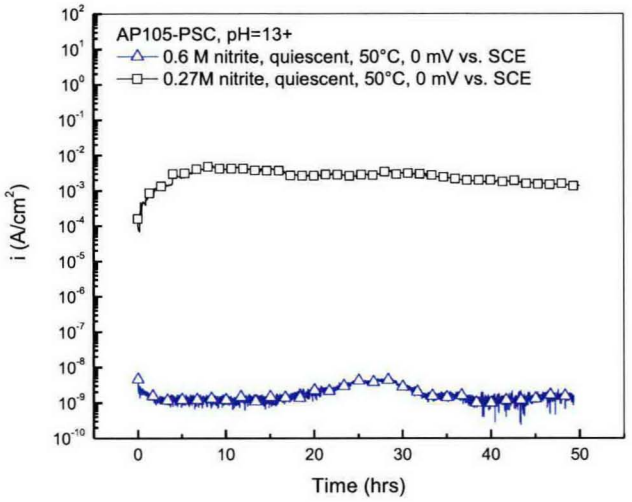


Figure 15. The Sample Appearance after Potentiostatic Test at 0 mV (vs. SCE) in the AP-105-PSC Simulant with 0.6 M Nitrite for 50 Hours (Sample Partially Immersed) at 50°C Under Quiescent Air Conditions.

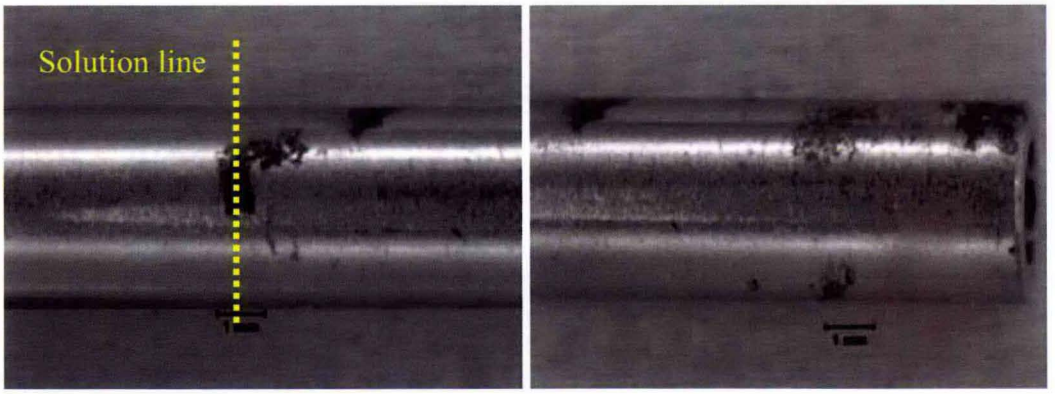


Figure 16. A Comparison of the Current Density as a Function of Time in the Potentiostatic Tests Conducted at 0 mV (vs. SCE) in Quiescent and Nitrogen Purged AP-105-PSC Simulants at 50°C.

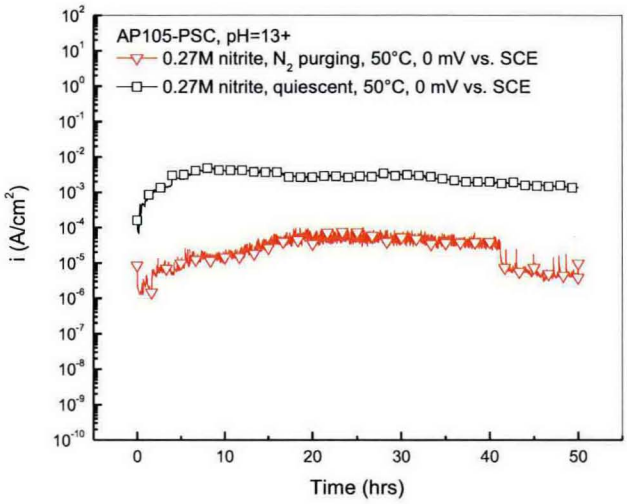
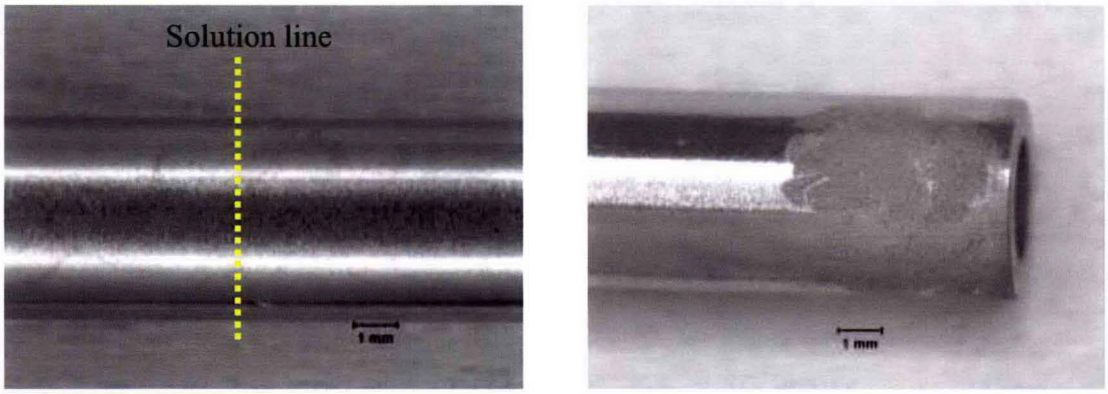


Figure 17. The Sample Appearance after Potentiostatic Test at 0 mV (vs. SCE) in Nitrogen Deaerated AP-105-PSC Simulant for 50 hours (Sample Partially Immersed) at 50°C.



Initially, it was thought that the rapid corrosion observed at the liquid/air interface was linked to the oxidation of nitrite in the presence of oxygen. However, corrosion at the interface was still observed in one test in which the head space of the test cell was purged with nitrogen to eliminate oxygen (i.e., the solution was not agitated). The current change as a function of time is shown in Figure 18 and the sample appearance after the potentiostatic test is shown in Figure 19. This demonstrated that the attack at the interface at 0 mV vs. SCE could still occur in the absence of oxygen. It also indicated that the role of nitrogen when actively purging the simulant was to primarily mix the bulk solution and the interface environment so that the local aggressive environment could be eliminated. Thus, it seems necessary to have a stable liquid/vapor interface to maintain the local chemistry at the interface in order to observe the corrosion attack as shown in Figure 12.

Figure 18. The Current Density as a Function of Time in the Potentiostatic Tests Conducted at 0 mV (vs. SCE) in AP-105-PSC Simulants with the Head Space of the Test Cell Purged with Nitrogen at 50°C.

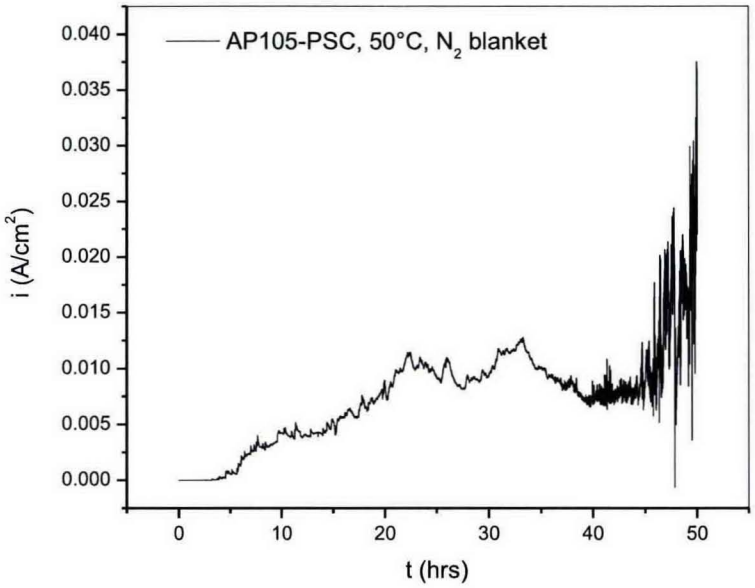
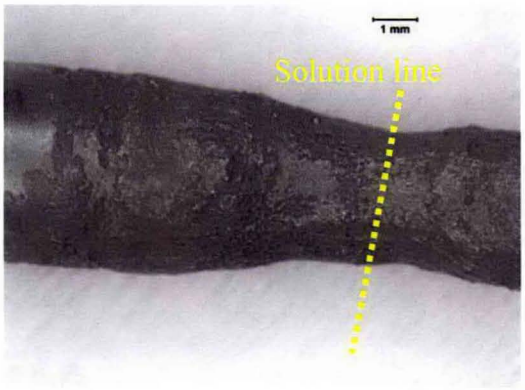


Figure 19. The Sample Appearance after the Potentiostatic Tests Conducted at 0 mV (vs. SCE) in AP-105-PSC Simulants with the Head Space of the Test Cell Purged with Nitrogen at 50°C.



The extent of corrosion attack at the liquid/vapor interface at a polarized potential decreased significantly with a decrease in temperature from 50°C to room temperature. Figure 20 shows a comparison of the current density as a function of time at room temperature (~25°C) and 50°C at 0 mV vs. SCE with quiescent air in the head space. Although corrosion was noted when the solution was at room temperature and at 0 mV vs. SCE, the extent of corrosion was much less severe compared to 50°C and 0 mV vs. SCE (Figure 22 (a) vs. Figure 12). The current density at room temperature did increase dramatically after approximately 33 hours of exposure (Figure 20), while at a temperature of 50°C under the same conditions, the current increased within the first few hours, indicating the onset of corrosion.

The applied potential also had an impact on the onset of corrosion initiation at the liquid/vapor interface. Figure 21 shows that corrosion initiation took approximately 10 hours to appear at the interface when polarized to 100 mV vs. OCP (-204 mV vs. SCE) at 50°C and under quiescent air conditions. Comparatively, the current increased (i.e., corrosion initiated) within a few hours at 0 mV vs. SCE at 50°C in quiescent air conditions. A similar trend was observed at room temperature. In Figure 21 (b), the current did not increase within 50 hours of exposure at room temperature with an applied potential of 50 mV vs. OCP (-160 mV vs. SCE). However an increase in the current was noted after 33 hours at room temperature and an applied potential of 0 mV vs. SCE. Figure 22 (b) shows minimal corrosion attack at the interface for the 50mV vs. OCP potentiostatic polarization at room temperature and quiescent air conditions. As expected from the current transient data, the corrosion attack for the 0 mV vs. SCE, room temperature, quiescent air case (Figure 22 (a)) was more severe; however, the overall corrosion damage to both specimens was not substantial.

Figure 20. Current as a Function of Time in Potentiostatic Tests Conducted at Different Temperature Levels and Quiescent Air Conditions.

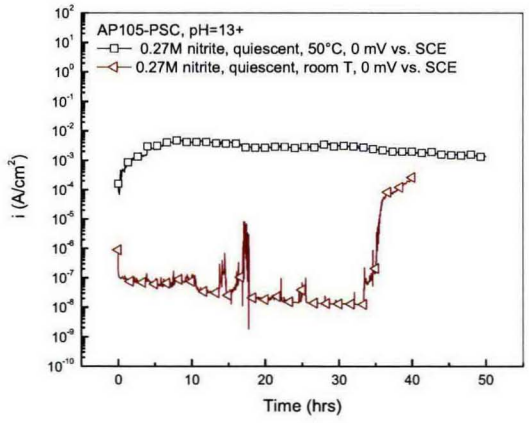
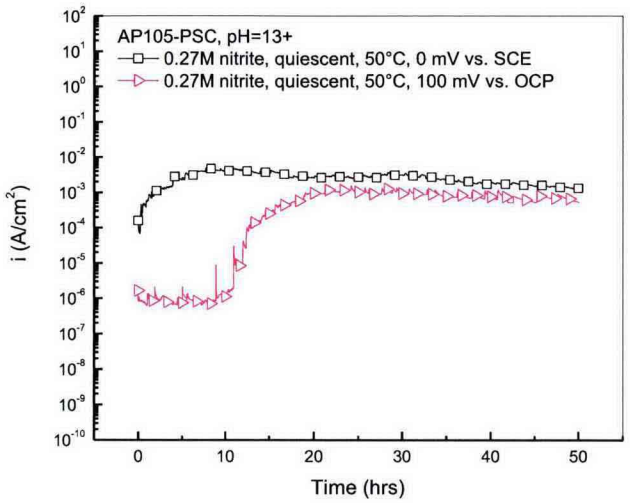
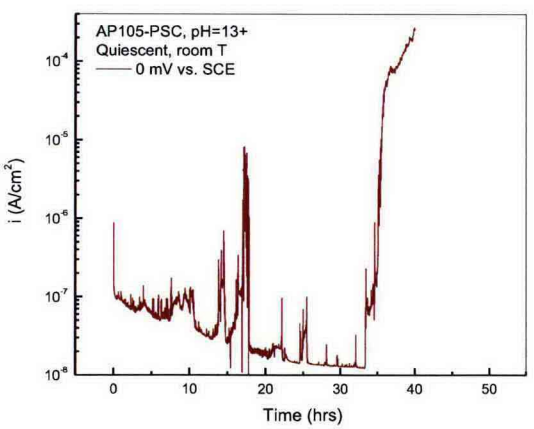


Figure 21. Current Density as a Function of Time in the Potentiostatic Tests Conducted in AP-105-PSC Simulants Under Quiescent Air Conditions at (a) 0 mV (vs. SCE, 50°C) and 100 mV (vs. OCP, 50°C); (b) 50 mV (vs. OCP, Room Temperature) and 0 mV (vs. SCE, Room Temperature).

(a)



(b)



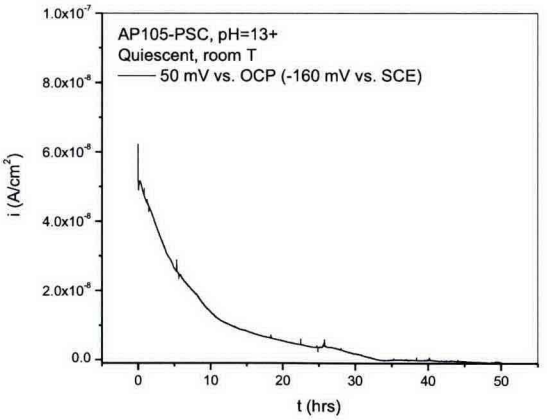
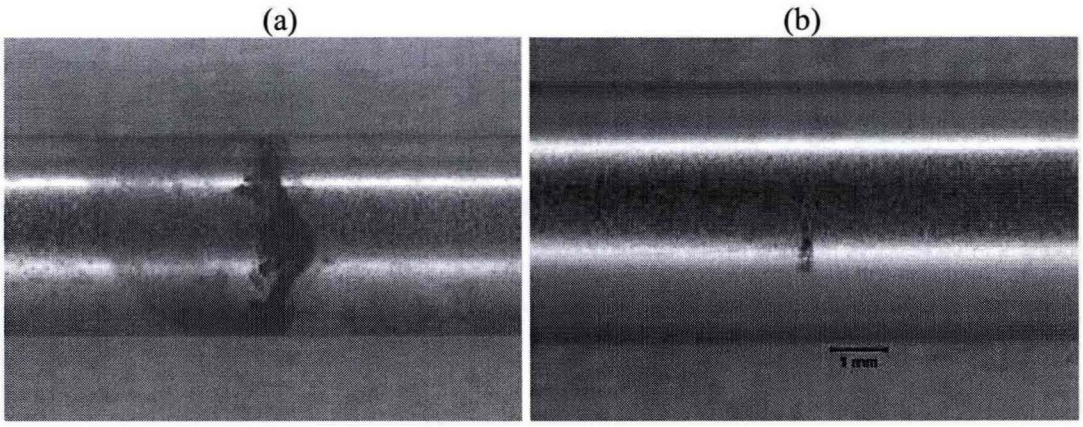


Figure 22. Sample Appearance after 50 Hours Potentiostatic Testing in AP-105-PSC Simulant at Different Potentials (Under Quiescent Air Conditions, Room Temperature). (a) 0 mV vs. SCE; (b) 50 mV vs. OCP (-160 mV vs. SCE).



To further investigate the corrosion attack at the liquid/vapor interface in the AP-105-PSC simulant, long-term immersion tests were performed with the samples partially immersed in the simulant to create a liquid/vapor interface. The effect of gas purging (through the bulk solution and the cell head space), temperature levels (room and 50°C), gas types (quiescent, compressed zero air, nitrogen and argon) on the interfacial corrosion susceptibility and extent were of particular interest. Figure 23 compares the corrosion rates of the samples that were partially immersed in the AP-105-PSC simulant at different conditions. It should be noted that the corrosion rate was calculated using the exposed surface area. This tends to underestimate the corrosion rate since the corrosion attack usually focused at the liquid/vapor interface or a few local sites. The samples exposed to the simulant open to the ambient air showed evident attack at the liquid/vapor interface (Figure 24 and Figure 25) and the extent of corrosion was less at room temperature. The corrosion rates at the other conditions (e.g., purged with nitrogen, argon and compressed zero air) did not differ from each other significantly. Additionally, the corrosion attack on the samples partially immersed in the actively sparged simulants were mainly located on the portion exposed to the vapor space region. Conversely, the corrosion was widely spread to the entire sample surface in cases where the solution remained stagnant or only the head space of the cell was purged with gases. These differences in the amount and mode of attack may suggest that the mixing of the bulk solution and the interface solution may have prevented the formation of a relatively aggressive environment adjacent to the sample surface.

It was also noted that the samples exposed to solutions with oxygen behaved differently. When the solution was open to the ambient air, the corrosion attack was more severe at an elevated temperature than at room temperature. In the case where the oxygen was introduced by actively purging the solution using zero air (i.e., air without CO_2), the corrosion was minor as the mixing of the interface with the bulk likely prevented the locally aggressive environment from forming. When the head space of the cell was purged with zero air, the corrosion attack was still not as severe as that in the solution open to the ambient air. Since the pH of the bulk solution did not change dramatically after the exposure, as shown in Table 6, it is not clear whether the local pH change at the interface played a significant role on the initiation of the attack at the interface.

Figure 23. Corrosion Rate Calculated Based on Weight Loss for the Samples Partially Immersed in the AP-105-PSC Simulants Under Freely Corroding Conditions for More than Three Months (T=50°C Unless Noted Otherwise).

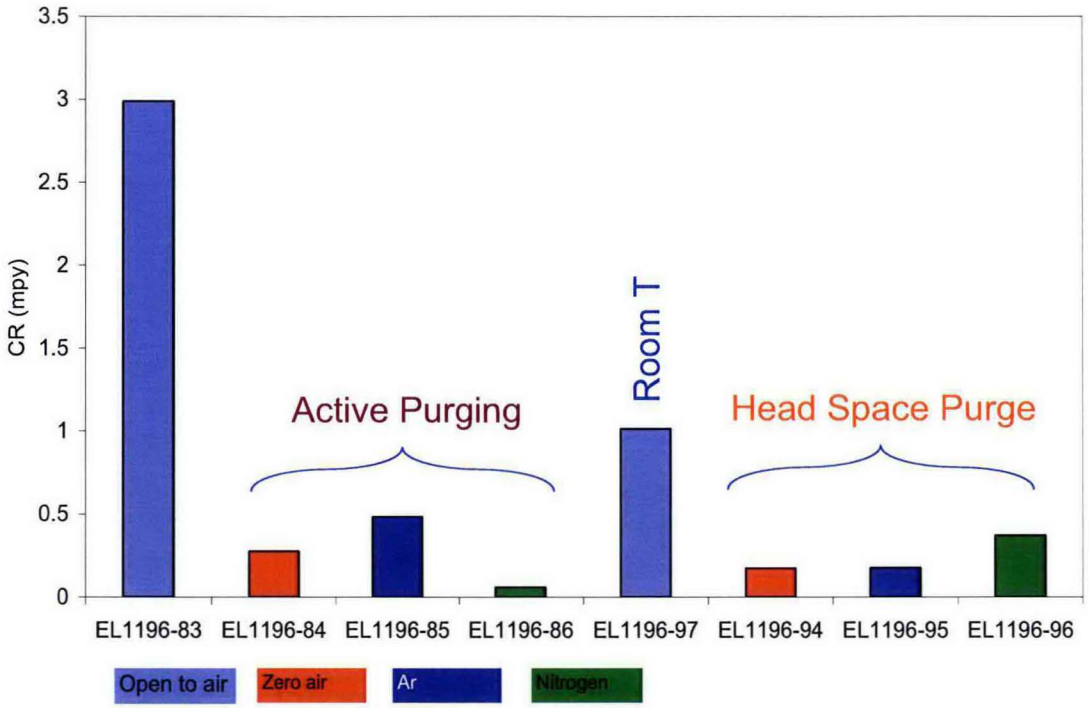
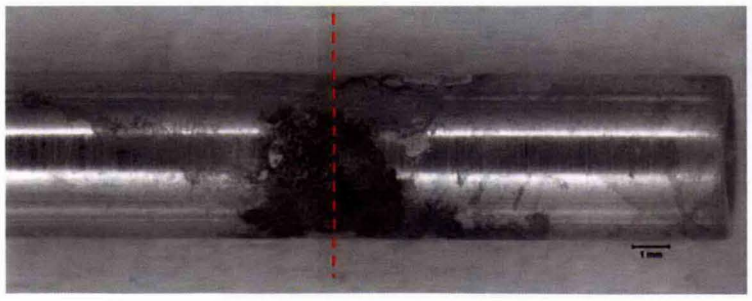


Figure 24. The Appearance of the Sample (a) and the Cross Section of a Corroded Site (b) after Exposed in AP-105-PSC under Quiescent Air Conditions (Sample Partially Immersed, T=50°, EL1196-83).

(a)



(b)

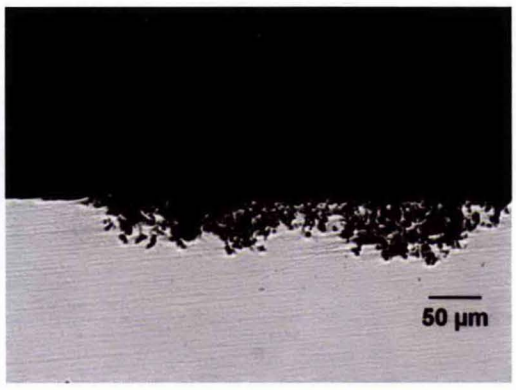


Figure 25. The Appearance of the Sample (a) and the Cross Section of a Corroded Site (b) after Exposed in AP-105-PSC under Quiescent Air Conditions (Sample Partially Immersed, Room Temperature, EL1196-97) at OCP.

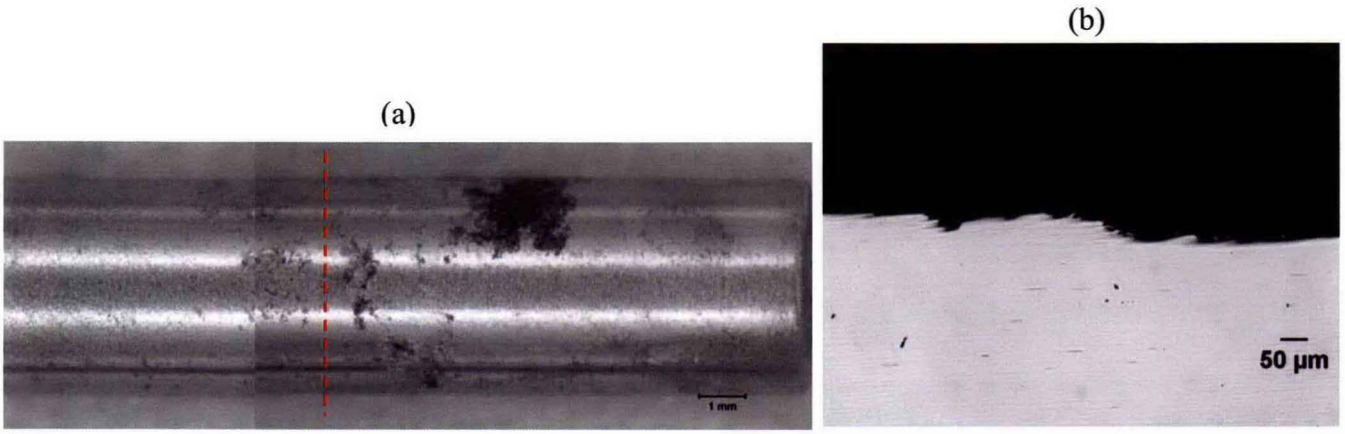


Table 6. The Bulk pH Values of the Simulant after the Long-Term Immersion Tests.

Exposed sample	Solution pH after test
EL1196-83	13.28
EL1196-84	13.23
EL1196-85	13.32
EL1196-86	13.21
EL1196-97	13.32
EL1196-94	13.4
EL1196-95	13.44
EL1196-96	13.38

The interfacial corrosion appears to be a complicated process and the exact mechanism is still uncertain without conducting a comprehensive investigation. Based on the results obtained to date in the present work, several mechanisms are possible, as discussed below.

(a). Nitrite depletion through oxidation at a polarized potential

Severe attack at the interface in deaerated AP-105-PSC simulants at polarized potentials above OCP may be able to convert the inhibitory nitrite locally to nitrate. Thus, a locally aggressive environment could be formed. It has been demonstrated above that the interfacial attack strongly depends on the applied potential. Typically, a more positive polarized potential led to more severe attack with a shorter initiation time. The depletion of nitrite could be linked to the oxidation of nitrite to nitrate via the electrochemical reaction below:

$$NO_2^- + H_2O \rightarrow NO_3^- + 2H^+ + 2e^-$$

$$E(NO_2^- / NO_3^-) = 0.835 - 0.000198TpH + 0.000099T\log([NO_3^-]/[NO_2^-])$$

The equilibrium potential for this half reaction is listed in Table 7. Clearly, a polarization of 0 mV vs. SCE and 50 mV vs. OCP (-160 mV vs. SCE) are both sufficiently noble to oxidize nitrite to nitrate and the oxidation is still thermodynamically possible even at some OCPs. Although nitrite oxidation can occur anywhere on the immersed electrode surface, the local depletion can be compensated by the nitrite in the bulk solution through mass transport. At the liquid/vapor interface, however, the mass transport may be limited such that a local low nitrite environment can be maintained to form an aggressive environment.

Table 7. The Equilibrium Potential of Nitrite and Nitrate Redox Couple as a Function of Temperature at pH 13.5 (Nitrite=0.27M, Nitrate=3.58M).

T (°C)	E (V vs. SCE)
25	-0.170
50	-0.235

To illustrate that the depletion of nitrite and a corresponding increase in nitrate concentration compared to the bulk AP-105-PSC simulant solution could lead to a more corrosive environment, a modified AP-105-PSC simulant was created in which the nitrite was removed and the nitrate concentration was increased to 3.85 M. This high nitrate content represents complete conversion of nitrite to nitrate. CPP testing showed an open hysteresis loop (Figure 26) with severe localized corrosion attack noted, as shown in Figure 27. Clearly, the depletion of nitrite can lead to a very aggressive environment. The CPP curve shows a repassivation potential more negative then the OCP, indicating that localized corrosion may occur at open circuit. This could be a plausible explanation for the observation of severe corrosion in the vapor phase and interfacial regions on some samples.

Figure 26. A Comparison of CPP Curves in Nitrogen Deaerated AP-105-PSC Simulant at Different Nitrite and Nitrate Concentrations (pH=13+, T=50°C).

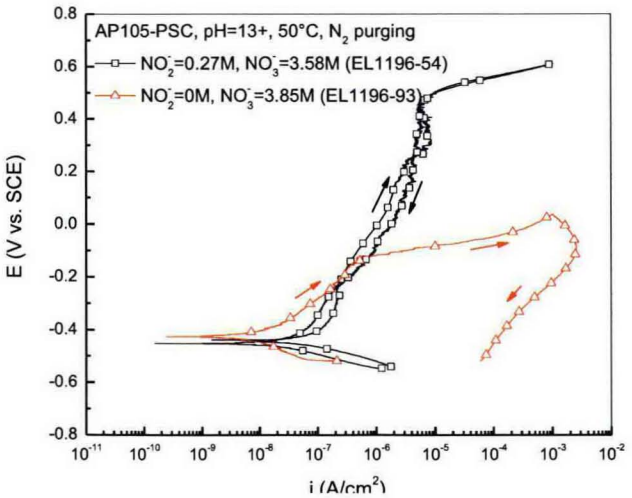
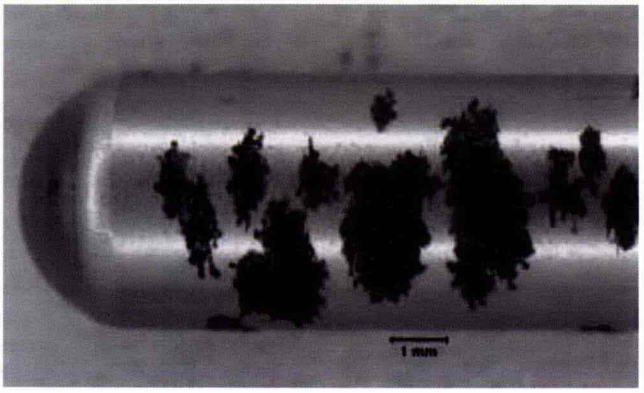


Figure 27. The Sample Appearance after CPP Testing in Nitrogen Deaerated AP-105-PSC with No Nitrite and 3.85 M Nitrate (pH=13+, T=50°C).



(b). Oxygen enhanced corrosion and possible nitrite depletion

In general, increased oxygen concentration results in higher corrosion rates. Furthermore, the role of oxygen is uncertain in the process of nitrite depletion. Oxygen may be a promoter for the nitrite depletion to aid in creating a more corrosive environment. As shown Figure 28, the CPP curve in AP-105-PSC simulant under quiescent air conditions and 50°C showed a positive hysteresis loop and the sample showed pitting corrosion (Figure 29). In the long-term immersion tests, however, the samples immersed in the simulants purged by compressed zero air (no CO_2) did not show appreciable corrosion attack. These observations seem to indicate that the presence of oxygen may have no strong influence on the liquid/vapor corrosion process. Rather, the presence of CO_2 in the quiescent air coupled with evident corrosion, and the lack of CO_2 and observable corrosion in the zero air (and nitrogen), suggests that CO_2 may be the controlling species in liquid/vapor corrosion process.

Figure 28. A Comparison of the CPP Curves Obtained in the AP-105-PSC Simulant under Different Aeration Conditions using Fully Immersed Samples.

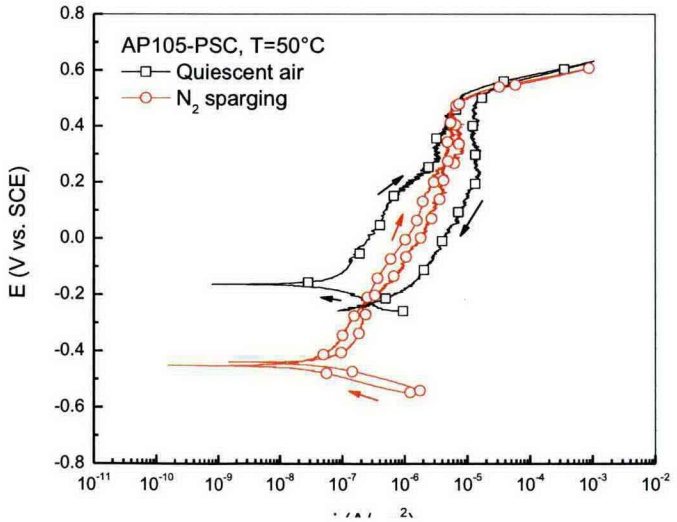
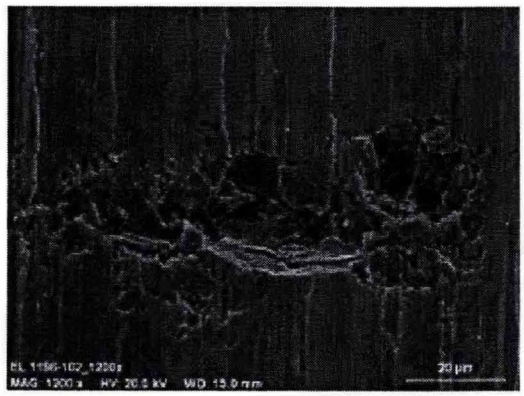


Figure 29. The Pit on the Sample Tested in the AP-105-PSC Simulant Under Quiescent Air Conditions and at 50°C (pH=13+).



(b). Local pH change causes an aggressive environment

In the long-term immersion tests, the samples immersed in the simulants under quiescent conditions (open to air) showed appreciable interface attack. However, when the solution or the cell head space was purged with zero air (compressed air without CO_2), the corrosion attack was minimal. This may indicate that the attack at the interface was due to a change in the interfacial pH resulting from reaction with CO_2 in the air.

The results of the four tests in which oxygen and carbon dioxide were both excluded from the test systems with the AP-105 simulant at 50 °C imply that one or both of these gases are required for rapid corrosion at the liquid air interface. The results of the two tests carried out with air from which carbon dioxide has been removed imply that the carbon dioxide content of air is the key factor in determining the rate of the interfacial corrosion process. Because in the absence of carbon dioxide the corrosion rate was low and since the bulk pH at the conclusion of these tests was observed to be similar, it seems that interfacial corrosion is a localized phenomena and that the rate of transport of hydroxide ion from the bulk solution to the corrosion site is insufficient to neutralize the acidic influence of carbon dioxide in unmixed solutions. However, no confirmatory chemical analysis has been performed to validate the proposed CO_2/pH reduction mechanism.

4.2 SLOW STRAIN RATE TESTING IN TANK 241-AP-105 BASED SIMULANTS

Table 8 summarizes the results of SSRTs performed in AP-105 based simulants. Variants include "mixed" and "evaporated" simulants. Tests were performed at 50°C, at potentials of 0 mV and -250 mV vs. SCE, and at OCP. In two cases the tests were stopped at the ultimate tensile strength of the steel, in order to study the role of the strain in the development of intergranular SCC in the gage sections of the samples. Replicate tests were conducted for some conditions.

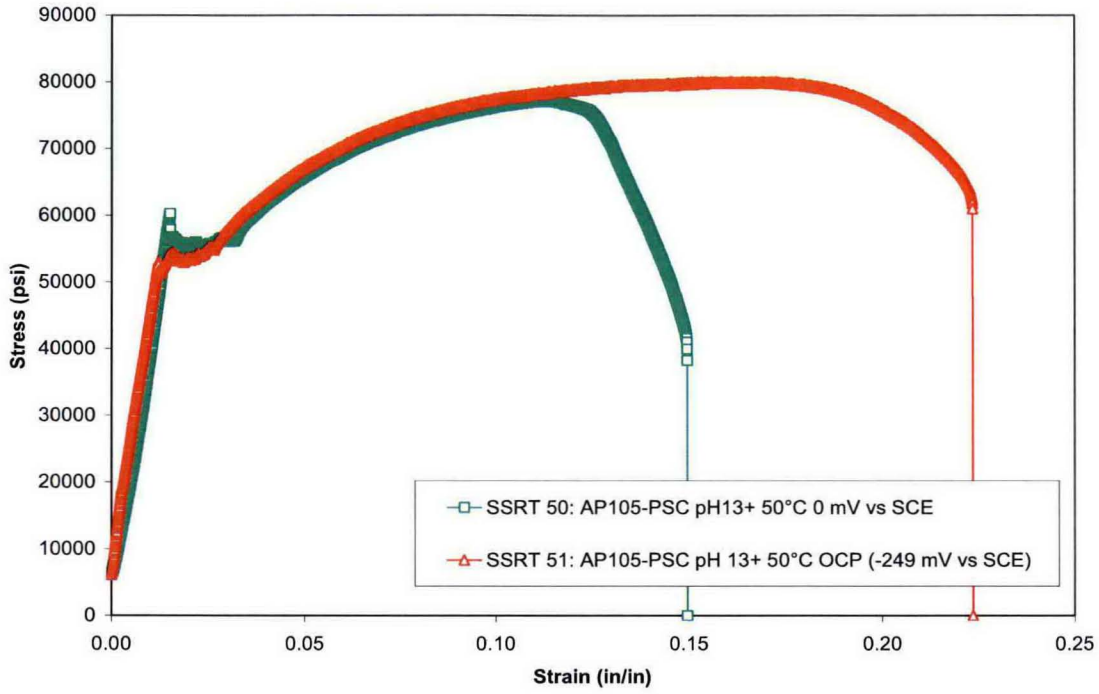
Table 8. A Summary of Slow Strain Rate Tests Performed in AP-105 Based Simulants.

Test ID	Base Chemistry	pH	Temp (°C)	Pot (mV)	OCP (mV)	Failure Strain (%)	Failure Time (hrs)	SEM Surface Exam	Estimated CGR (mm/sec)
50	AP-105-PSC	13+	50	0	-242	15.0	41.6	Visual cracking	
51	AP-105-PSC	13+	50	OCP	-249	22.3	62.1	Secondary Crack IG	1.3×10^{-7}
52	AP-105-PSC	13+	50	OCP	-289	21.5	62.1	Ductile*	-
53	AP-105-PSC	13+	50	0	-259	16.3	49.2	Visual cracking	3×10^{-6}
54	AP-105-PSC	13+	50	0	-287	19.4	53.8	Visual cracking	
59	AP-105-Evaporated	13+	50	OCP	-510	21.2	59.0	Ductile	-
60	AP-105-PSC**	13+	50	OCP	-277	-	-	No cracking	-
62	AP-105-Evaporated (ratio 0.1)	13+	50	OCP	-333	23.3	64.7	Ductile	-
63	AP-105-Mixed (ratio 0.1)	13+	50	OCP	-259	23.2	64.3	Ductile	-
64	AP-105-Mixed	13+	50	OCP	-312	21.7	60.3	Ductile	-
65	AP-105-PSC**	13+	50	-250	-281	-	-	No cracking	-

*Secondary cracks were re-examined using the SEM, no apparent intergranular features
** Test was stopped at ultimate tensile stress

Figure 30 shows a plot of the stress-strain data from two of the slow strain rate tests, SSRT 50 and 51, performed in the AP-105-PSC base simulant. The specimens failed at 15.0 and 22.3 % strain. The former failure strain is lower than expected for this grade of steel, and is indicative of reduced cross-sectional area associated with severe corrosion attack during the testing. Visual and stereographic examination of the test specimens indicated severe corrosion, though the nature of the corrosion was not typical of the corrosion that had been observed in previous testing.

Figure 30. The Stress-Strain Behavior of Samples Tested in AP-105-PSC Based Simulants at 0 mV vs. SCE and at OCP (-249 mV vs. SCE).



A fracture surface examination of the samples tested at OCP (SSRT 51 and SSRT 52) indicated ductile failure. However, in SSRT 51, with an OCP of -249 mV vs. SCE, secondary crack examination showed intergranular features, indicative of high pH SCC (Figure 31). Similar behavior has been observed in previous testing, for example testing in modified AY-102 simulants with high nitrate contents when the specimen was polarized between -200 to -300 Mv vs. SCE. In addition, some tarnishing was seen on the shafts of samples as shown in Figure 32.

The intergranular features observed in the secondary cracks in the shaft of SSRT 51, tested in AP-105-PSC simulant at OCP, were unexpected. SCC has not been observed in any tests performed at OCP in waste simulants, including AN-107. One thought is that the sample may have been overly strained to enable the formation of the side cracks. This overly strained condition is unlikely to be relevant under normal tank operations. To investigate the role of strain, SSRT 60 was performed in AP-105-PSC simulant at OCP, but the test was stopped at the ultimate tensile strength. Post-test examination did not reveal any evidence of secondary cracking (Figure 33).

Figure 31. An Electron-Micrograph of a Secondary Crack in Test Sample SSRT-51 Performed in AP-105-PSC Standard Simulant at 50°C, pH 13+, and at OCP (-249 mV vs. SCE).

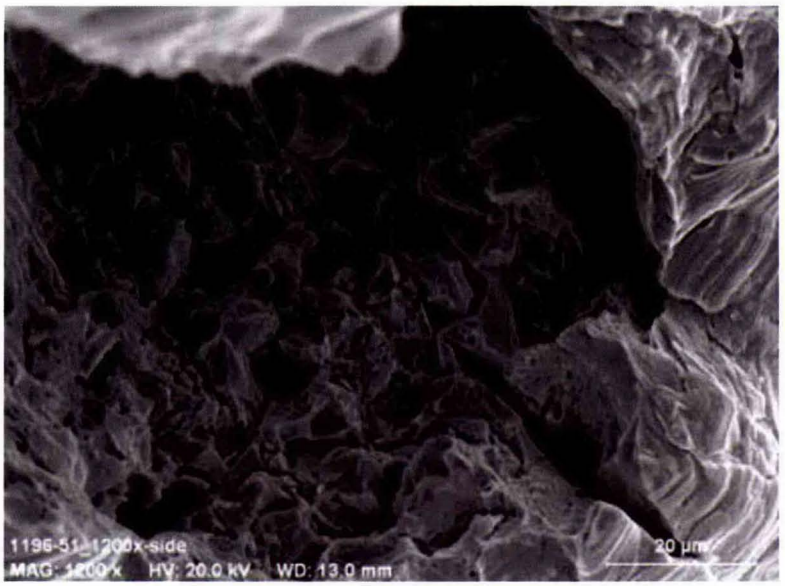


Figure 32. A Stereo-Micrograph of the Test Sample from SSRT-51 Performed in AP-105-PSC Standard Simulant at 50°C, pH 13+, and at OCP (-249 mV vs. SCE).

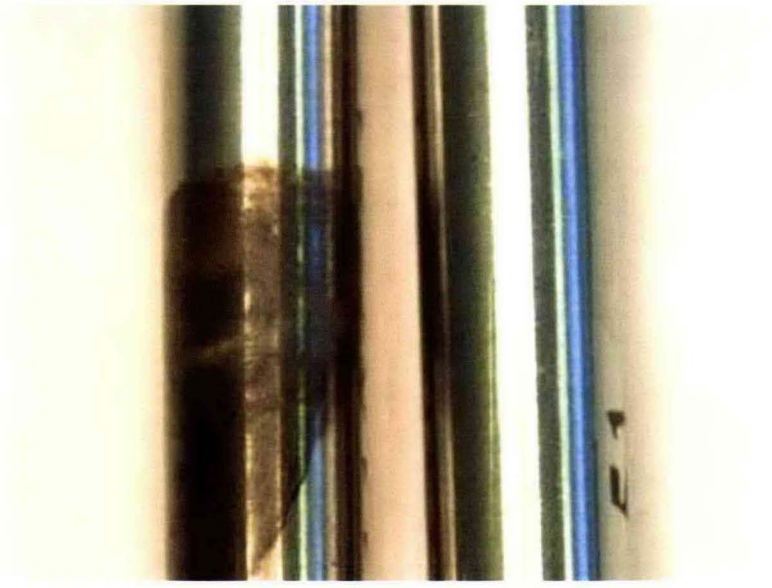
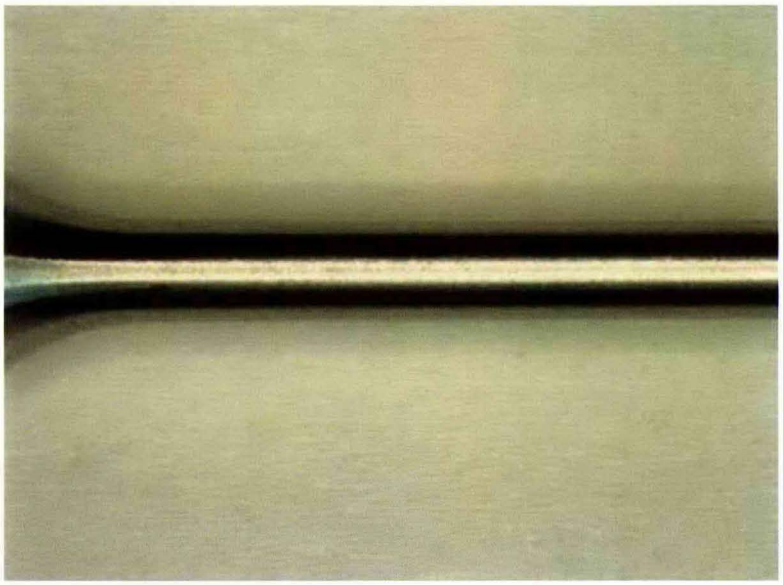


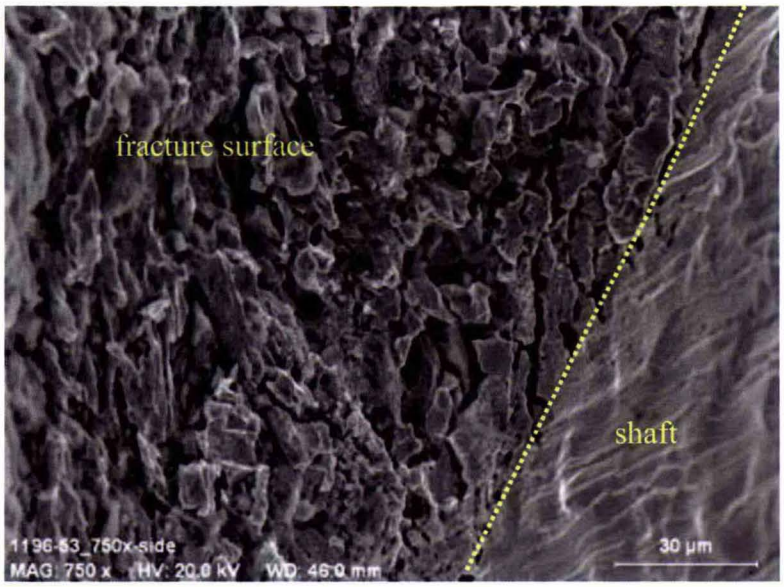
Figure 33. A Stereo-Micrograph of the Test Sample from SSRT-60 Performed in AP-105-PSC Standard Simulant at 50°C, pH 13+, and at OCP (-277 mV vs. SCE). The test was stopped at the ultimate tensile strength.



It was also noted that the OCP in SSRT 51 was -249 mV and the OCP in SSRT 52 was -289 mV vs. SCE. The test performed at the more noble potential was the one that had intergranular features. To determine if the more noble potential and/or the increased strain was primarily responsible for the SCC at OCP, SSRT 65 was performed in AP-105-PSC simulant at -250 mV vs. SCE, and stopped at the ultimate tensile strength. No secondary cracking was observed, indicating the SCC in SSRT 51 was most likely influenced by the high strain.

Examination of the fracture surface of the samples tested at 0 mV vs. SCE in the AP-105-PSC simulant showed intergranular features, indicative of high pH SCC (Figure 34). The observation of SCC at 0 mV vs. SCE is expected in a nitrate-based simulant, based on the results obtained in the previous testing programs. Previous testing had demonstrated that steels were susceptible to SCC in simulants containing high concentrations of nitrate and with low concentrations of inhibiting nitrite.

Figure 34. Electron-Micrograph of the Fracture Surface of Test Sample from SSRT-53 Performed in AP-105-PSC Standard Simulant at 50°C, pH 13+, and at 0 mV vs. SCE.



Visual examination of the samples tested under polarizing conditions (0 mV vs. SCE) also revealed severe corrosion on the sample above the gauge section (Figure 35 and Figure 36). A close examination of the SSRT cell indicated that the corroded section was at the liquid/vapor interface (Figure 37). Similar corrosion attack was observed in replicate tests. The discussion in the earlier section suggests the attack at the interface may be a result of the depletion of the inhibiting species (e.g., nitrite) or a reduction in the interfacial pH, both of which would result in the formation of a locally aggressive environment.

Significant corrosion has not been observed during SSR testing except under highly aggressive conditions in modified AN-107 simulants. Re-examination of the samples from testing in AN-107 with decreased nitrite concentrations showed severe corrosion along the entire length on the test sample, as opposed to just at the liquid/vapor interface. For those tests in the AN-107 program, however, the nitrite concentration was lower than 0.27 M while the simulant contained comparable amount of nitrate. Thus, the environment was sufficiently aggressive to attack the entire immersed portion. In the case of AP-105-PSC, it seems the nitrite concentration is near a threshold level below which localized corrosion could initiate. Therefore, the corrosion was observed at the liquid/vapor interface where even a slight decrease in nitrite or drop in pH could change its concentration to be below the threshold leading to an aggressive environment.

Corrosion attack was also seen near the base of several test samples. This attack was originally believed to be crevice corrosion associated with the seal between the test cell and sample. However, further examination indicated the corrosion was higher up on the sample than the test cell seal. Because a significant amount of corrosion product was observed at the interface (Figure 36), it was speculated that corrosion products may have accumulated at the base of the test cell and contributed to creating an occluded region. This hypothesis, however, was not studied further but is supported by the observation of corrosion products at the location of heavy corrosion. What is unclear is if the buildup of corrosion products is the cause or the result (or both) of the corrosion reaction at this location.

Figure 35. Stereo-Micrograph of the Test Sample from SSRT-53 Performed in AP-105-PSC Standard Simulant at 50°C, pH 13+, and at 0 mV vs. SCE.

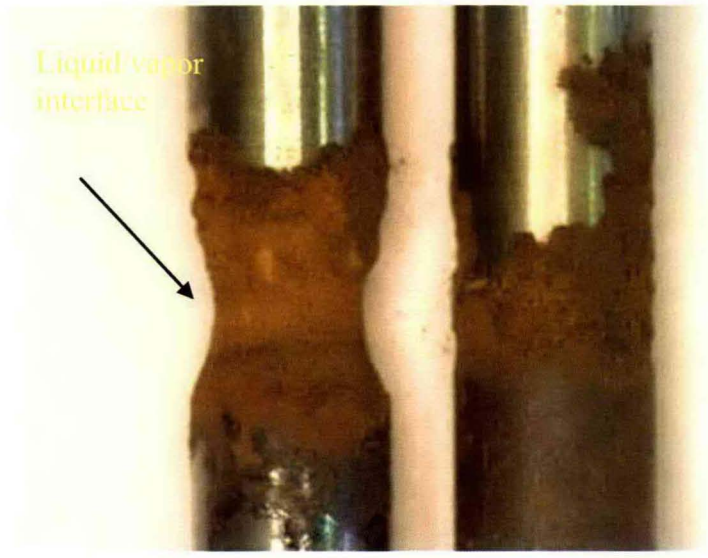


Figure 36. Photograph of the Test Sample from SSRT-54 Performed in AP-105-PSC Standard Simulant at 50°C, pH 13+, and at 0 mV vs. SCE.

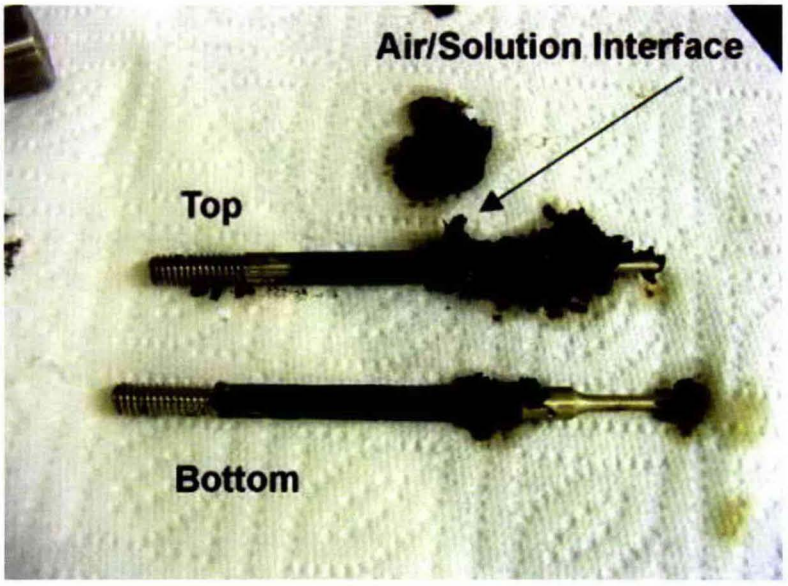
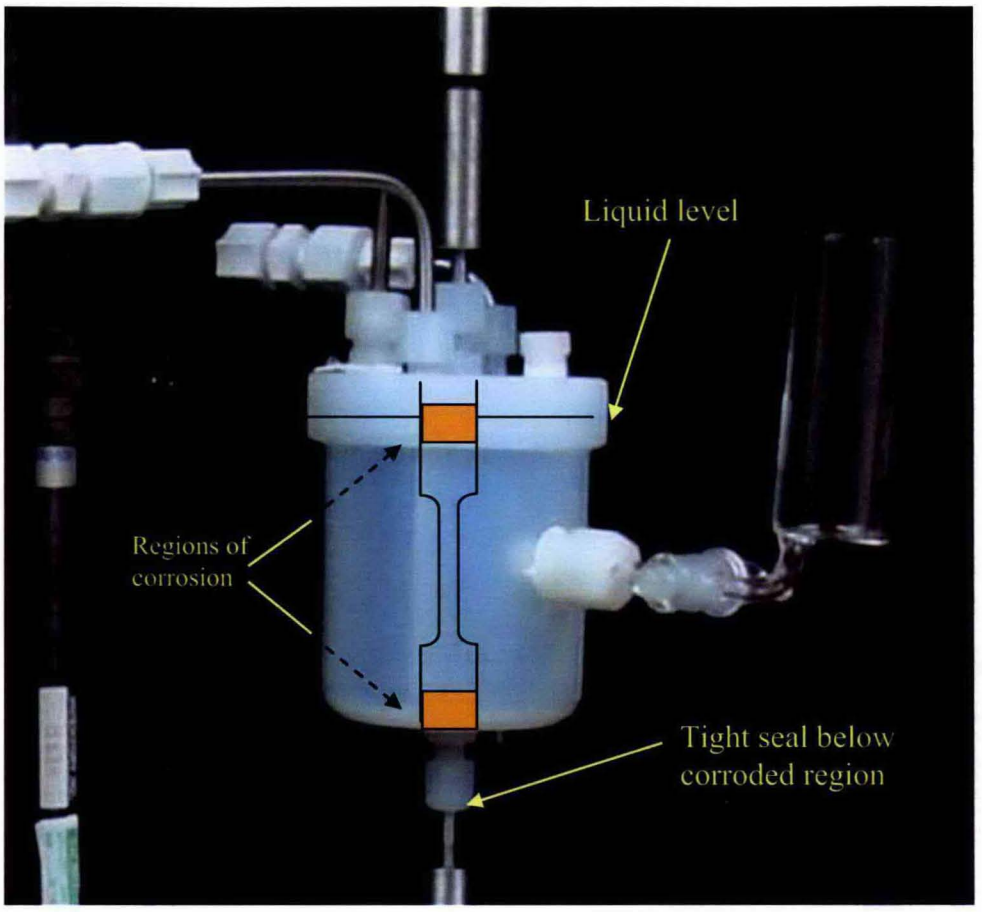


Figure 37. Photograph and Schematic of the Test Cell and Sample Indicating Regions of Corrosion (Schematic Not To Scale).



Tests performed in the AP-105 variants, that is mixed and evaporated simulants (SSRT 64 and SSRT 59, respectively), showed no evidence of SCC. These simulants have nitrite/nitrate ratios of ~0.14, so it was expected there may be SCC based on previous testing in the simulants with low nitrite contents. The simulants were modified to further decrease the nitrite/nitrate ratio to 0.1 to study the SCC sensitivity to the chemistry. SSRT 63 and SSRT 62, performed in mixed and evaporated simulants with a decreased nitrite content showed no evidence of SCC. Note that all of these tests were performed at OCP, and potentials were lower than potentials at which SCC has typically been observed.

4.3 ELECTROCHEMICAL POLARIZATION BEHAVIOR IN TANK 241-SY-103-PIL BASED SIMULANTS

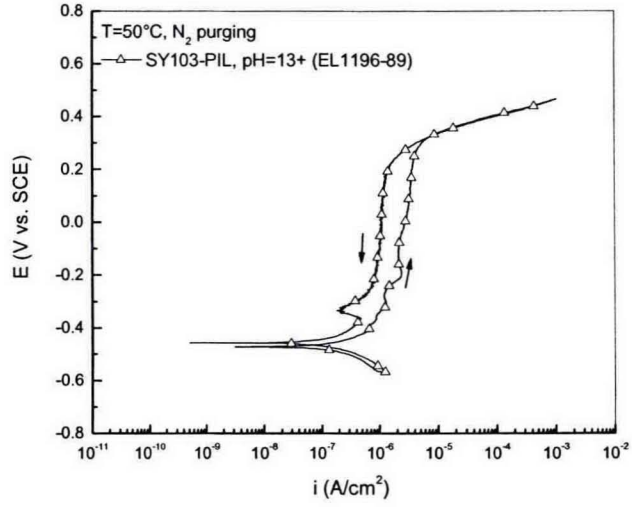
Table 9 summarizes the results of a CPP test conducted in the SY-103-PIL baseline simulant that investigated the susceptibility of the steel to localized corrosion in a simulant containing high chloride (0.5M). The chloride concentration in this simulant is the highest among the simulants that have been investigated thus far. No tests were performed in modified SY-103-PIL simulants.

Table 9. A Summary of Electrochemical Test Performed in SY-103-PIL Based Simulant.

Base Chemistry	pH	NO_2^- (M)	NO_3^- (M)	TIC (M)	OH^- (M)	Cl^- (M)	F^- (M)	T (°C)	Aeration condition	Visual	Sample ID (#EL1196-)
SY-103-PIL	>13	2.91	1.97	0.123	2.43	0.5	0	50	N_2 purging	No pitting	89

Figure 38 shows the CPP curve obtained in deaerated SY-103-PIL simulant at 50°C with a pH above 13. The CPP curve showed a negative hysteresis loop. No pitting corrosion was noted on the samples during post-test inspection. This phenomenon could indicate that there are other inhibiting species present in this simulant (e.g., 2.91 M nitrite in SY-103-PIL and/or pH 13), even though the chloride concentration in this simulant is high, 0.5 M.

Figure 38. A CPP Curve in Deaerated SY-103-PIL Simulant (pH>13 and T=50°C).



4.4 SLOW STRAIN RATE TESTING IN TANK 241-SY-103-PIL BASED SIMULANTS

Table 10 summarizes the results of the slow strain rate tests performed in SY-103-PIL simulants in quiescent air. Tests were performed at 50°C, and potentiostatically polarized to 0 mV vs. SCE or at OCP. Both tests were performed in the standard SY-103-PIL simulant. This simulant has high nitrate (1.97 M) and nitrite (2.91 M) concentrations, as well as a high chloride (0.5 M) concentration.

Table 10. A Summary of Slow Strain Rate Tests Performed in SY-103-PIL Based Simulants.

Test ID	Base Chemistry	pH	Temp (°C)	Pot (mV)	OCP (mV)	Failure Strain (%)	Failure Time (hrs)	SEM Surface Exam	Estimated CGR (mm/sec)
55	SY-103-PIL	14	50	OCP	-424	22.0	61.2	Ductile	-
57	SY-103-PIL	14	50	0	-477	22.4	62.2	Ductile	-

Figure 39 is a plot of the stress-strain data from the two tests. When polarized to 0 mV vs. SCE the SSRT specimen failed at 22.4% strain. The specimen that was tested at open circuit failed at 22.0% strain. No evidence of SCC was observed in either of the tests. Both stereoscopic (Figure 40) and electron microscopic (Figure 41) examinations displayed ductile fracture features. Examination of the secondary microcracks observed in the gauge section of the specimen indicated no intergranular features. These results are consistent with CPP results already discussed. That is, although chloride concentration is elevated in this simulant, other inhibiting chemicals may still be able to prevent SCC.

Figure 39. The Stress-Strain Behavior of Samples Tested in SY-103-PIL Based Simulants at 0 mV vs. SCE and at OCP (-424 mV vs. SCE).

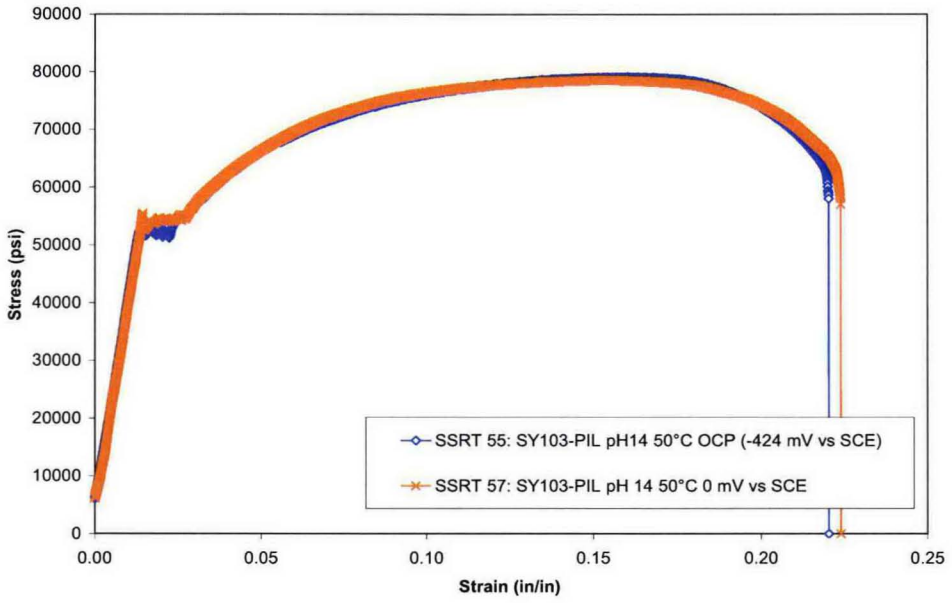
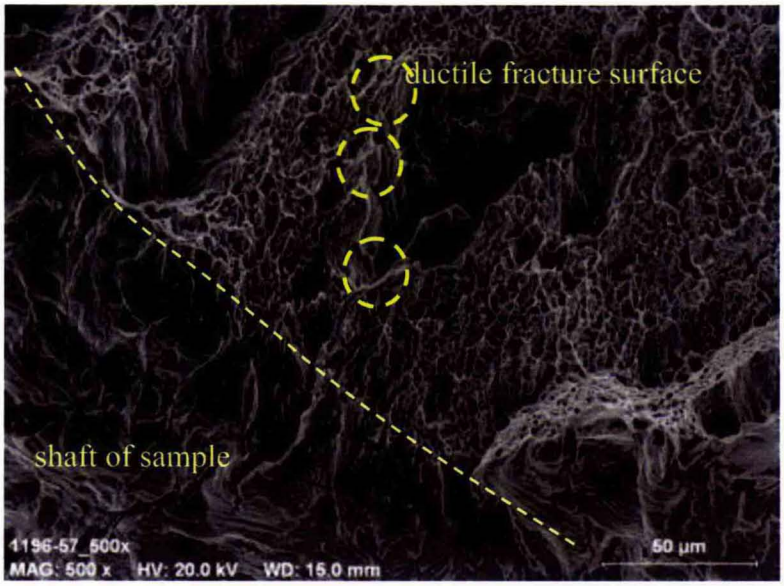


Figure 40. Stereo-Micrograph of the Test Sample from SSRT-57 Performed in SY-103-PIL Standard Simulant at 50°C, pH 14, at a Potential of 0 mV vs. SCE. The yellow dashed circles indicate axial microcracks observed on the shaft of the sample.

Figure 41. Electron-Micrograph of the Fracture Surface of Test Sample from SSRT-57 Performed in SY-103-PIL Standard Simulant at 50°C, pH 14, at a Potential of 0 mV vs. SCE.



4.5 ELECTROCHEMICAL POLARIZATION BEHAVIOR IN TANK 241-AW-105 BASED SIMULANTS

Table 11 summarizes the CPP test conducted in the AW-105 baseline simulant. These tests were aimed at investigating the susceptibility of the steel to localized corrosion in simulants containing high fluoride concentrations (0.58M fluoride in the AW-105-PIL simulant) or a low nitrite-to-nitrate concentration ratio (Nitrite/nitrate of 0.145 in the AW-105-PSC simulant). No tests were performed using modified AW-105 simulants.

Table 11. A Summary of Electrochemical Test Performed in AW-105 Based Simulant.

Base Chemistry	pH	NO_2^- (M)	NO_3^- (M)	TIC (M)	OH^- (M)	Cl^- (M)	F^- (M)	T (°C)	Aeration condition	Testing type	Visual	Sample ID (#EL1196-)
AW-105-PIL	>13	0.124	0.419	0.097	0.4502	0.01	0.58	50	N_2 purging	CPP Full immersion	No pitting	90
AW-105-PSC	>13	0.0638	0.44	0.1076	0.2630	0.0083	0.156	50	N_2 purging	CPP Full immersion	No pitting	108

Figure 42 shows the CPP curve obtained in deaerated AW-105-PIL simulant at 50°C with a pH above 13. The CPP curve showed a negative hysteresis loop and no pitting corrosion was noted on the samples during post-test inspection even though the fluoride concentration in this simulants is as high as 0.58 M. This indicates that either there are other inhibiting species present in these simulant (e.g., pH 13) or that the concentration of the aggressive species (e.g., nitrate at 0.42 M) is below a critical threshold above which localized corrosion would occur.

Figure 42. A CPP Curve in Deaerated AW-105-PIL Simulant (pH>13 and T=50°C).

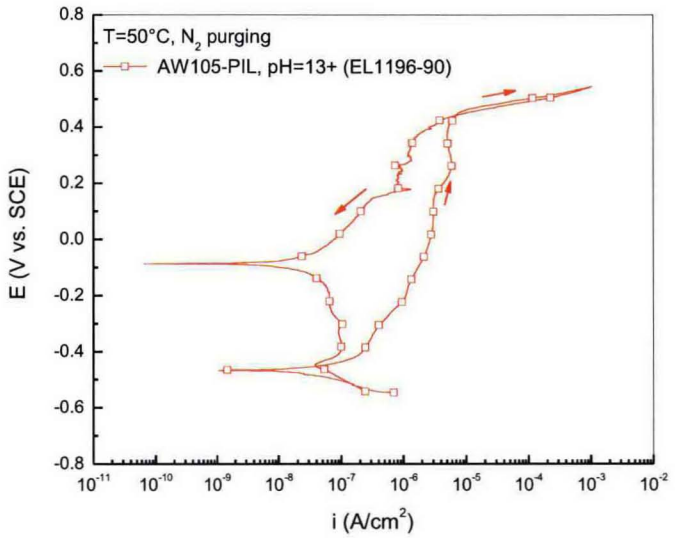
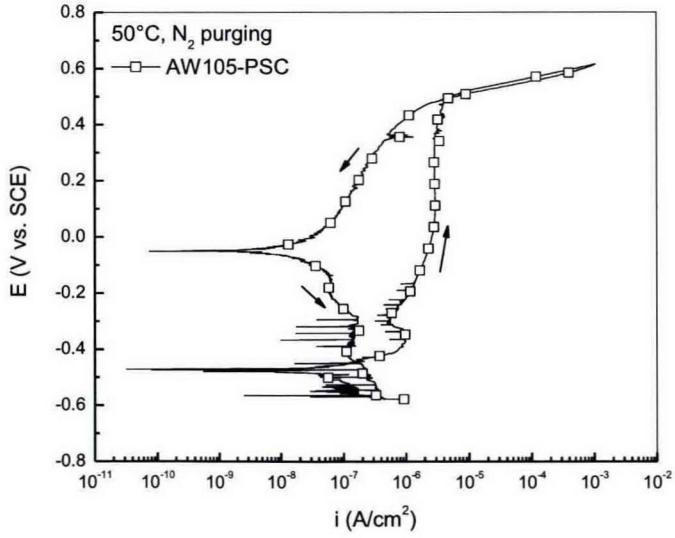


Figure 43 is a CPP curves in deaerated AW-105-PSC simulant at 50°C. Again, no clear positive hysteresis loop was observed on the curve and the sample did not show any indication of localized corrosion. The lack of localized corrosion on the samples suggests that even though the nitrite/nitrate ratio in this simulants is lower than other simulants investigated before, other inhibitory species present in these simulants were able to efficiently prevent localized corrosion. Additionally, the benign nature of these simulants with respect to localized corrosion may be a result of the relatively low concentration of the aggressive nitrate.

Figure 43. A CPP Curve in Deaerated AW-105-PSC Simulant (pH>13 and T=50°C).



4.6 SLOW STRAIN RATE TESTING IN TANK 241-AW-105 BASED SIMULANTS

Table 12 summarizes the results of the SSRTs performed in AW-105 based simulants. Tests were performed at 50°C and at OCP or potentiostatically polarized to 0 mV vs. SCE. Two tests were performed in the base AW-105-PIL simulant. This simulant has a low nitrate (0.42 M) and nitrite (0.12 M) concentration, as well as a high fluoride (0.58 M) content. Six tests were performed in AW-105-PSC or PSC-modified simulant. The PSC simulant has a low nitrate (0.44 M) and low nitrite (0.06 M) concentration. The PSC –modified tests were performed with either half the typical nitrite, or with three times the typical nitrite and six times the typical nitrate. These modifications were made to study the nitrite / nitrate ratio versus potential relationship.

Table 12. A Summary of Slow Strain Rate Tests Performed in AW-105 Based Simulants.

Test ID	Base Chemistry	pH	Temp (°C)	Pot (mV)	OCP (mV)	Failure Strain (%)	Failure Time (hrs)	SEM Surface Exam	Estimated CGR (mm/sec)
56	AW-105-PIL	13+	50	OCP	-290	22.3	62.0	Ductile	-
58	AW-105-PIL	13+	50	0	-193	21.7	60.3	Ductile	-
66	AW-105-PSC	13+	50	OCP	-235	21.3	61.9	Ductile	-
71	AW-105-PSC	13+	50	-100	-269	23.4	65.1	Ductile	-
72	AW-105-PSC	13+	50	-50	-210	21.9	60.8	Ductile	-
73	AW-105-PSC (half nitrite)	13+	50	-100	-217	22.5	65.4	Ductile	-
74	AW-105-PSC "6X"	13+	50	-100	-257	22.1	61.3	Ductile	-
75	AW-105-PSC "6X"	13+	50	-50	-270	8.5	23.6	Visible corrosion	

Figure 44 is a plot of the stress-strain data from the two tests performed in AW-105-PIL. When polarized to 0 mV vs. SCE, the SSRT specimen failed at 21.7% strain. The specimen that was tested at open circuit failed at 22.3% strain. Corrosion product was observed around axial micro-cracks along the shaft of the test sample that was performed at OCP (Figure 45). These microcracks have been observed in many of the previous test samples, and are attributed to grain boundary tearing. No intergranular features were observed during SEM examination, as shown in Figure 46 and Figure 47, though it is possible that such features corroded away prior to examination (though this seems unlikely given the nominally benign nature of this simulant) The test performed at 0 mV vs. SCE was also devoid of intergranular features on the fracture surface (Figure 48); however, there was some interfacial corrosion along the shaft of the test specimen at the liquid/vapor interface (Figure 49). Since the nitrite concentration in the AW-105-PIL is relatively low compared to other aggressive species, the attack at the interface may be due to a similar mechanism that led to the interface corrosion in the AP-105-PSC. That is, although the existing nitrite concentration was able to inhibit localized corrosion in the bulk solution, in the case that the nitrite concentration was decreased due to an unknown depletion mechanism at the interface, the environment could become aggressive to cause localized corrosion.

Figure 44. Stress-Strain Behavior of Samples Tested in AW-105-PIL Based Simulants at 0 mV vs. SCE and at OCP (-290 mV vs. SCE).

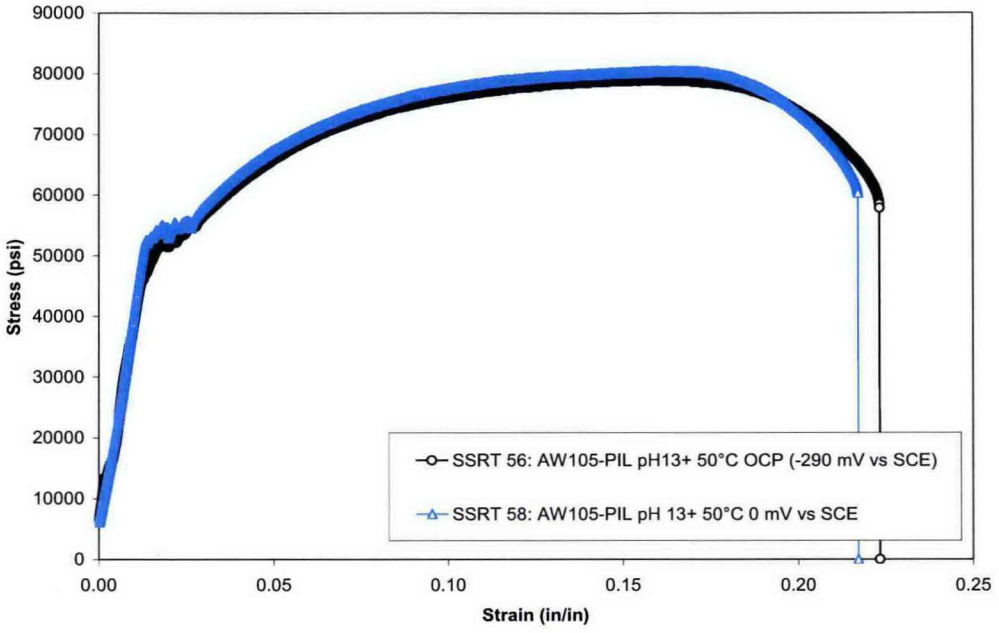


Figure 45. Stereo-Micrograph of the Test Sample from SSRT-56 Performed in AW-105-PIL Standard Simulant at 50°C, pH 13+, at OCP (-290 mV vs. SCE). The yellow dashed circles indicate axial microcracks observed on the shaft of the sample.

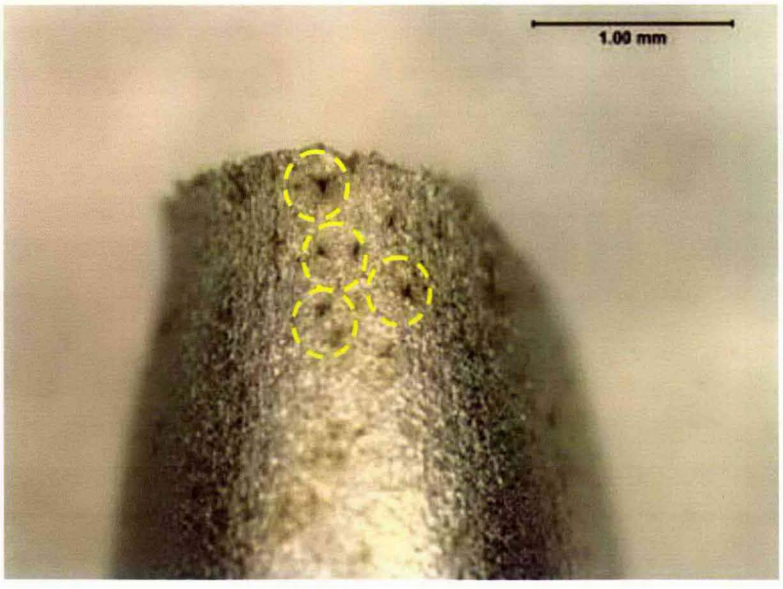


Figure 46. Electron-Micrograph of the Fracture Surface of Test Sample from SSRT-56 Performed in AW-105-PIL Standard Simulant at 50°C, pH 13+, at OCP (-290 mV vs. SCE).

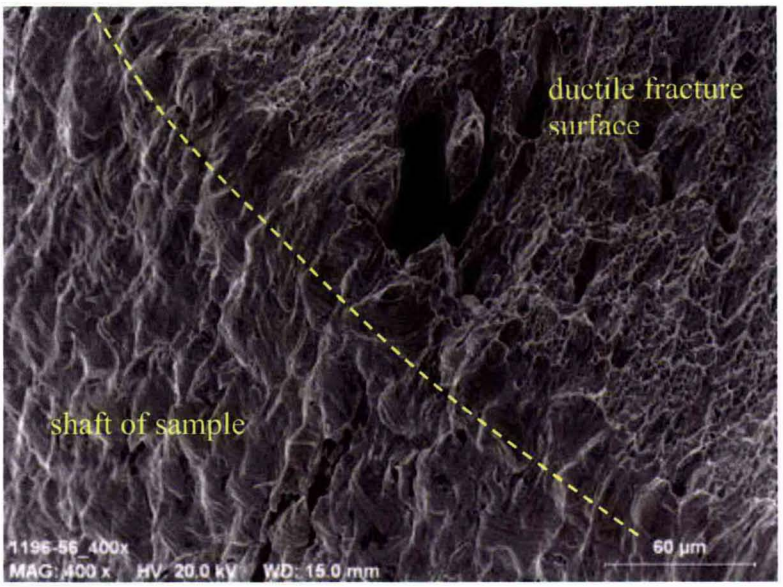


Figure 47. Electron-Micrograph of an Axial Micro-Crack on the Shaft of Test Sample from SSRT-56 Performed in AW-105-PIL Standard Simulant at 50°C, pH 13+, at OCP (-290 mV vs. SCE).

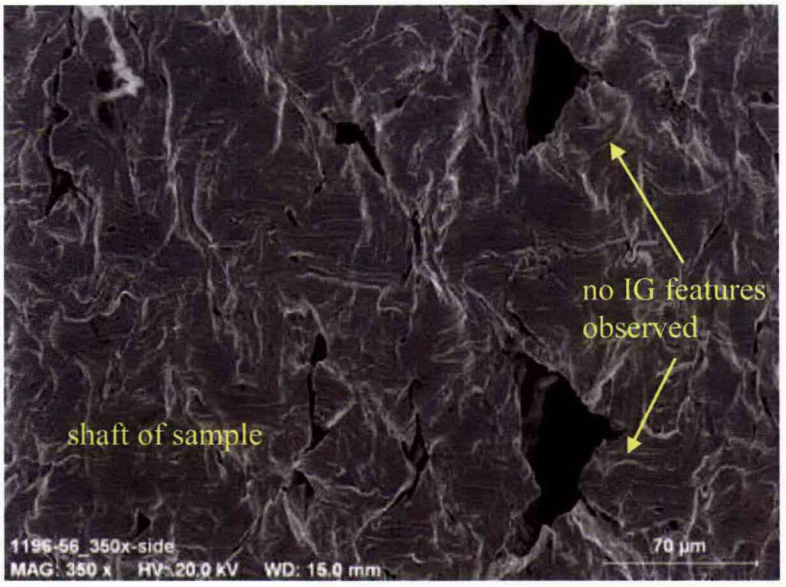


Figure 48. Electron-Micrograph of the Fracture Surface of Test Sample from SSRT-58 Performed in AW-105-PIL Standard Simulant at 50°C, pH 13+, at 0 mV vs. SCE.

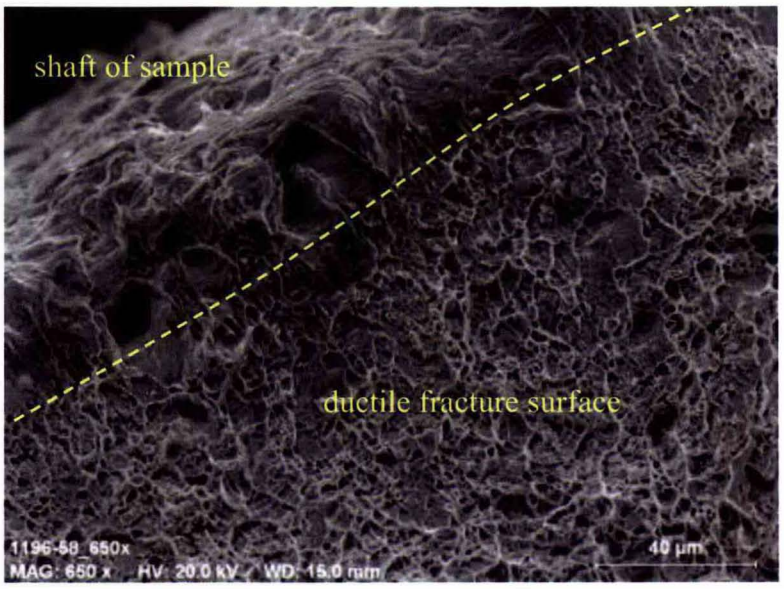
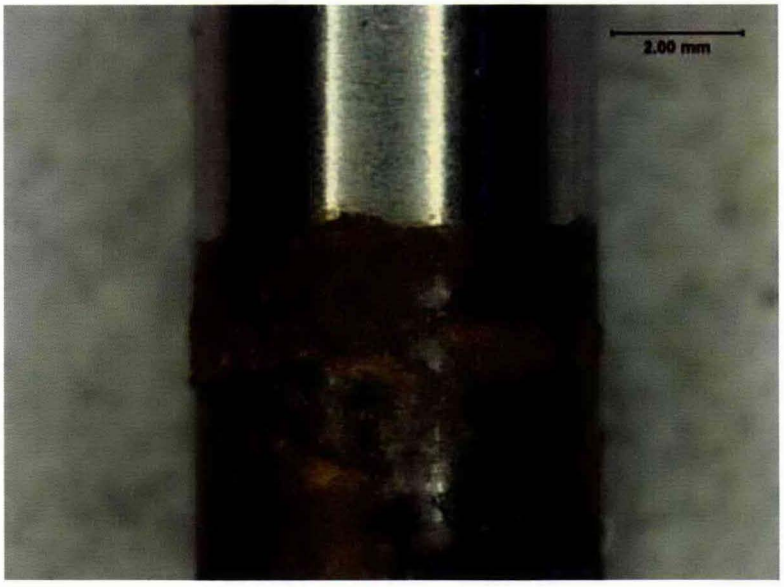


Figure 49. Stereo-Micrograph of the Shaft of Test Sample from SSRT-58 Performed in AW-105-PIL Standard Simulant at 50°C, pH 13+, at 0 mV vs. SCE.



Tests in AW-105-PSC base simulants showed no evidence of SCC when performed at OCP, -100 mV or -50 mV vs. SCE. Failure occurred between 21.3 and 23.4 %. Tests in the "6X" simulant were performed with the same nitrite/nitrate ratio as the "half nitrite" modified simulant, but with six times the absolute amounts of both nitrite and nitrate. This was done to explore the relations between nitrite / nitrate ratio and absolute nitrate content versus potential. Figure 50 is a plot of the stress-strain data from two of the tests performed in AW-105-PSC modified simulants. The test performed at -100 mV vs. SCE failed at 22.1 % strain. Corrosion was observed at the liquid/vapor interface, but no intergranular features were observed on the fracture surface during

SEM examination, see Figure 51 and Figure 52. The test performed at -50 mV vs. SCE failed at 8.5 % strain, and severe corrosion was observed on the fracture surface and along its gauge length, see Figure 53. The results suggest that there is a "critical" potential between -100 mV and -50 mV vs. SCE necessary for significant corrosion to occur in this modified simulant.

Figure 50. Stress-Strain Behavior of Samples Tested in AW-105-PSC "6X" Simulant at -50 and -100 mV vs. SCE.

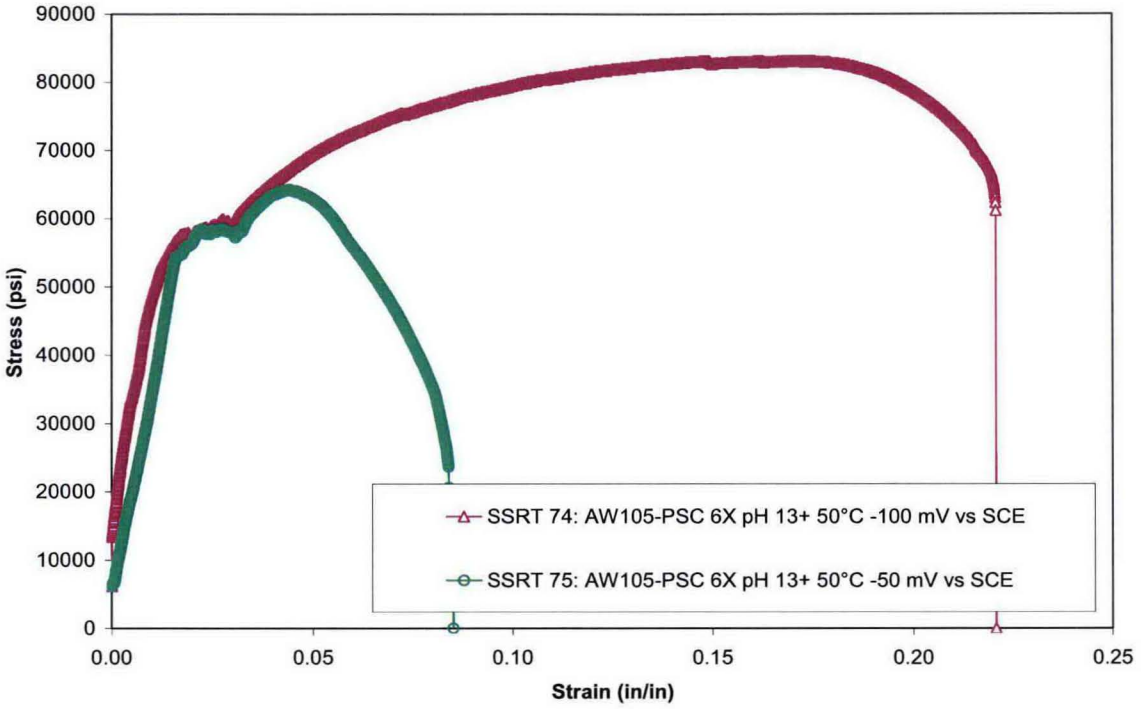


Figure 51. Photograph of the Test Sample from SSRT-74 Performed in AW-105-PSC 6X Simulant at 50°C, pH 13+, at a Potential of -100 mV vs. SCE.

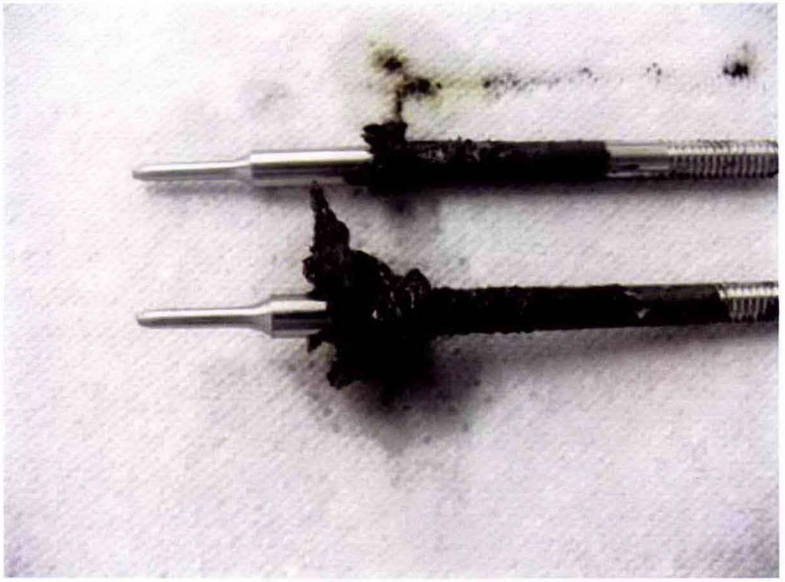


Figure 52. Electron-Micrograph of the Fracture Surface of Test Sample from SSRT-74 Performed in AW-105-PSC 6X Simulant at 50°C, pH 13+, at a Potential of -100 mV vs. SCE.

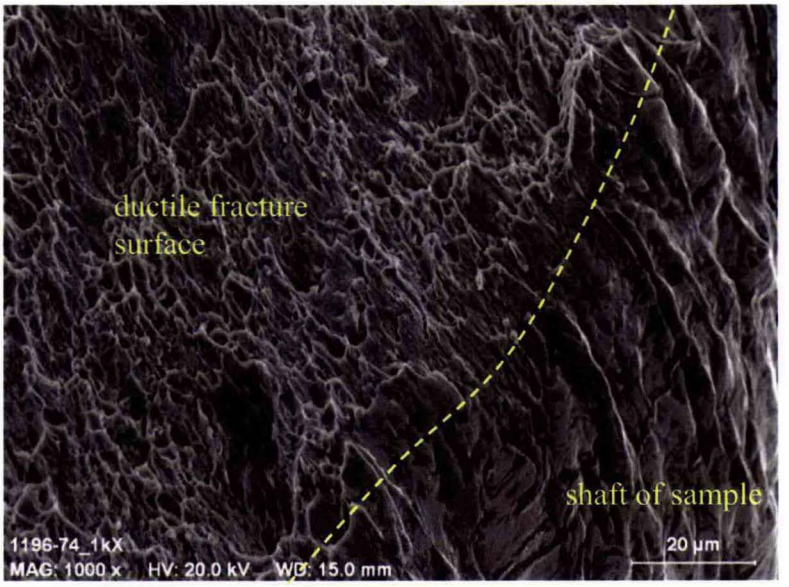
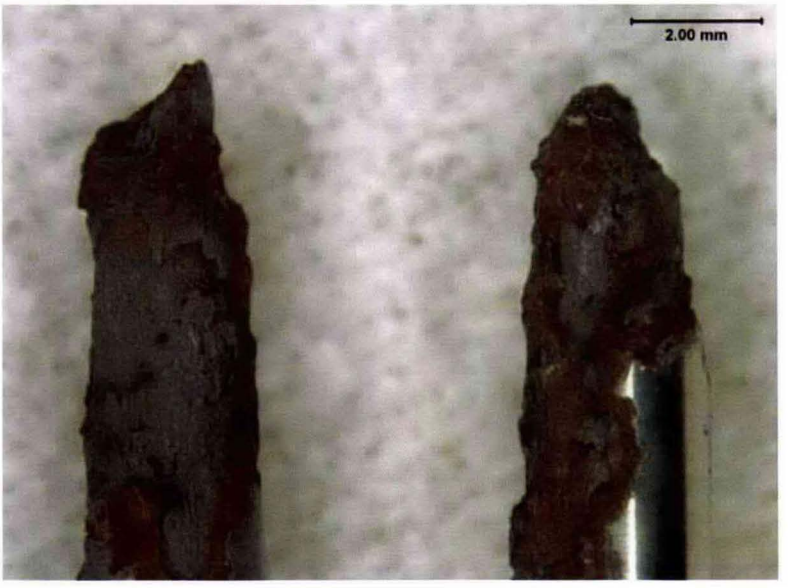


Figure 53. Stereo-Micrograph of the Test Sample from SSRT-75 Performed in AW-105-PSC 6X Simulant at 50°C, pH 13+, at a Potential of -50 mV vs. SCE.



4.7 SLOW STRAIN RATE TESTING IN TANK 241-AN-107 BASED SIMULANTS

Table 13 summarizes the results of SSRTs performed in AN-107 simulants. Tests were performed at 50°C and potentiostatically polarized to potentials between -740 and -790 mV vs. SCE. The objective of these experiments was to test the propensity of carbonate cracking at low potentials since AN-107 simulant contains 1.4 M carbonate. Previous testing in AY-102-PIL simulants with high carbonate (1.021M) contents indicated cracking at low potentials -750 to -800 mV vs. SCE. These potentials correspond to the active-passive transition range observed in the AY-102-PIL CPP curve from previous studies.

Table 13. A Summary of Slow Strain Rate Tests Performed in AN-107 Based Simulants.

Test ID	Base Chemistry	pH	Temp (°C)	Pot (mV)	OCP (mV)	Failure Strain (%)	Failure Time (hrs)	SEM Surface Exam	Estimated CGR (mm/sec)
47	AN-107	11	50	-740	-315	22.5	62.9	Ductile	-
48	AN-107	11	50	-765	-296	21.4	61.6	Ductile	-
49	AN-107	11	50	-790	-274	22.0	61.1	Ductile	-

Figure 54 is a plot of the stress-strain data from the three SSRTs. The samples all failed at strain from 21.4 to 22.5 %. No intergranular features were observed during SEM examination of any of these tests, suggesting the steel is not susceptible to cracking in AN-107 at potentials where carbonate cracking was observed in AY-102-PIL simulants, see example (Figure 55). It should be pointed out that the OCP of steel in the AN-107 simulants were generally much higher than the tested potentials above because the cathodic reactions were likely dominated by nitrite and/or nitrate reduction that occurred at potentials much more positive than -800 mV vs. SCE. In carbonate-based waste simulants, an active-passive transition associated with the formation of carbonate films was observed at potentials near -800 mV vs. SCE and was not observed on the CPP curves in the AN-107 simulants. Therefore, these tested potentials were selected similar to the potentials in AY-102-PIL where carbonate cracking was observed. Based on the observations in AY-102-PIL, the potential range for carbonate cracking was near -800 mV vs. SCE and fairly narrow. In the AN-107 simulants, the results above could indicate that cracking at these low potentials is not possible or the tested potentials may be away from any active/passive transition that may (or may not) be present. As mentioned above, because of the significant amount of nitrite and nitrate in AN-107 simulants, it is unlikely that the OCP of the tank steel would be anywhere near -800 mV vs. SCE and therefore the likelihood of the steel cracking at these low potentials is extremely small. Because of this, no further work was conducted to investigate the susceptibility of steel to carbonate cracking in AN-107 simulants.

Figure 54. Stress-Strain Behavior of Samples Tested in AN-107 Based Simulants at various potentials.

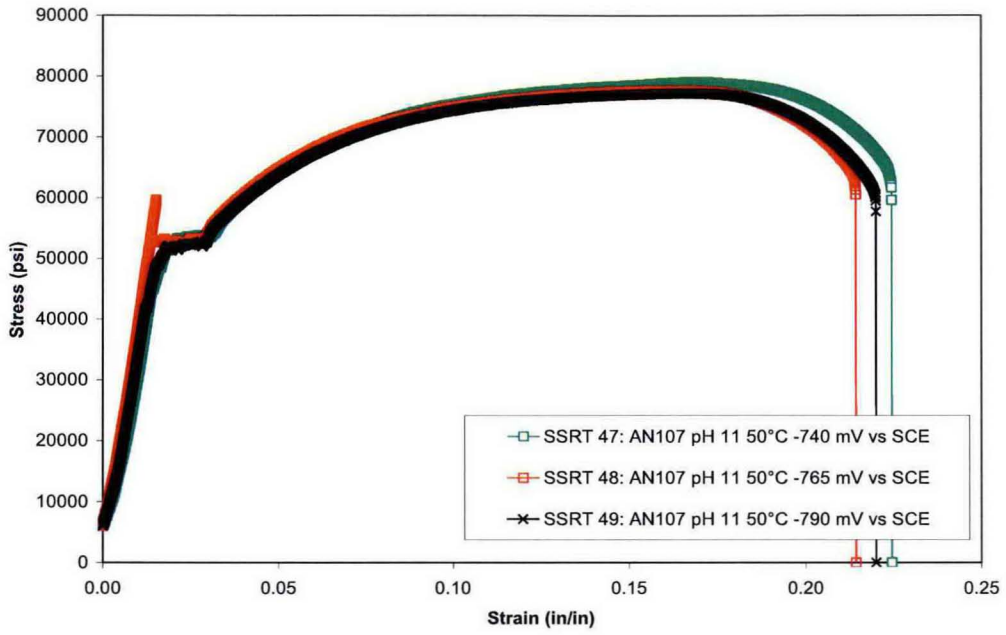
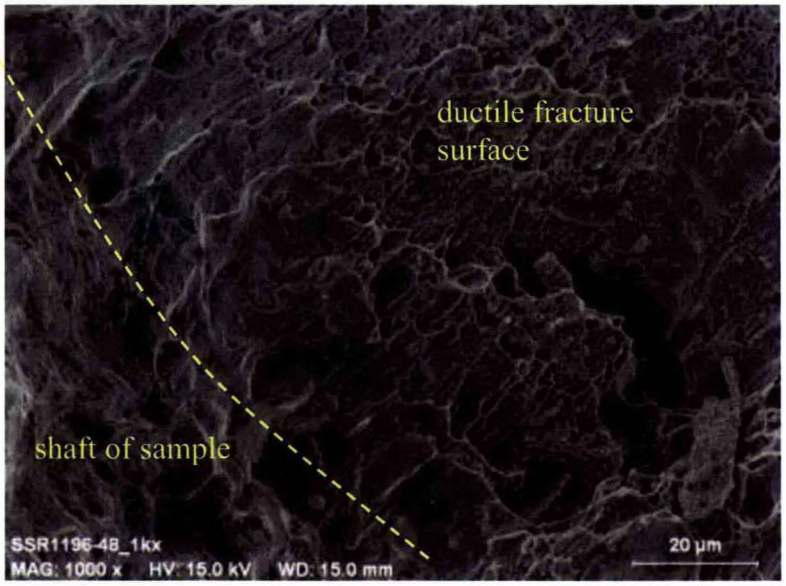


Figure 55. Electron-Micrograph of the Fracture Surface of Test Sample from SSRT-48 Performed in AN-107 Standard Simulant at 50°C, pH 11, at a Potential of -765 mV vs. SCE.



4.8 ELECTROCHEMICAL POLARIZATION BEHAVIOR IN TANK 241-AZ-102 BASED SIMULANT

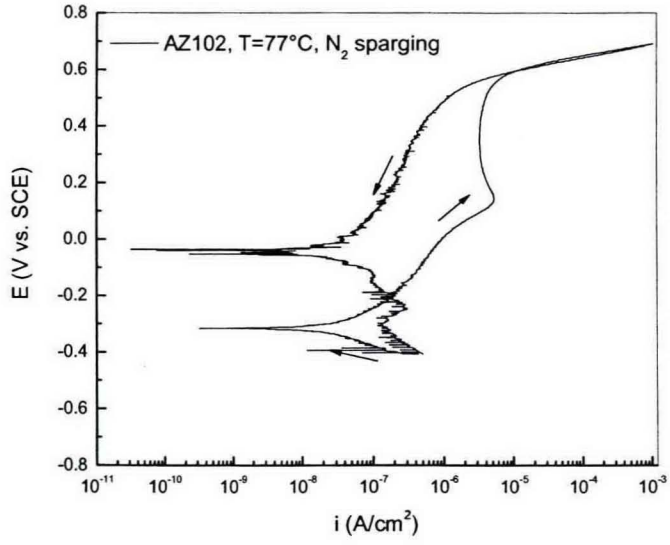
Table 14 summarizes the results of the CPP test conducted in the AZ-102 simulant that investigated the susceptibility of the steel to localized corrosion in simulants at a temperature level higher than 50°C. The test temperature for AZ-102 simulant was 77°C, which represents the upper bound of the temperature levels in all waste simulants. No tests were performed using modified AZ-102 simulants.

Table 14. A Summary of Electrochemical Test Performed in AZ-102 Based Simulant.

Base Chemistry	pH	NO_2^- (M)	NO_3^- (M)	TIC (M)	OH^- (M)	Cl^- (M)	F^- (M)	T (°C)	Aeration condition	Testing type	Visual	Sample ID (#EL1196-)
AZ-102	>12	0.883	0.105	0.619	-	-	0.052	77	N_2 purging	CPP Full immersion	No pitting	103

Figure 56 is the CPP curve obtained in the deaerated AZ-102 simulant at 77°C. No clear positive hysteresis loop was observed and the sample did not show any indication of localized corrosion even at 77°C. The lack of localized corrosion on the sample is consistent with the inhibitory role of nitrite, since the nitrite concentration in this simulant is significantly higher than nitrate and other aggressive species (nitrite-to-nitrate concentration ratio of 8.4).

Figure 56. CPP Curve in Deaerated AZ-102 Simulant (pH>12 and T=77°C).



4.9 SLOW STRAIN RATE TESTING IN TANK 241-AZ-102 BASED SIMULANT

Table 15 summarizes the results of the slow strain rate test performed in the AZ-102 simulant. Only one test was performed, and it was at 77°C and at OCP. The standard AZ-102 simulant has high nitrite (0.88 M) and low nitrate (0.105 M) concentrations, and contains no halides.

Table 15. A Summary of Slow Strain Rate Tests Performed in AZ-102 Simulant.

Test ID	Base Chemistry	pH	Temp (°C)	Pot (mV)	OCP (mV)	Failure Strain (%)	Failure Time (hrs)	SEM Surface Exam	Estimated CGR (mm/sec)
61	AZ-102	12+	77	OCP	-239	21.0	58.3	Ductile	-

The AZ-102 simulant has a very high nitrite/nitrate ratio (8.4) and no chlorides or fluorides, so no SCC or pitting was expected. In addition, the CPP curve exhibited no positive hysteresis. No localized corrosion was observed during post-test examination of the sample. The single SSRT in AZ-102 simulant failed at 21.0 % strain (Figure 57). No evidence of SCC was observed on the fracture surface of the test sample during SEM examination (see Figure 58). The SSRT result and CPP test results are consistent with previous test results in which nitrite was demonstrated to be inhibitory towards localized corrosion and SCC.

Figure 57. The Stress-Strain Behavior of the Sample Tested in AZ-102 Simulants at OCP (-239 mV vs. SCE).

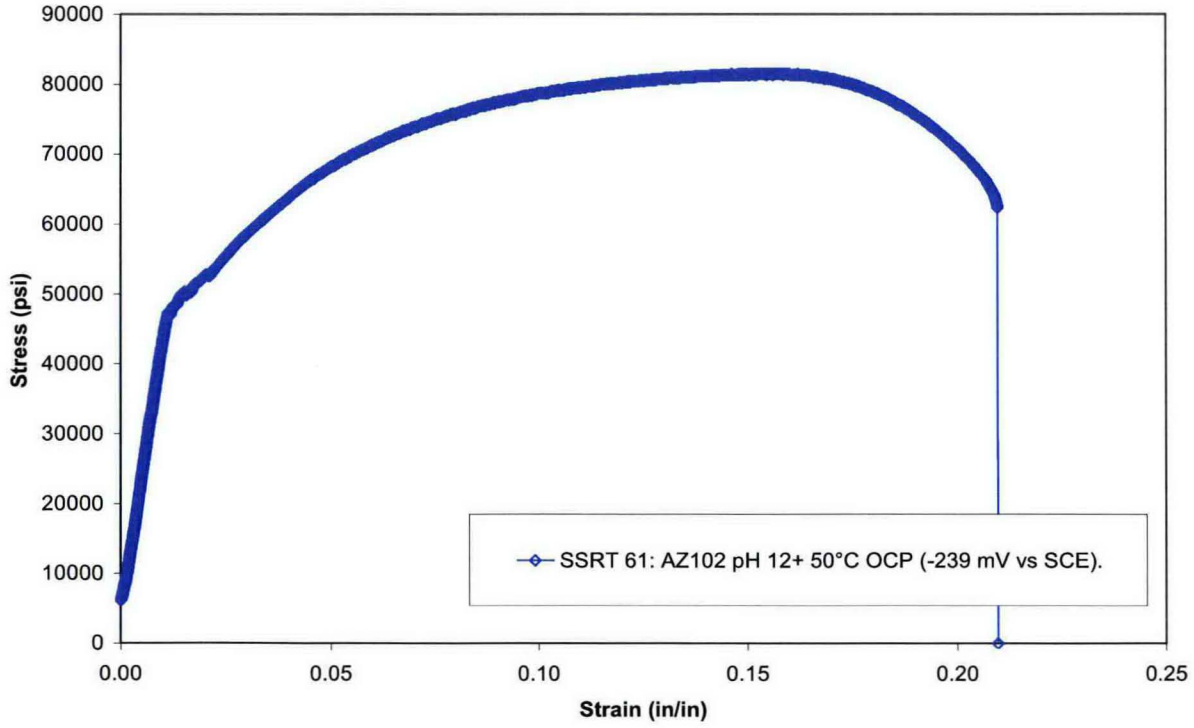
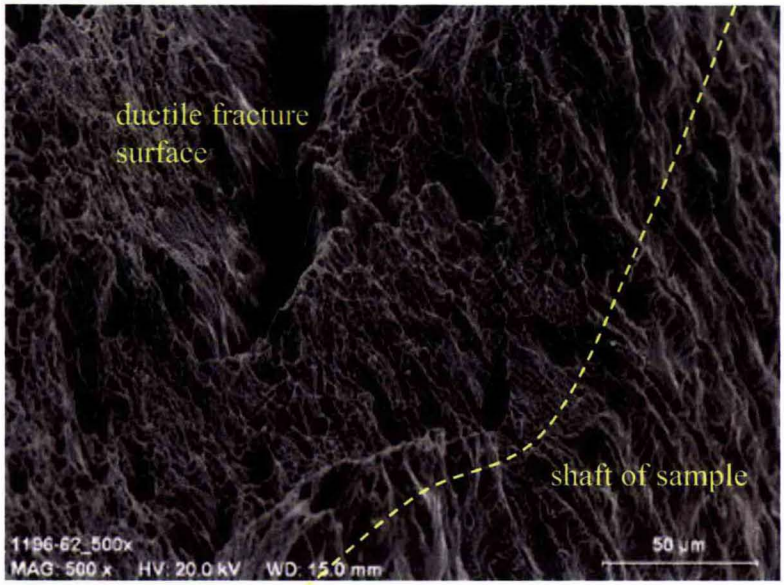


Figure 58. Electron-Micrograph of the Fracture Surface of Test Sample from SSRT-61 Performed in AZ-102 Simulant at 77°C, pH 12+, at a Potential of -239 mV vs. SCE.



4.10 ELECTROCHEMICAL POLARIZATION BEHAVIOR IN TANK 241-SY-101 BASED SIMULANT

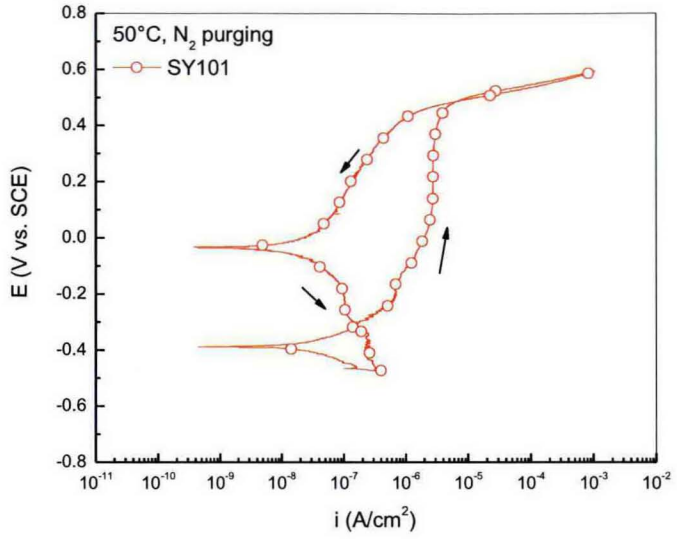
Table 16 summarizes the results of the CPP test conducted in the SY-101 simulant. The SY-101 simulant has a relatively lower nitrite-to-nitrate concentration ratio than other simulants being investigated. No tests were performed using modified SY-101 simulants.

Table 16. A Summary of Electrochemical Test Performed in SY-101 Based Simulant.

Base Chemistry	pH	NO_2^- (M)	NO_3^- (M)	TIC (M)	OH^- (M)*	Cl^- (M)	F^- (M)	T (°C)	Aeration condition	Testing type	Visual	Sample ID (#EL1196-)
SY-101	>13	0.2027	0.9313	0.1328	0.6555	0.0228	0.0277	50	N_2 purging	CPP Full immersion	No pitting	109

Figure 59 is a CPP curve in deaerated SY-101 simulant at 50°C. No positive hysteresis loop was observed on the curve and the sample did not show any indication of localized corrosion. The lack of localized corrosion on the samples suggests that even though the nitrite/nitrate ratio in this simulant is lower than other simulants investigated before, other inhibitory species present in this simulants were able to efficiently prevent localized corrosion. Additionally, the benign nature of this simulant with respect to localized corrosion may be a result of the relatively low concentration of the aggressive species.

Figure 59. CPP curves in deaerated SY-101 simulant at pH 13+ and 50°C.



4.11 SLOW STRAIN RATE TESTING IN TANK 241-SY-101 BASED SIMULANT

Table 17 summarizes the results of the slow strain rate tests performed in the SY-101 simulant. Only one test was performed, and it was at 50°C and OCP. This simulant has high nitrate (0.93 M) and low nitrite (0.20 M) concentrations.

Table 17. Summary of Slow Strain Rate Tests Performed in SY-101 Simulants.

Test ID	Base Chemistry	pH	Temp (°C)	Pot (mV)	OCP (mV)	Failure Strain (%)	Failure Time (hrs)	SEM Surface Exam	Estimated CGR (mm/sec)
67	SY-101	13+	50	OCP	-206	22.9	63.7	Ductile	-

The SY-101 simulant has a relatively low nitrite/nitrate ratio (0.18), so SCC or pitting was considered possible. However, no positive hysteresis was observed in the CPP curve and no localized corrosion was observed during post-test examination of the sample. The single SSRT performed in SY-101 simulant failed at 22.9 % strain (Figure 60). No evidence of SCC was observed on the fracture surface of the test sample during SEM examination (see Figure 61).

Figure 60. Stress-Strain Behavior of the Sample Tested in SY-101 Simulant at OCP (-206 mV vs. SCE).

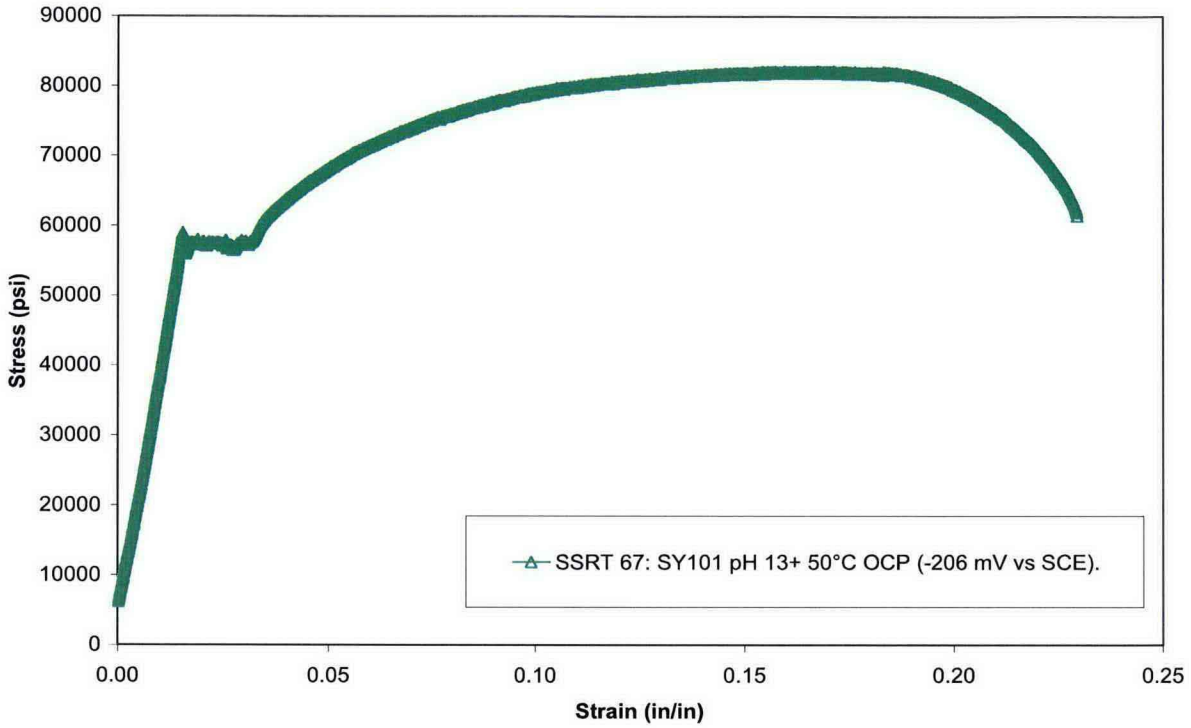
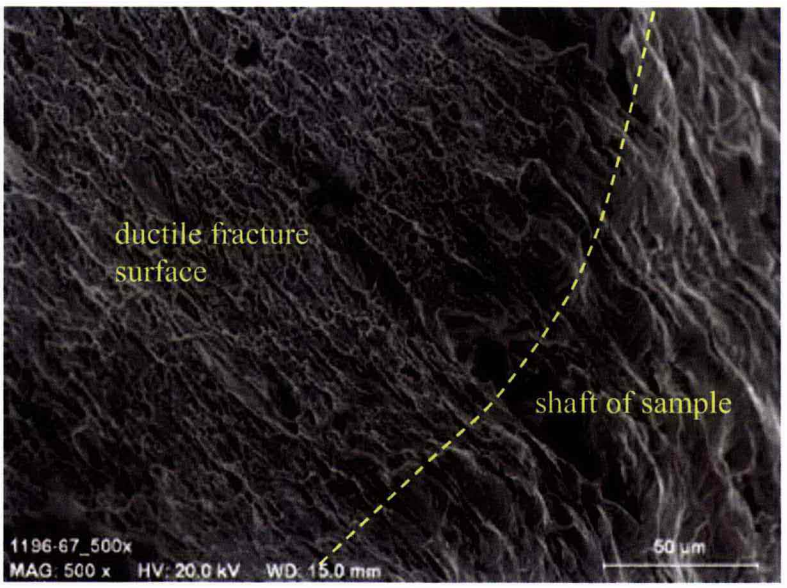


Figure 61. Electron-Micrograph of the Fracture Surface of Test Sample from SSRT-67 Performed in SY-101 Simulant at 50°, pH 13+, at a Potential of -206 mV vs. SCE.



4.12 ELECTROCHEMICAL POLARIZATION BEHAVIOR IN TANK 241-AY-101-CSL SIMULANT

Table 18 summarizes the results of the CPP tests conducted in the standard AY-101-CSL simulants and the modified AY-101-CSL simulants. The tests performed in the standard AY-101-CSL simulants established the baseline of the susceptibility of the tank steel to localized corrosion whereas the tests in the modified AY-101-CSL simulants (with pH adjusted) were performed to understand the impact of pH on the localized corrosion susceptibility of the tank steel.

Table 18. Summary of Electrochemical Test Performed in AY-101-CSL Based Simulant.

Base Chemistry	pH	NO_2^- (M)	NO_3^- (M)	TIC (M)	OH^- (M)*	Cl^- (M)	F^- (M)	T (°C)	Aeration condition	Testing type	Visual	Sample ID (#EL1196-)
AY-101-CSL	11.8	0.0368	0.181	0.1474	0.0051	0.0064	0.0015	50	N_2 purging	CPP Full immersion	Pitting	111
AY-101-CSL	12.8	0.0368	0.181	0.1474	0.0051	0.0064	0.0015	50	N_2 purging	CPP Full immersion	No Pitting	112
AY-101-CSL	11.8	0.0368	0.181	0.1474	0.0051	0.0064	0.0015	Room	N_2 purging	CPP Full immersion	No Pitting	113
AY-101-CSL	12.3	0.0368	0.181	0.1474	0.0051	0.0064	0.0015	50	N_2 purging	CPP Full immersion	Pitting	115

* This reflects the concentration prior to pH adjustment.

Figure 62 is a comparison of the CPP curves obtained in the AY-101-CSL simulants under different conditions. The CPP curve at pH 11.8 and 50°C showed an open loop with the passivation potential below the OCP. This is consistent with the observation of severe localized corrosion on the sample after the CPP test, as shown in Figure 63. At room temperature and pH 11.8, the CPP curve showed a negative hysteresis loop. The pitting corrosion noted at 50°C was not observed on the sample tested at the same pH but at room temperature. At pH 12.3 and 50°C, the CPP curve still exhibited an open loop even though the pitting potential was slightly higher than at pH 11.8. The sample showed severe localized corrosion after the CPP test, as shown in Figure 64. When the pH of the simulant was increased to 12.82, the CPP curve was similar to that at room temperature and pH 11.8 in that it showed a negative hysteresis loop. No pitting corrosion was noted at pH 12.8, even at 50°C. The testing results in the AY-101-CSL as a function of temperature and pH implied that the steel was susceptible to localized corrosion in this simulant at 50°C and pH 11.8 despite the relatively low concentration of aggressive species (such as nitrate = 0.181 M). The pitting corrosion at this pH, however, can be mitigated by decreasing the temperature. Furthermore, the results suggest that a threshold of pH exists above which pitting corrosion will not occur even at an elevated temperature (50°C). This threshold appeared to be between pH 12.3 and pH 12.8, but was not precisely determined with the limited experimental efforts conducted.

Figure 62. A Comparison of CPP Curves in the Deaerated AY-101-CSL Simulant at Different pH Levels and Temperatures.

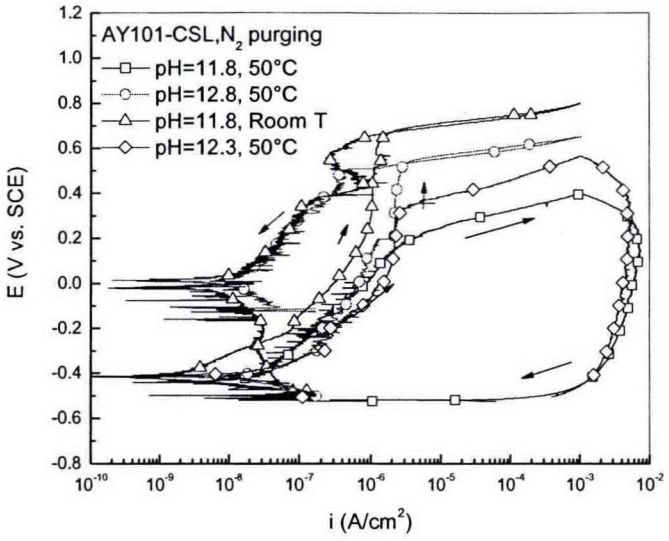


Figure 63. Appearance of the Sample after CPP test in the Deaerated AY-101-CSL Simulant at 50°C and pH 11.8. (a) Before Cleaning; (b) After cleaning.

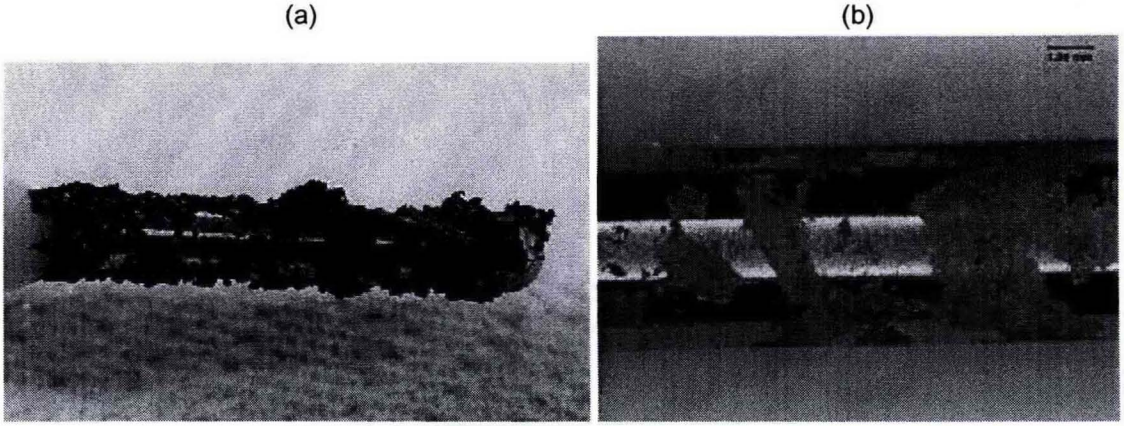
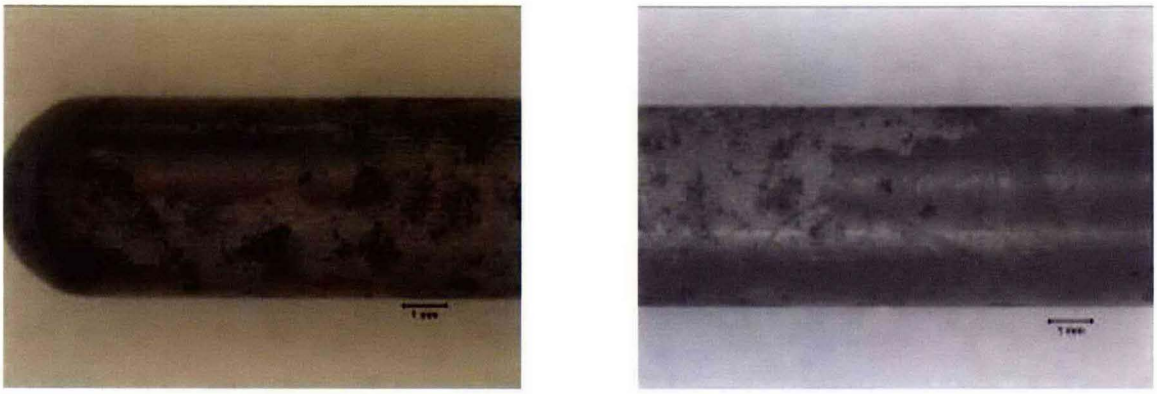


Figure 64. The Appearance of the Sample after CPP Test in AY-101-CSL Simulant at pH 12.3 and 50°C.

(a) (b)



4.13 SLOW STRAIN RATE TESTING IN TANK 241-AY-101-CSL BASED SIMULANT

Table 19 summarizes the results of the slow strain rate tests performed in the AY-101-CSL simulant. Only one test was performed at 50°C and OCP. This simulant has low nitrate (0.181 M) and nitrite (0.0368 M) concentrations.

Table 19. A Summary of Slow Strain Rate Tests Performed in AY-101-CSL Simulant.

Test ID	Base Chemistry	pH	Temp (°C)	Pot (mV)	OCP (mV)	Failure Strain (%)	Failure Time (hrs)	SEM Surface Exam	Estimated CGR (mm/sec)
69	AY-101-CSL	11.8	50	OCP	-181	21.6	59.9	Ductile	-

The one SSRT sample failed at 21.9% strain, and showed no evidence of SCC during SEM examination (Figure 65 and Figure 66). The simulant has a relatively low nitrate content, and it may be that there was insufficient nitrate to cause SCC. A large positive hysteresis was noted in CPP curve provided by electrochemical testing in the AY-101-CSL simulant at pH 11.8 at 50°C. These results indicate that evidence of pitting is not necessarily indicative of SCC susceptibility. Note that the SSRT was performed at OCP, and the combination of potential and limited test time may not have been sufficient to allow any localized corrosion to initiate.

Figure 65. Stress-Strain Behavior of the Sample Tested in AY-101-CSL Simulant at OCP (-181 mV vs. SCE).

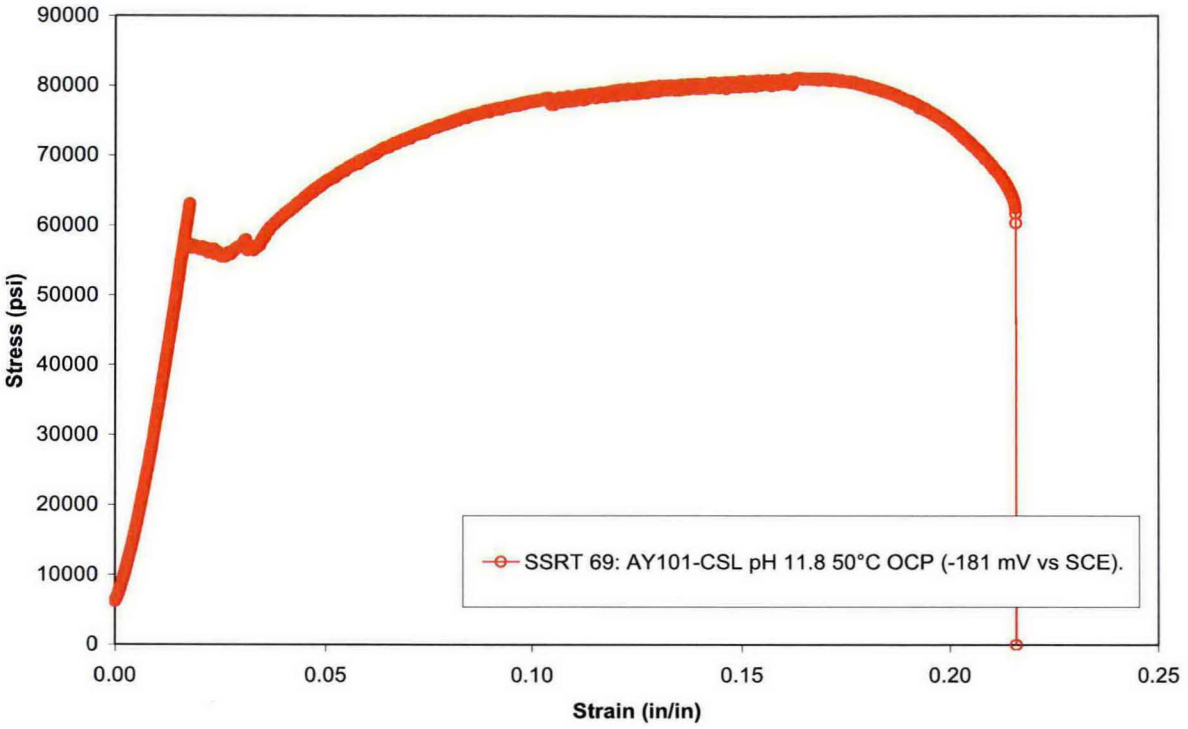
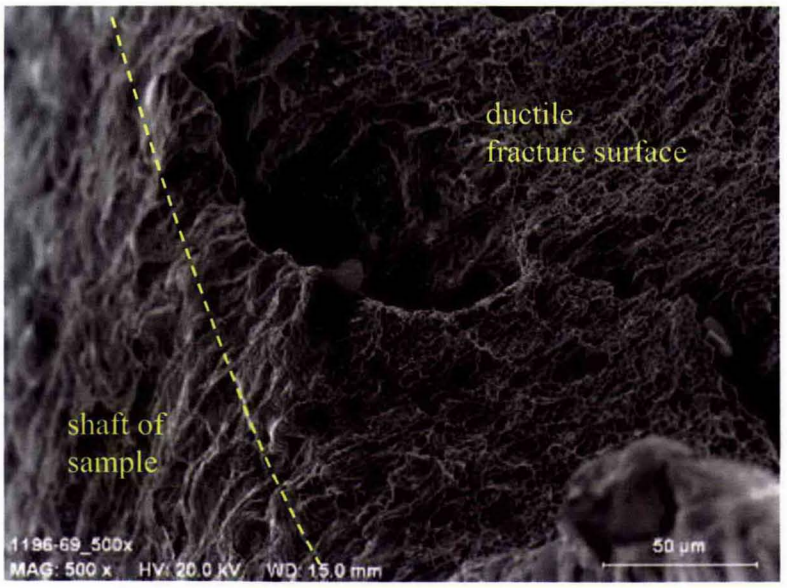


Figure 66. Electron-Micrograph of the Fracture Surface of Test Sample from SSRT-69 Performed in AY-101-CSL Simulant at 50°, pH 11.8, at a Potential of -181 mV vs. SCE.



4.14 DYNAMIC-K TESTING IN 5M $NANO_3$ AND TANK 241-AY-101-PSC BASED SIMULANT

Table 20 summarizes the details of the two dynamic-K tests performed during this test program. The objectives of the two K-tests were (1) to investigate the effect of a hold time on crack growth initiation; and, (2) to aid in the determination of K_{thSCC} by measuring the nominal K_I at which crack growth arrests under constant displacement conditions. With the test specimen geometry, both load and stress intensity reduce as a crack propagates under constant displacement conditions. A constant load during the test indicates the crack is not propagating. The crack's stability point and K_{thSCC} can then be calculated from the test parameters. Previous tests performed for this program were not held sufficiently long for this phenomenon to occur.

CT-17 was performed in 5 M $NaNO_3$ solution at OCP and at 50°C. This solution has previously been shown to cause severe cracking. The sample was loaded at a constant displacement rate until both DCPD and load measurements indicated cracking. The loading was stopped and the sample was held at constant displacement for approximately 80 days. DCPD (Figure 67) and load measurements (Figure 68) indicated continued cracking of the sample during the test. The maximum CGR for this sample was estimated as 4.5 inch / year (1.4×10^{-7} in/sec) based on DCPD data.

CT-18 was performed in AY-101-PSC simulant at 0 mV vs. SCE and at 50°C. Previous testing indicated no cracking in this environment for samples loaded to 40 ksi$\sqrt{in}$; however, the hold time was relatively short (approximately 30 days). The current investigation loaded the constant displacement sample to 45 ksi$\sqrt{in}$. DCPD (Figure 69) and load data (Figure 70) indicated that there may have been minor cracking in the sample, but it was not definitive because of the significant noise detected in the data. Note that a lower stress intensity (40 ksi$\sqrt{in}$) was accidently placed on the specimen for over a week near the onset of testing.

Table 20. A Summary of the Dynamic-K Tests Performed.

Test ID	Base Chemistry	pH	Temp (°C)	Pot (mV)	OCP (mV)	Test Type	Comments
17	5M $NaNO_3$	11	50	OCP	+107	Load to above K_{thSCC} and hold 80 days	DCPD, load reduction and SEM examination indicated significant cracking
18	AY-101-PSC	11	50	0	-328	Load to 45 ksi$\sqrt{in}$ and hold 150 days	DCPD and load reduction indicated possible minor cracking. Not confirmed by SEM examination

Figure 67. Plot of DCPD Calculated Crack Length as a Function of Time for CT-17 Performed in 5M $NaNO_3$ at Open Circuit Potential. The Displacement was Held Constant Following Loading to a Nominal K ~ 25 ksi$\sqrt{in}$.

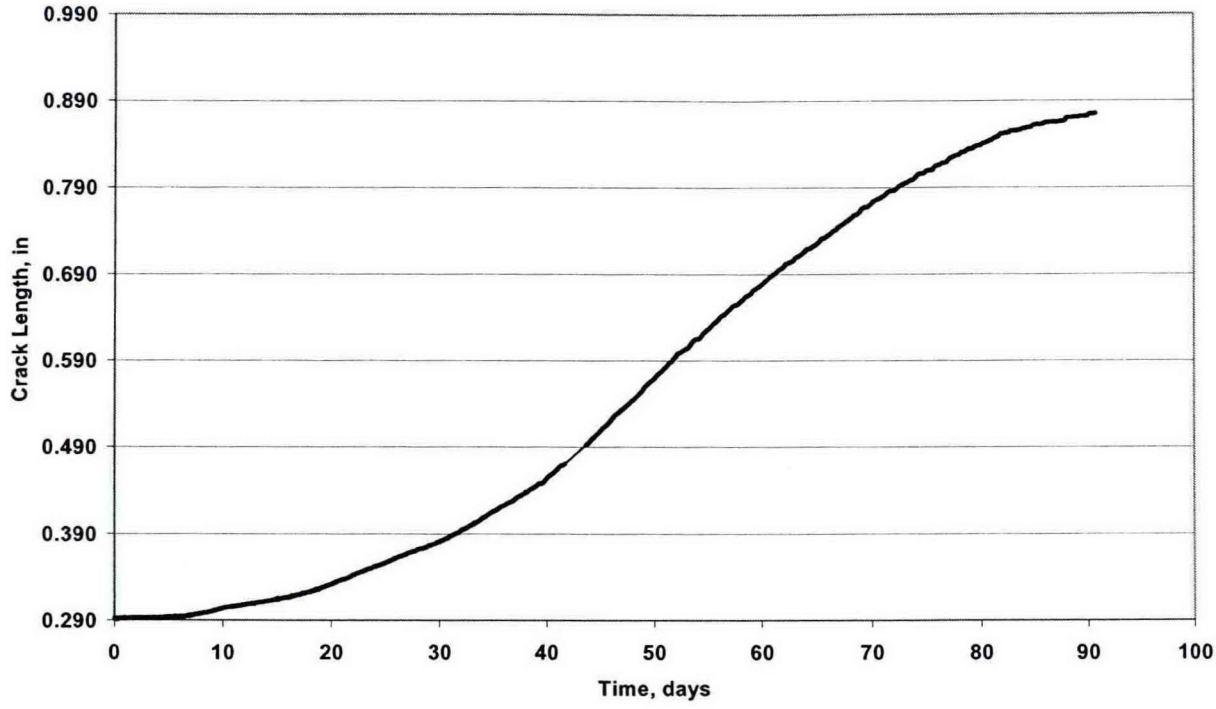


Figure 68. Load as a Function of Time for CT-17 Performed in 5M $NaNO_3$ at Open Circuit Potential. The Displacement was Held Constant Following Loading to a Nominal K ~ 25 ksi$\sqrt{in}$.

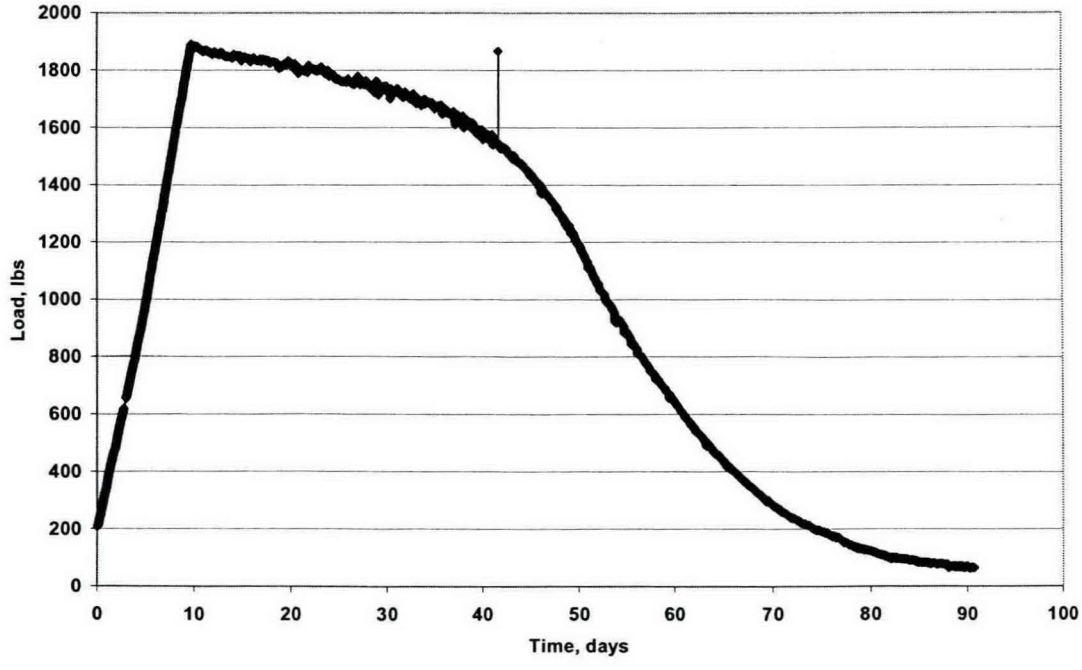


Figure 69. Plot of DCPD Calculated Crack Length as a Function of Time for CT-18 Performed in AY-101-PSC Simulant at 0 mV vs. SCE. The Displacement was Held Constant Following Loading and Adjustment to a Nominal K ~ 45 ksi√in.

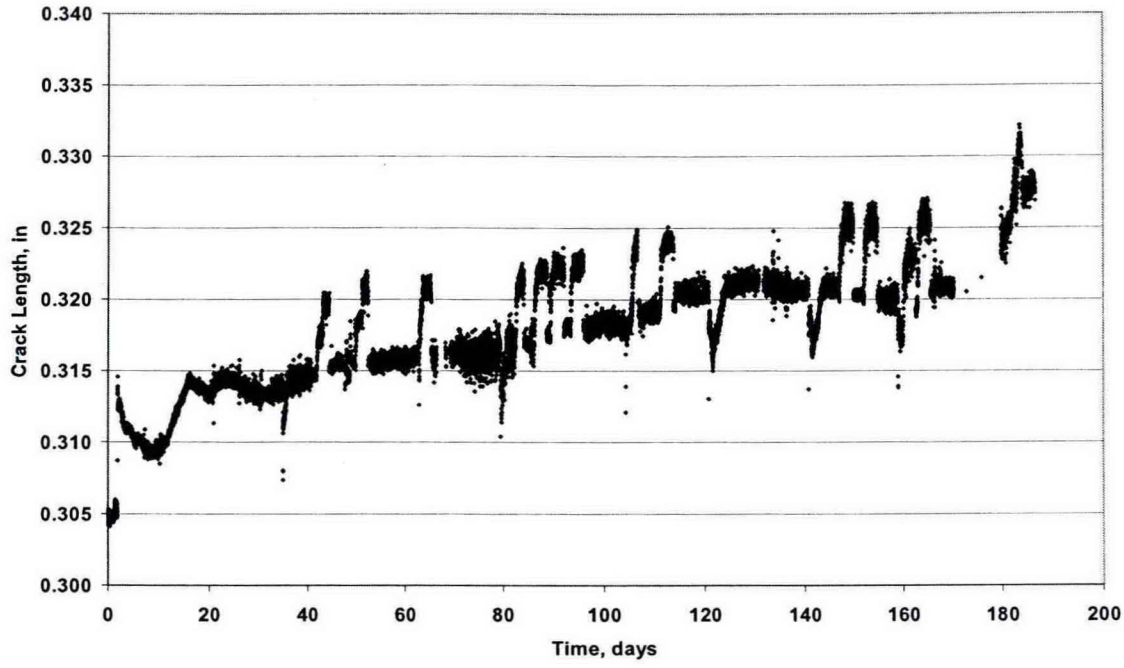
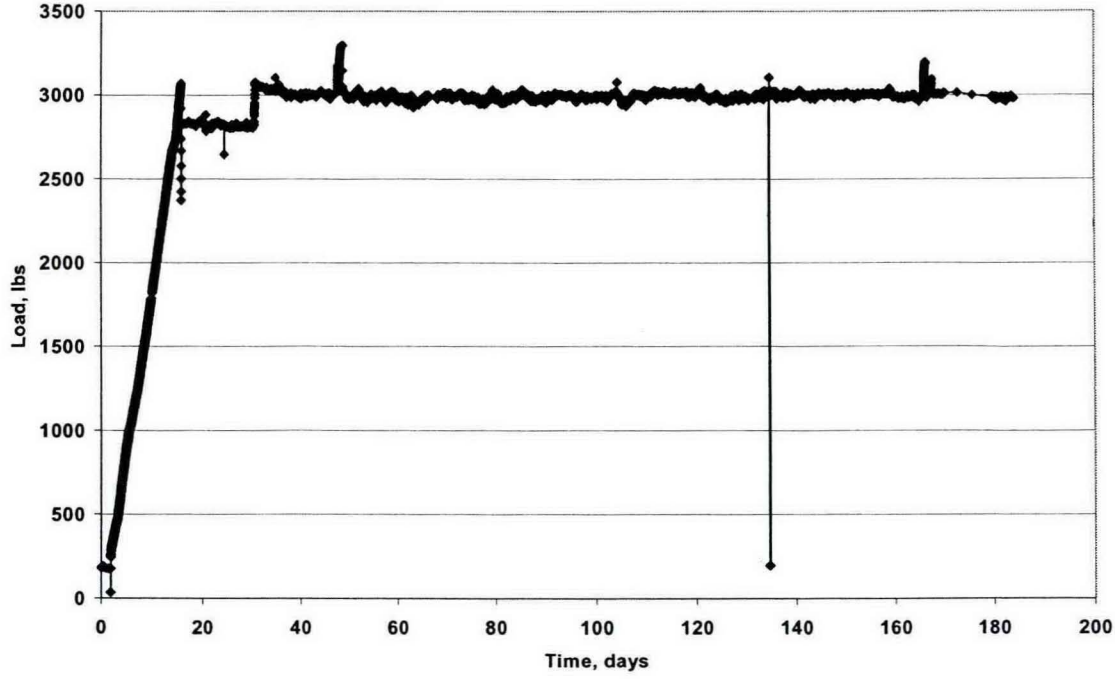


Figure 70. Load as a Function of Time for CT-18 Performed in AY-101-PSC Simulant at 0 mV vs. SCE. The Displacement was Held Constant Following Loading and Adjustment to a Nominal K ~ 45 ksi√in.



The fracture surfaces of the two K-test samples were examined using the SEM. Figure 71 is an electron-micrograph of the fracture surface of the test sample from CT-17, performed in 5M $NaNO_3$ solution. SCC was confirmed by the presence of intergranular features. Figure 72 is an electron-micrograph of the fracture surface of the test sample from CT-18, performed in the AY-101 simulant with an applied potential of 0 mV vs. SCE. No intergranular features were observed. This confirms the previous results, in which no SCC was detected in the AY-101 simulant loaded to 40 ksi$\sqrt{in}$ and held for 30 days. This indicates that K_{thSCC} is over 45 ksi$\sqrt{in}$ in this environment.

Figure 71. Electron-Micrograph of the Fracture Surface of Test Sample from CT-17 Performed in 5M NaNO3 at 50°, at OCP (+107 mV vs. SCE). The sample was held at a constant displacement for ~80 days following a constant displacement rate slow loading to a nominal K of 25 ksi$\sqrt{in}$.

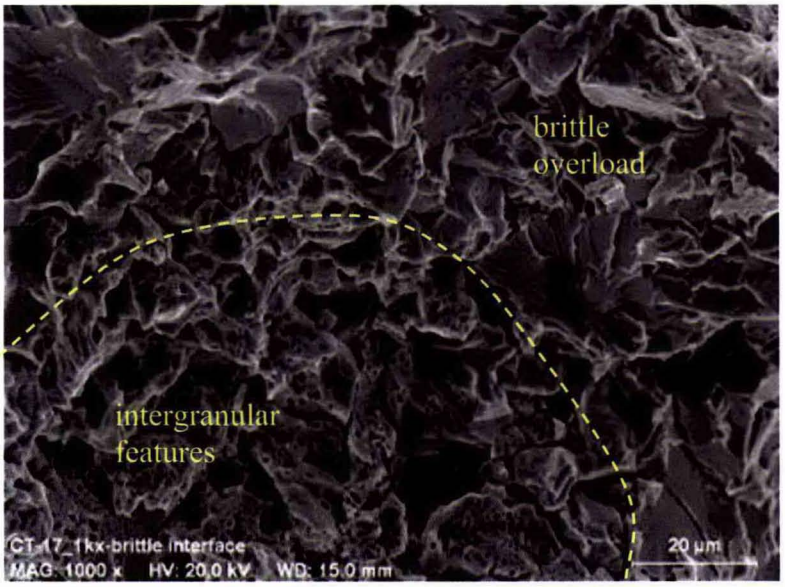
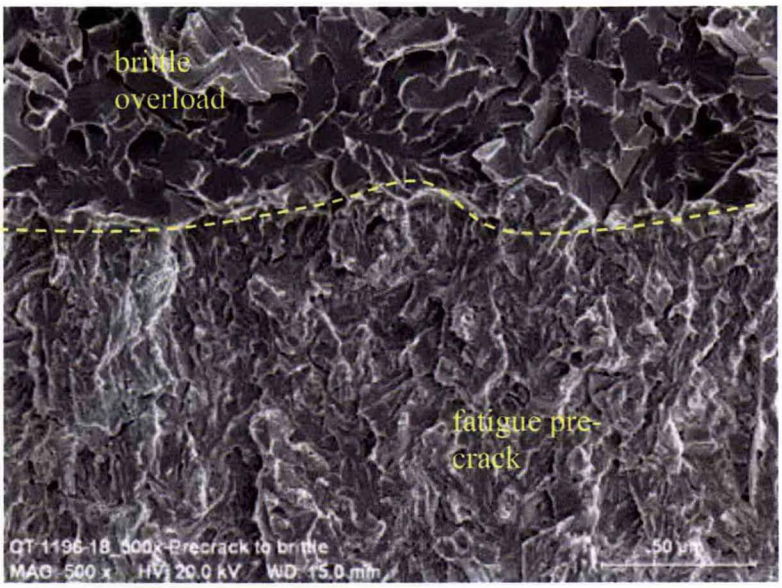


Figure 72. Electron-Micrograph of the Fracture Surface of Test Sample from CT-18 Performed in AY-101 Simulant at 50°, at 0 mV vs. SCE. The sample was held at a constant displacement for ~150 days following a constant displacement rate slow loading to a nominal K of 45 ksi√in.



The lack of intergranular features in test CT-18 was unexpected, given the apparent crack growth indicated by the DCPD measurements. Post–test analysis of the DCPD data indicated some drift in the applied DCPD current occurred over the course of the test, resulting in potential drop changes on the order of a few tens of millivolts. This explains the apparent crack growth from the DCPD data calculations. Another possibility is that there was some minor ductile tearing during the long-term hold.

The recent K-tests were performed using a constant displacement rate slow loading and a long-term hold. This technique was developed to try to eliminate some of the inconsistencies observed in data from tests that were performed using constant loads tests. However, it has not yet been confirmed that the test technique provided conservative values of K_{thSCC}. The technique relies on crack arrest following some SCC propagation. The K_{thSCC} calculation is then based on the final load and crack length values at arrest. To date, only one test (CT-17 performed in 5M $NaNO_3$ solution) has shown significant crack propagation and has been held for a long enough time to confirm crack arrest. Tests in various simulants have shown some minimal cracking, but not sufficient to provide a high level of confidence in the K_{thSCC} estimates. The effect of loading rate on K_{th} has also yet to be considered. Loading rate effects may influence the applied K at which SCC initiates, and the slower loading may produce artificially high K_{thSCC} estimates, though this would go against results typically observed in SSRTs. If this is the case then it is even more important to allow any growing cracks to arrest. The microstructural mechanisms involved in SCC crack initiation become an important consideration.

The dynamic-K test used in the current program shows promise as a test technique, but there are some issues still to be resolved. One limitation is that the tests must be run for a sufficient period of time for cracking to initiate and to arrest. This has only been done with the 5 M $NaNO_3$

solution. Given the low CGRs observed in some of the tests performed in waste simulants, tests would have to be performed for months, or years in some cases, in order to achieve the same results. A second limitation of the dynamic K-test is that it has not been validated that the test results are conservative. There are few comparisons that can be made between the current results and previous years' results, as the tests were performed under different conditions. Previous constant load testing in AN-107 simulant indicated a K_{thSCC} of approximately 20 ksi$\sqrt{in}$. However, the more recent dynamic K-test in AN-107 simulant implied a K_{thSCC} closer to 35 ksi$\sqrt{in}$, as crack growth was minimal when loaded to that level and held for 30 days. Note that in the latter test, the sample was not held for sufficient time for the crack to arrest. It is possible that the crack would have continued to propagate and eventually arrested at K nearer to 20 ksi$\sqrt{in}$. If so, the test techniques' results would have been self-consistent.

There are common features of the results of the constant load and dynamic-K tests that are encouraging. The CGRs measured in the waste simulant have been significantly less than those measured in the 5 M $NaNO_3$ solution. Consistent with this is the higher K_{thSCC} estimates in the waste simulants. Although the technique requires some further validation to ensure conservatism, the current qualitative indications are that the tests are providing useful information.

In previous work, crack growth in constant load tests was identified by DCPD, examination in the stereo-microscope and metallographically. Many of the tests showed a minimal amount of crack growth and visual observations become subjective. It is very difficult to distinguish between fatigue pre-crack, ductile tearing at the crack tip, and intergranular SCC. In some cases, the results were inconsistent between techniques, and in general the conservative result was reported. The difficulties in distinguishing microstructural features led to the use of the SEM in post test-examinations.

4.15 GENERAL DISCUSSION OF RESULTS

The purpose of this work was to examine the effects of different tank farm operational variables (chemistry, temperature) on the propensity for localized corrosion and stress corrosion cracking. To accomplish this goal, a range of tank chemistry simulants and variations thereof have been examined in an attempt to bound certain tank farm characteristics and to better elucidate the controlling mechanisms and processes that may compromise tank integrity from a materials degradation perspective. In the course of this work, nitrite has been found to inhibit both localized corrosion and SCC whereas nitrate promotes these degradation modes. In the present work, the localized and SCC corrosion behavior of steel in waste simulants for Tanks 241-AP-105 (AP-105), 241-SY-103 (SY-103), 241-AW-105 (AW-105), 241-AZ-102 (AZ-102), 241-SY-101 (SY-101), AN-107 and AY-101 were investigated to better examine the effects of low nitrite-nitrate concentration ratios, high bounding chloride and fluoride concentrations, and low and high absolute nitrite and nitrate concentrations. The AP-105-PSC simulant has a unique chemistry that includes 0.27 M nitrite and 3.58 M nitrate (nitrite/nitrate ratio of 0.075). Although the nitrite concentration is less than 10% of the nitrate concentration, this chemistry appears to be more benign than some of the previously investigated simulants (e.g., AN-107) at pH above 13 (assuming the nitrite concentration can be maintained). While this nitrite concentration seemed to play some inhibiting role, the previous discussion indicates that this concentration may be near a threshold of nitrite below which the nitrite will not be able to provide effective protection for the

steel. Severe corrosion was observed at the liquid/vapor interface where the nitrite may have become depleted to a concentration below the threshold level for efficient inhibition or alternatively the pH was suppressed below a critical value.

Corrosion attack at the liquid/vapor interface strongly depends on temperature, potential, and liquid/vapor interface stability. The results obtained thus far indicate that the extent of corrosion could be decreased relative to test conditions at potentials near OCP or at temperatures near room temperature. The corrosion initiation time generally increased significantly for these conditions. However, the long-term immersion tests revealed that the corrosion at the liquid/vapor interface is likely even at room temperature. It appears that the CO_2 present in the air may have played a role by changing the pH locally to create an aggressive environment locally at the liquid/vapor interface. No definitive conclusion can be drawn with respect to the initiation mechanism of the interfacial attack. Even though the experimental evidence indicated that potential, oxygen, and CO_2 may play certain roles, a comprehensive understanding of the initiation mechanism is lacking.

Figure 73 summarizes the susceptibility of the steel to pitting corrosion as a function of inhibiting species and aggressive species in various simulants. Open symbols indicate that no pitting corrosion was observed after CPP testing. For AN-107 simulants, pitting corrosion was observed in all cases. However, the difference of repassivation potential and the OCP was considerably larger in some cases and thus the safety margin was sufficiently wide to prevent pitting under freely corroding conditions. Therefore, the tests that showed a |Epit-OCP| greater than 500 mV are indicated with half-filled symbols, meaning that pitting corrosion was observed but a large safety margin (the difference between OCP and pitting potential) exists. Note that pitting corrosion was observed after polarizing to potentials higher than OCP during CPP testing. The conditions outlined in Figure 73 indicate that pitting *might* occur under the given environmental conditions. Therefore, Figure 73 should be used only as an illustrative tool to help understand the prospective roles of inhibiting and aggressive species.

Three zones are indicated in Figure 73: no pitting zone, pitting possible but unlikely zone, and pitting possible zone. AP-105-evaporated simulants were outliers that did not lead to localized corrosion at an extremely high nitrate concentration (5.087M). For illustrative purposes, dashed lines have been included in Figure 73 to qualitatively differentiate the pitting possible, pitting possible but unlikely, and no pitting regions. At each nitrate concentration level, there appears to be a critical nitrite level, above which the material was protected from localized corrosion.

Figure 73. Susceptibility of Materials to Pitting Corrosion as a Function of Nitrite and Nitrate Concentration. The Symbols Represent Various Simulant Chemistries Previously Studied.

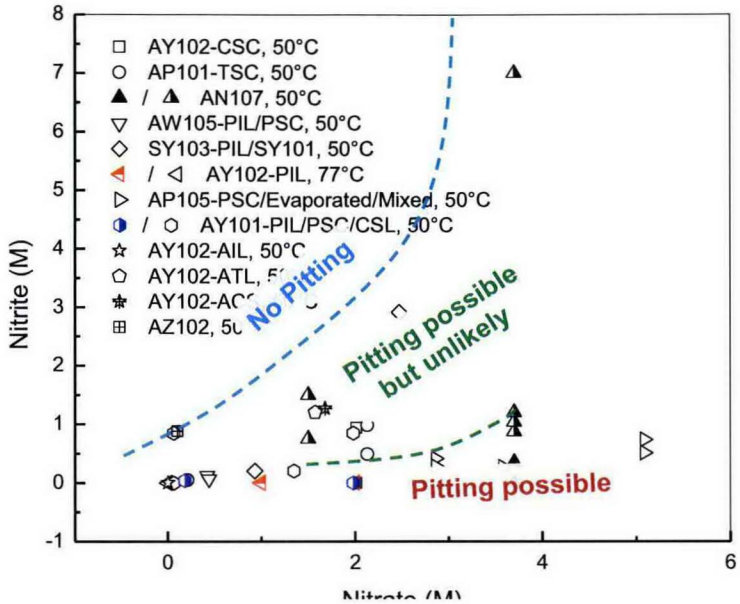


Figure 74 shows the estimated CGRs for tests that cracked as a function of applied potential in all simulants investigated. These data are primarily from SSRTs, with the one exception being the data point for the 5M $NaNO_3$ solution which was provided by a dynamic –K test. The new data obtained from the recent tests do not affect the general trend of the curve, which was developed using results from previous work. From previous testing, significant crack growth was only observed at potentials higher than -100 mV (vs. SCE) for the nitrate-based simulants (e.g., AY-101-PSC). Much slower CGRs were observed in carbonate-based simulants at potentials near -800 mV (vs. SCE). Similar slow CGRs were also observed in modified (increased nitrate) carbonate based simulants around -300 to -200 mV vs. SCE. The new data is seen in this third peak in the plot at -249 mV vs. SCE. This was generated from the one CGR experiment conducted in AP-105-PSC stimulant at OCP that showed cracking.

Figure 74. Estimated CGR vs. Potential in the Investigated Simulants.

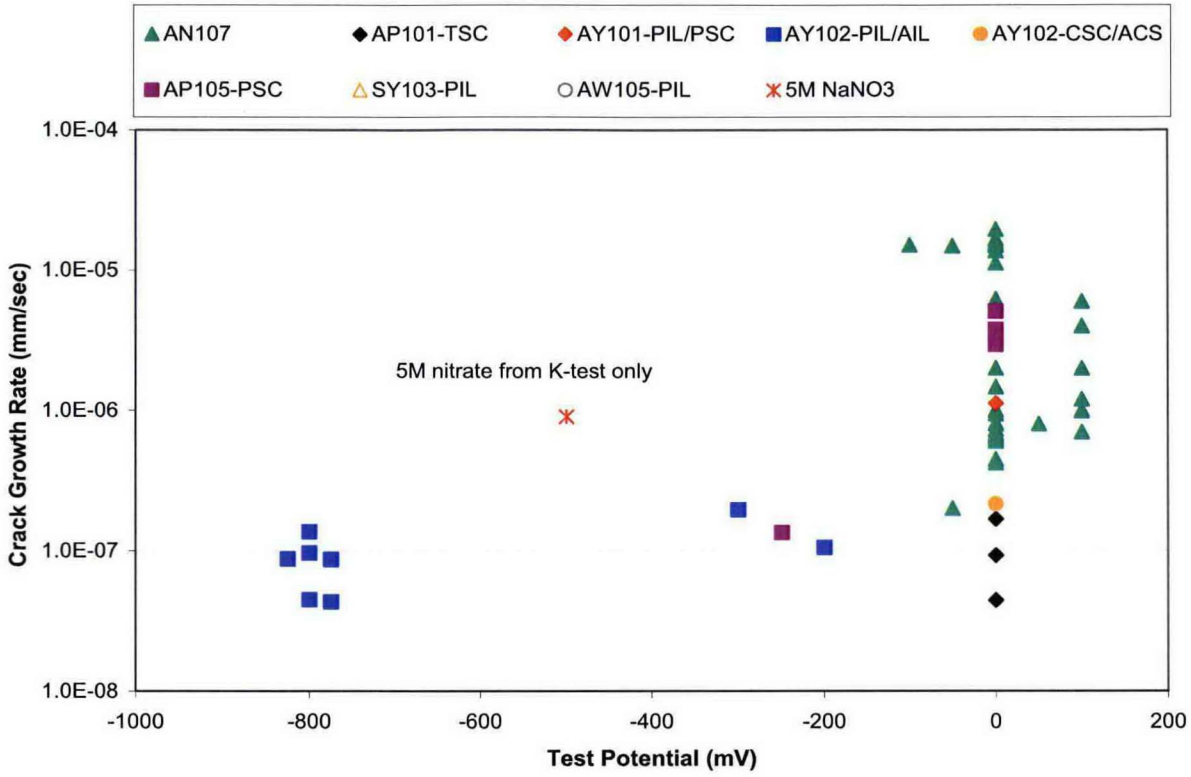
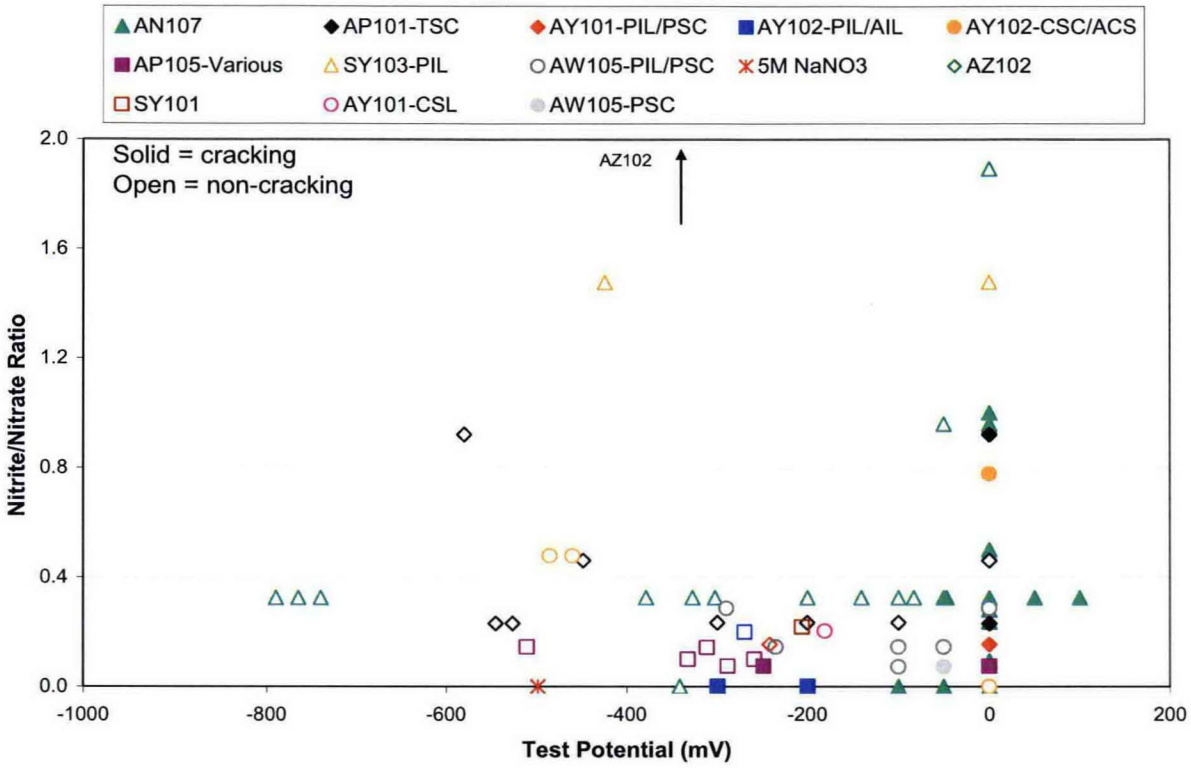


Figure 75 is a plot of the nitrite/nitrate ratio vs. applied test potential. This data indicates conditions for SCC susceptibility. A similar plot was developed during previous work, and has been updated to include the new test data. SSRTs that showed cracking are indicated by solid symbols and tests that showed no cracking are indicated by open symbols. The general trend for the nitrate-based simulants is that SCC susceptibility tends to increase with increasing potential and decrease with increasing nitrite concentration. There is a transitional region of SCC behavior at low nitrite/nitrate ratios between potentials of -200 and -300 mV vs. SCE which remains poorly defined.

The results of the AP-105-PSC, SY-103-PIL and AW-105 testing are consistent with the results from previous tests programs, as can be seen from Figure 75. The AP-105-PSC simulant has a very low nitrite/nitrate ratio (0.075), and did show evidence of SCC, even at the relatively low OCP potential (-249 mV vs. SCE). The AW-105-PIL simulant has a slightly higher nitrite/nitrate ratio (0.29) and showed no evidence of SCC, at a comparable potential (-290 mV vs. SCE). These data help to further define the transitional region of the plot. The SY-103-PIL simulant has a much higher nitrite/nitrate ratio (1.47), and also shows no evidence of cracking, as the data in the Figure 75 would predict. The AW-105-PSC simulant and modified "6X" simulant data further defines the critical region in low nitrite/nitrate ratio and higher potential 0 mV to -100 mV vs. SCE region. Figure 75 indicates that SCC is possible in many of the simulants. However, it is important to realize that all but one of the tests that showed cracking behavior were anodically polarized. The one exception is the one of the two tests performed in AP-105-PSC at OCP that cracked. This is the only test that has shown evidence of cracking at OCP. This observation is important from a tank integrity perspective.

Figure 75. A Plot of Nitrite/nitrate Ratio vs. Applied Test Potential Indicating Conditions for SCC Susceptibility. Only Nitrate Based simulant Results Are Included.



An important conclusion that was drawn from this test program is that localized corrosion at liquid/vapor interfaces is possible at high pH. This indicates that the current requirements to maintain a high pH may not necessarily be sufficient to ensure long-term tank integrity. The interfacial corrosion is not currently well understood, and should be considered as a possible focus area for future work.

Based on the work conducted to date, it would seem that the risk of localized corrosion and SCC is relatively low under nominal tank operating conditions. There is, however, a possibility of SCC in achievable chemistries (these are chemistries similar to those already existing in the tank farm or those that may develop due to mixing/transfer operations) if a sufficiently noble potential is reached. This observation highlights the importance of the tank probe monitoring program. Also of significant note was the observation of rapid corrosion at the liquid/vapor interface which appears to be related to a drop in the interfacial pH due to the presence of CO_2 in the head space. Because the corrosion rates observed with some simulants were quite rapid, additional efforts to explore optimal mitigation strategies for this interfacial region are recommended.

5.0 SUMMARY OF KEY FINDINGS

Based on the work conducted, the key findings of the research are listed below.

- The SCC potency of the waste simulants for the three tanks studied followed the trends previously established for nitrate-based simulants. SCC only occurred at relatively high applied potentials (e.g., 0 mV vs. SCE) or at low nitrite/nitrate concentrations ratios.

- Limited GCR testing performed in AY-101 simulants indicated that stress intensity factors above 45 ksi$\sqrt{in}$ were necessary for crack propagation to occur in the waste simulants tested.

- Though at current tank conditions the PSC for tank 241-AP-105 (AP-105-PSC) simulant of the tank showed a low propensity for corrosion. The tank steel exposed to the Tank AP-105-PSC simulant at elevated temperatures and under anodically polarizing conditions demonstrated a susceptibility to stress corrosion cracking (SCC) and localized corrosion at the liquid/vapor interface. Long-term immersion tests indicated that the steel was susceptible to corrosion at the liquid/vapor interface even at OCP, but the extent at room temperature was not as severe as at elevated temperatures (e.g., 50°C). The AP-105-PSC is the only simulant in which SCC was observed in a slow strain rate test (SSRT) performed at OCP. Local chemistry changes (nitrite depletion or pH drop) may be responsible for the interfacial attack, though the precise mechanism is unclear at this time. The liquid/vapor interface attack indicates that localized corrosion is possible in simulants with high pH, and this should be considered in any future corrosion mitigation strategies.

- The PIL for Tank 241-SY-103 (SY-103-PIL) simulant, which has the upper limit of chloride concentration of the DSTs, appears to be benign with respect to corrosion and SCC relative to the AP-105-PSC and previously tested Tank 241-AN-107 simulants and the PIL for Tank 241-AY-102 (AY-102PIL) simulant. Any possible corrosion liability associated with the high chloride content, appears to be offset by the relatively high nitrite content.

- The PIL for Tank 241-AW-105 (AW-105-PIL) simulant, which has the upper limit of fluoride concentration, also appears to be benign with respect to tank steel SCC. However, some localized corrosion has been observed at the liquid/vapor interface.

- The AZ-102 simulant, tested at the higher temperature of 77°C, appears to be benign with respect to SCC, confirming the inhibitory nature of nitrite. The AZ-102 simulant has a high nitrite/nitrate ratio of 8.4.

APPENDIX A

SIMULANT RECIPES, CERTIFICATES FOR CHEMICALS AND QA DOCUMENTS

Tracking #65.

AN-107 Supernate Simulant Recipe for a 2-Liter Batch, pH = 11
BASE SOLUTION: April 2005 Version

Balance Device ID No: 080 NIST Weight (10 g): 10.0000
Balance Device ID No: 078 NIST Weight (150 g): 149.9
Prepared By: Nay Kelley Date Prepared: 11/1/07

Tare a 2-liter Volumetric Flask and then Add the Following, in Order:

Compound	Formula	Mass Required, grams	Actual Mass Used, grams
Deionized Water	H_2O	400.00	AR 2000 100
Calcium Nitrate, 4-Hydrate	$Ca(NO_3)_2.4H_2O$	6.98	6.97
Cerium Nitrate, 6-Hydrate	$Ce(NO_3)_3.6H_2O$	0.32	0.35
Cesium Nitrate	$CsNO_3$	0.054	0.040
Copper Nitrate, 2.5-Hydrate	$Cu(NO_3)_2.2.5H_2O$	0.22	0.22
Ferric Nitrate, 9-Hydrate	$Fe(NO_3)_3.9H_2O$	24.46	24.50
Lanthanum Nitrate	$La(NO_3)_3.6H_2O$	0.28	0.30
Lead Nitrate	$Pb(NO_3)_2$	1.24	1.24
Magnesium Nitrate, 6-Hydrate	$Mg(NO_3)_2.6H_2O$	0.52	0.52
Manganous Chloride, 4-Hydrate	$MnCl_2.4H_2O$	4.06	4.06
Neodymium Nitrate, 6-Hydrate	$Nd(NO_3)_3.6H_2O$	0.58	0.58
Nickel Nitrate, 6-Hydrate	$Ni(NO3)2.6H_2O$	5.26	5.26
Potassium Nitrate	KNO_3	9.20	9.20
Strontium Nitrate	$Sr(NO_3)_2$	0.032	0.035
Zinc Nitrate, 6-Hydrate	$Zn(NO_3)_2.6H_2O$	0.42	0.41
Zirconyl Nitrate	$ZrO(NO_3)_2.xH_2O$	0.36	0.37
EDTA, Ethylenediaminetetraacetate	Na_4EDTA	14.52	14.52
HEDTA, n-Hydroxyethylenediamine triacetate	HEDTA	4.32	4.32
Sodium Gluconate	$C_6H_{11}NaO_7$	7.86	7.87
Glycolic Acid	$C_2H_4O_3$	53.86	53.86
Citric Acid Monohydrate	$C_6H_8O_7.H_2O$	18.88	18.88
Nitrilotriacetic Acid	$C_6H_9NO_6$	1.14	1.14
Iminodiacetic Acid	$HN(CH_2COOH)_2$	12.08	12.09
Boric Acid	H_3BO_3	0.40	0.40
Sodium Chloride	NaCl	11.66	11.70
Sodium Fluoride	NaF	0.58	0.56 AR
Sodium Chromate	$Na_2Cr_2O_4$	1.10	1.10
Sodium Sulfate	Na_2SO_4	24.40	24.40
Potassium Molibdate	K_2MoO_4	0.18	0.18
	SUM	604.9660	

In a SEPARATE Container, Mix the Following:

			30.50
Aluminum Nitrate, 9-Hydrate	$Al(NO_3)_3.9H_2O$	10.74	10.74
Sodium Phosphate, 12-Hydrate	$Na_3PO_4.12H_2O$	8.86	8.88
Sodium Formate	NaHCOO	31.42	31.42
Sodium Acetate Trihydrate	$NaCH_3COO.3H_2O$	4.74	3.74
Sodium Oxalate	$Na_2C_2O_4$	2.52	2.52
Deionized Water	H_2O	400.00	100
	SUM	488.82	

Mix Thoroughly. Then Add this Solution to the Volumetric Flask.

After the Addition to the Volumetric Flask, Add the Following:

Sodium Carbonate	Na_2CO_3	296.90	296.5

Mix Thoroughly

Next, Mix the Following:

Sodium Nitrate	$NaNO_3$	594.58	594.60
Sodium Nitrite	$NaNO_2$	165.58	165.60
Water	H_2O	200.00	200.00
Add and Mix thoroughly.	Sum	960.16	

Mix thoroughly and dilute to the 2-Liter mark in the Volumetric Flask.

SUM OF ALL	2350.46

Record the Final Weight

Density:

Measure the pH 10.38

Adjust the Final Solution to pH = 11 by progressively adding 2 g of sodium hydroxide (NaOH) up to 20g. MIX THOROUGHLY after any addition of sodium hydroxide and measure pH.

Comments:

QA APPROVED
NAME: Cleaver
DATE: 1-7-08

initial pH 10.38

Final pH 11.00

AP105-PSC

Base Solution 2007 Version

Batch Size: 4 L
pH: 13+

AP105-PSC

Balance Device ID: 020 NIST Weight (20 g): 20.0000
Balance Device ID: 018 NIST Weight (500 g): 500.0

Technician: Noy Kelley **Date:** 11/14/07 **Tracking :** 68

Add 2400 L mL DI water to a beaker.
Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate.
Turn on heater and adjust to 60°C (±10°C).
Add the following chemicals and record their actual weights:

Chemical	Formula	Required Mass (g)	Actual Mass (g)	Comments
Sodium Aluminate	$NaAlO_2.2H_2O$	70.71	70.71	
Sodium Chloride	NaCl	7.20	7.20	
Sodium Fluoride	NaF	1.53	1.53	
Sodium Chromate	Na_2CrO_4	6.87	6.87	
Sodium Sulfate	Na_2SO_4	26.82	26.83	
Sodium Phosphate, 12-Hydrate	$Na_3PO_4.12H_2O$	45.77	45.78	
Sodium Formate	NaHCOO	2.72	2.72	
Sodium Acetate Trihydrate	$NaCH_3COO.3H_2O$	4.08	4.09	
Sodium Oxalate	$Na_2C_2O_4$	4.02	4.01	
Sodium Carbonate	Na_2CO_3	138.21	138.2	
Sodium Nitrate	$NaNO_3$	1211.75	1211.8	
Potassium Nitrate	KNO_3	5.38	5.41	
Sodium Nitrite	$NaNO_2$	74.52	74.5	
Glycolic Acid	$C_2H_4O_3$	3.23	3.23	
Sodium Hydroxide	NaOH	28.18	28.18	

* Sodium fluoride is highly toxic. Handle with caution. 1631.06

Adjust total solution volume to 3400 mL by adding DI water.
Adjust solution temperature to 50°C to 60°C.
Filter solution by vacuum through medium glass filter. ***Handle with caution, hot and caustic solution.***
Rinse beaker with approximately 50 mL of DI water
Rinse filter with approximately 50 mL of DI water
Transfer final filtrate and rinse solutions to large beaker with stir bar.
Measure and record initial pH AK ~~11:35~~ 13.21
Check the pH to make sure it is 11/14/07 13+

QA APPROVED
NAME: Cedum
DATE: 1-7-08

Transfer to volumetric flask and include rinse with DI water. Allow solution to cool

Adjust final solution to volume of 4 L with DI water, and mix thoroughly.

SUM	Total chemicals (target)	1630.98 g	Total chemicals (actual)	1631.06	g
	Total water (target)	4 L	Total water (actual)	4000	mL
	Target Specific Density	1.41	Calculated density	1.41	

Check final solution pH and record. pH= 13.2 Readjust if significantly different from target.

Comments: record any difficulties or discrepancies

AP105-PSC

Base Solution 2007 Version

Batch Size: 2 L
pH: 13+

AP105-PSC

Balance Device ID: 020 NIST Weight (20 g): 20.0000
Balance Device ID: 018 NIST Weight (500 g): 500.0

Technician: Noy Kelley **Date:** 12/12/07 **Tracking :** 73

Add 1200 mL DI water to a beaker.
Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate.
Turn on heater and adjust to 60°C (±10°C).
Add the following chemicals and record their actual weights:

Chemical	Formula	Required Mass (g)	Actual Mass (g)	Comments
Sodium Aluminate	$NaAlO_2.2H_2O$	35.35	35.36	
Sodium Chloride	NaCl	3.60	3.60	
Sodium Fluoride	NaF	0.76	0.76	
Sodium Chromate	Na_2CrO_4	3.43	3.42	
Sodium Sulfate	Na_2SO_4	13.41	13.40	
Sodium Phosphate, 12-Hydrate	$Na_3PO_4.12H_2O$	22.88	22.88	
Sodium Formate	NaHCOO	1.36	1.36	
Sodium Acetate Trihydrate	$NaCH_3COO.3H_2O$	2.04	2.04	
Sodium Oxalate	$Na_2C_2O_4$	2.01	2.02	
Sodium Carbonate	Na_2CO_3	69.11	69.20	
Sodium Nitrate	$NaNO_3$	605.88	605.9	
Potassium Nitrate	KNO_3	2.69	2.70	
Sodium Nitrite	$NaNO_2$	37.26	37.20	
Glycolic Acid	$C_2H_4O_3$	1.62	1.62	
Sodium Hydroxide	NaOH	14.09	14.16	

* Sodium fluoride is highly toxic. Handle with caution.

Adjust total solution volume to 1700 mL by adding DI water.
Adjust solution temperature to 50°C to 60°C.
Filter solution by vacuum through medium glass filter. ***Handle with caution, hot and caustic solution.***
Rinse beaker with approximately 50 mL of DI water
Rinse filter with approximately 50 mL of DI water
Transfer final filtrate and rinse solutions to large beaker with stir bar.
Measure and record initial pH 13.44
Check the pH to make sure it is 13+

QA APPROVED
NAME: Odum
DATE: 1-7-08

Transfer to volumetric flask and include rinse with DI water. Allow solution to cool

Adjust final solution to volume of 2 L with DI water, and mix thoroughly.

SUM	Total chemicals (target)	815.49 g	Total chemicals (actual)	815.62
	Total water (target)	2 L	Total water (actual)	2000
	Target Specific Density	1.41	Calculated density	1.41

Check final solution pH and record. pH= 13.44 Readjust if significantly different from target.

Comments: record any difficulties or discrepancies

AP105-PSC

Base Solution 2007 Version

Batch Size: 4 L
pH: 13+

AP105-PSC

Balance Device ID: 020 NIST Weight (20g): 19.9999
Balance Device ID: 018 NIST Weight (500 g): 500.0

Technician: Nay Kelley **Date:** 1/18/08 **Tracking :** 76

Add **2400 L** mL DI water to a beaker.
Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate.
Turn on heater and adjust to 60°C (±10°C).
Add the following chemicals and record their actual weights:

Chemical	Formula	Required Mass (g)	Actual Mass (g)	Comments
Sodium Aluminate	$NaAlO_2.2H_2O$	70.71	70.71	
Sodium Chloride	NaCl	7.20	7.20	
Sodium Fluoride	NaF	1.53	1.53	
Sodium Chromate	Na_2CrO_4	6.87	6.87	
Sodium Sulfate	Na_2SO_4	26.82	26.82	
Sodium Phosphate, 12-Hydrate	$Na_3PO_4.12H_2O$	45.77	45.77	
Sodium Formate	NaHCOO	2.72	2.72	
Sodium Acetate Trihydrate	$NaCH_3COO.3H_2O$	4.08	4.08	
Sodium Oxalate	$Na_2C_2O_4$	4.02	4.02	
Sodium Carbonate	Na_2CO_3	138.21	138.3	
Sodium Nitrate	$NaNO_3$	1211.75	1211.6	
Potassium Nitrate	KNO_3	5.38	5.40	
Sodium Nitrite	$NaNO_2$	74.52	74.6	
Glycolic Acid	$C_2H_4O_3$	3.23	3.23	Precipitation (1%)
Sodium Hydroxide	NaOH	28.18	28.25	dissolve & precipitation all

* Sodium fluoride is highly toxic. Handle with caution.

Adjust total solution volume to **3400** mL by adding DI water.
Adjust solution temperature to 50°C to 60°C.
Filter solution by vacuum through medium glass filter. ***Handle with caution, hot and caustic solution.***
Rinse beaker with approximately 50 mL of DI water
Rinse filter with approximately 50 mL of DI water
Transfer final filtrate and rinse solutions to large beaker with stir bar.
Measure and record initial pH 13.45
Check the pH to make sure it is **13+**

QA APPROVED
NAME: Cldun
DATE: 2-5-08

Transfer to volumetric flask and include rinse with DI water. Allow solution to cool

Adjust final solution to volume of **4 L** with DI water, and mix thoroughly.

SUM	Total chemicals (target)	**1630.98 g**	Total chemicals (actual)	1631.10	g
	Total water (target)	**4 L**	Total water (actual)	4000	mL
	Target Specific Density	**1.41**	Calculated density	1.41	

Check final solution pH and record. **pH=**13.45 Readjust if significantly different from target.

Comments: record any difficulties or discrepancies

AP105-PSC

Base Solution 2007 Version

Batch Size: 4 L
pH: 13+

AP105-PSC

Balance Device ID: 080 NIST Weight (10 g): 10.0000
Balance Device ID: 078 NIST Weight (500 g): 500.0

Technician: Noy Kelley **Date:** 2/1/08 **Tracking :** 77

Add **2400 L** mL DI water to a beaker.
Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate.
Turn on heater and adjust to 60°C (±10°C).
Add the following chemicals and record their actual weights:

Chemical	Formula	Required Mass (g)	Actual Mass (g)	Comments
Sodium Aluminate	$NaAlO_2.2H_2O$	70.71	70.70	
Sodium Chloride	NaCl	7.20	7.20	
Sodium Fluoride	NaF	1.53	1.55	
Sodium Chromate	Na_2CrO_4	6.87	6.84	
Sodium Sulfate	Na_2SO_4	26.82	26.84	
Sodium Phosphate, 12-Hydrate	$Na_3PO_4.12H_2O$	45.77	45.80	
Sodium Formate	NaHCOO	2.72	2.72	
Sodium Acetate Trihydrate	$NaCH_3COO.3H_2O$	4.08	4.09	
Sodium Oxalate	$Na_2C_2O_4$	4.02	4.02	
Sodium Carbonate	Na_2CO_3	138.21	138.3	
Sodium Nitrate	$NaNO_3$	1211.75	1212	
Potassium Nitrate	KNO_3	5.38	5.40	
Sodium Nitrite	$NaNO_2$	74.52	74.6	
Glycolic Acid	$C_2H_4O_3$	3.23	3.37	Small precipitation occure
Sodium Hydroxide	NaOH	28.18	28.3	Dissolve after adding NaOH
			1631.73	

* Sodium fluoride is highly toxic. Handle with caution.

Adjust total solution volume to **3400** mL by adding DI water.
Adjust solution temperature to 50°C to 60°C.
Filter solution by vacuum through medium glass filter. ***Handle with caution, hot and caustic solution.***
Rinse beaker with approximately 50 mL of DI water
Rinse filter with approximately 50 mL of DI water
Transfer final filtrate and rinse solutions to large beaker with stir bar.
Measure and record initial pH 12.98
Check the pH to make sure it is **13+**

QA APPROVED
NAME: Oldum
DATE: 2-5-08

Transfer to volumetric flask and include rinse with DI water. Allow solution to cool

Adjust final solution to volume of **4 L** with DI water, and mix thoroughly.

SUM	Total chemicals (target)	**1630.98 g**	Total chemicals (actual)	1631.73	g
	Total water (target)	**4 L**	Total water (actual)	4000	mL
	Target Specific Density	**1.41**	Calculated density	1.41	

Check final solution pH and record. **pH=** 12.98 Readjust if significantly different from target.

Comments: record any difficulties or discrepancies

AY101-PSC

Base Solution 2007 Version

Batch Size: 2 L
pH: >13

AY-101-PSC

Balance Device ID: 020 NIST Weight (10g): 10.0000
Balance Device ID: 018 NIST Weight (500 g): 500.0

Technician: Noy Kelley **Date:** 2/6/08 **Tracking :** 78

Add **1200 L** mL DI water to a beaker.
Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate.
Turn on heater and adjust to 60°C (±10°C).
Add the following chemicals and record their actual weights:

Chemical	Formula	Required Mass (g)	Actual Mass (g)	Comments
Sodinum Alumniate	$NaAlO_2.2H_2O$	25.25	25.27	
Sodium Chloride	NaCl	2.13	2.14	
Sodium Fluoride	NaF	1.16	1.17	
Sodium Chromate	Na_2CrO_4	0.92	0.92	
Sodium Sulfate	Na_2SO_4	5.65	5.65	
Sodium Phosphate, 12-Hydrate	$Na_3PO_4.12H_2O$	37.71	37.71	
Sodium Formate	NaHCOO	1.73	1.75	
Sodium Acetate Trihydrate	$NaCH_3COO.3H_2O$	2.41	2.45	
Sodium Oxalate	$Na_2C_2O_4$	1.34	1.34	
Sodium Carbonate	Na_2CO_3	42.61	42.62	
Sodium Nitrate	$NaNO_3$	226.07	226.10	
Sodium Nitrite	$NaNO_2$	28.29	28.30	
Sodium Silicate	$Na_2SiO_3.9H_2O$	0.99	1.0	Precipitation
Glycolic Acid	$C_2H_4O_3$	1.60	1.59	
Sodium Hydroxide	NaOH	56.88	56.9	

* Sodium fluoride is highly toxic. Handle with caution.

431.91 Clear when filter

Adjust total solution volume to **1700** mL by adding DI water.
Adjust solution temperature to 50°C to 60°C.
Filter solution by vacuum through medium glass filter. ***Handle with caution, hot and caustic solution.***
Rinse beaker with approximately 50 mL of DI water
Rinse filter with approximately 50 mL of DI water
Transfer final filtrate and rinse solutions to large beaker with stir bar.
Measure and record initial pH 13.66
Check the pH to make sure it is **>13**

QA APPROVED
non-standard NAME: Odum
DATE: 2-12-08

Transfer to volumetric flask and include rinse with DI water. Allow solution to cool

Adjust final solution to volume of **2 L** with DI water, and mix thoroughly.

SUM	Total chemicals (target)	**434.74 g**	Total chemicals (actual)	431.91	J
	Total water (target)	**2 L**	Total water (actual)	2000	mL
	Target Specific Density	**1.22**	Calculated density	1.22	

Check final solution pH and record. **pH=** 13.66 Readjust if significantly different from target.

Comments: record any difficulties or discrepancies

AP105-PSC

Base Solution 2007 Version

Batch Size: 4 L
pH: 13+

AP105-PSC

Balance Device ID: 020 NIST Weight (20 g): 20.0000
Balance Device ID: 018 NIST Weight (500 g): 500.0

Technician: Noy Kelley **Date:** 2/14/08 **Tracking :** 79

Add **2400 L** mL DI water to a beaker.
Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate.
Turn on heater and adjust to 60°C (±10°C).
Add the following chemicals and record their actual weights:

Chemical	Formula		Required Mass (g)	Actual Mass (g)	Comments
Sodium Aluminate	$NaAlO_2.2H_2O$		70.71	70.72	
Sodium Chloride	NaCl		7.20	7.20	
Sodium Fluoride	NaF		1.53	1.53	
Sodium Chromate	$Na_2CrO_4.4H_2O$		9.92	10.0	
Sodium Sulfate	Na_2SO_4		26.82	26.82	
Sodium Phosphate, 12-Hydrate	$Na_3PO_4.12H_2O$		45.77	45.83	
Sodium Formate	NaHCOO		2.72	2.73	
Sodium Acetate Trihydrate	$NaCH_3COO.3H_2O$		4.08	4.08	
Sodium Oxalate	$Na_2C_2O_4$		4.02	4.03	
Sodium Carbonate	Na_2CO_3		138.21	138.2	
Sodium Nitrate	$NaNO_3$		1211.75	1212	
Potassium Nitrate	KNO_3		5.38	5.38	
Sodium Nitrite	$NaNO_2$		74.52	74.52	
Glycolic Acid	$C_2H_4O_3$		3.23	3.24	
Sodium Hydroxide	NaOH		28.18	28.24	

* Sodium fluoride is highly toxic. Handle with caution.

1634.56

Adjust total solution volume to **3400** mL by adding DI water.
Adjust solution temperature to 50°C to 60°C.
Filter solution by vacuum through medium glass filter. ***Handle with caution, hot and caustic solution.***
Rinse beaker with approximately 50 mL of DI water
Rinse filter with approximately 50 mL of DI water
Transfer final filtrate and rinse solutions to large beaker with stir bar.
Measure and record initial pH 13.45
Check the pH to make sure it is **13+**

QA APPROVED
NAME: CQ dum
DATE: 2-15-08

Transfer to volumetric flask and include rinse with DI water. Allow solution to cool

Adjust final solution to volume of **4 L** with DI water, and mix thoroughly.

SUM	Total chemicals (target)	**1634.03 g**	Total chemicals (actual)	1634.56
	Total water (target)	**4 L**	Total water (actual)	4000
	Target Specific Density	**1.41**	Calculated density	1.41

Check final solution pH and record. **pH=**13.45 Readjust if significantly different from target.

Comments: record any difficulties or discrepancies

AP105-PSC

Base Solution 2007 Version

Batch Size: 4 L
pH: 13+

AP105-PSC
0.6M nitrite

Balance Device ID: 020 NIST Weight (20 g): 20.0000
Balance Device ID: 018 NIST Weight (500 g): 500.0

Technician: Nay Kelley **Date:** 2/14/08 **Tracking :** 80

Add **2400 L** mL DI water to a beaker.
Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate.
Turn on heater and adjust to 60°C (±10°C).
Add the following chemicals and record their actual weights:

Chemical	Formula	Required Mass (g)	Actual Mass (g)	Comments
Sodium Aluminate	$NaAlO_2.2H_2O$	70.71	70.72	
Sodium Chloride	NaCl	7.20	7.20	
Sodium Fluoride	NaF	1.53	1.53	
Sodium Chromate	$Na_2CrO_4.4H_2O$	9.92	10.0	
Sodium Sulfate	Na_2SO_4	26.82	26.83	
Sodium Phosphate, 12-Hydrate	$Na_3PO_4.12H_2O$	45.77	45.78	
Sodium Formate	NaHCOO	2.72	2.72	
Sodium Acetate Trihydrate	$NaCH_3COO.3H_2O$	4.08	4.09	
Sodium Oxalate	$Na_2C_2O_4$	4.02	4.04	
Sodium Carbonate	Na_2CO_3	138.21	138.2	
Sodium Nitrate	$NaNO_3$	1211.75	1212	
Potassium Nitrate	KNO_3	5.38	5.38	
Sodium Nitrite	$NaNO_2$	165.60	165.6	
Glycolic Acid	$C_2H_4O_3$	3.23	3.23	
Sodium Hydroxide	NaOH	28.18	28.27	

* Sodium fluoride is highly toxic. Handle with caution.

1725.59

Adjust total solution volume to **3400** mL by adding DI water.
Adjust solution temperature to 50°C to 60°C.
Filter solution by vacuum through medium glass filter. ***Handle with caution, hot and caustic solution.***
Rinse beaker with approximately 50 mL of DI water
Rinse filter with approximately 50 mL of DI water
Transfer final filtrate and rinse solutions to large beaker with stir bar.
Measure and record initial pH 13.52
Check the pH to make sure it is **13+**

QA APPROVED
NAME: Cedum
DATE: 2-15-08

Transfer to volumetric flask and include rinse with DI water. Allow solution to cool

Adjust final solution to volume of **4 L** with DI water, and mix thoroughly.

SUM	Total chemicals (target)	**1725.11 g**	Total chemicals (actual)	1725.59	g
	Total water (target)	**4 L**	Total water (actual)	4000	mL
	Target Specific Density	**1.43**	Calculated density	1.43	

Check final solution pH and record. **pH=** 13.52 Readjust if significantly different from target.

Comments: record any difficulties or discrepancies

AP105-PSC

Base Solution 2007 Version

Batch Size: 4 L
pH: 13+

AP105-PSC

Balance Device ID: 026 NIST Weight (20 g): 20.0000
Balance Device ID: 018 NIST Weight (500 g): 500.0

Technician: Nog Kelley **Date:** 2/28/08 **Tracking :** 81

Add **2400 L** mL DI water to a beaker.
Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate.
Turn on heater and adjust to 60°C (±10°C).
Add the following chemicals and record their actual weights:

Chemical	Formula	Required Mass (g)	Actual Mass (g)	Comments
Sodium Aluminate	$NaAlO_2.2H_2O$	70.71	70.73	
Sodium Chloride	NaCl	7.20	7.20	
Sodium Fluoride	NaF	1.53	1.54	
Sodium Chromate	$Na_2CrO_4.4H_2O$	9.92	9.96	
Sodium Sulfate	Na_2SO_4	26.82	26.86	
Sodium Phosphate, 12-Hydrate	$Na_3PO_4.12H_2O$	45.77	45.78	
Sodium Formate	NaHCOO	2.72	2.79	
Sodium Acetate Trihydrate	$NaCH_3COO.3H_2O$	4.08	4.09	
Sodium Oxalate	$Na_2C_2O_4$	4.02	4.03	
Sodium Carbonate	Na_2CO_3	138.21	138.3	
Sodium Nitrate	$NaNO_3$	1211.75	1212	
Potassium Nitrate	KNO_3	5.38	5.38	
Sodium Nitrite	$NaNO_2$	74.52	74.5	
Glycolic Acid	$C_2H_4O_3$	3.23	3.23	Small amount of precipitate has occured
Sodium Hydroxide	NaOH	28.18	28.19	all precipitate should dissolve
			1634.58	

* Sodium fluoride is highly toxic. Handle with caution.

Adjust total solution volume to **3400** mL by adding DI water.
Adjust solution temperature to 50°C to 60°C.
Filter solution by vacuum through medium glass filter. ***Handle with caution, hot and caustic solution***.
Rinse beaker with approximately 50 mL of DI water
Rinse filter with approximately 50 mL of DI water
Transfer final filtrate and rinse solutions to large beaker with stir bar.
Measure and record initial pH 12.82
Check the pH to make sure it is **13+** add 12 g NaOH to pH 13+

Transfer to volumetric flask and include rinse with DI water. Allow solution to cool

Adjust final solution to volume of **4 L** with DI water, and mix thoroughly.

SUM	Total chemicals (target)	**1634.03 g**	Total chemicals (actual)	1634.58
	Total water (target)	**4 L**	Total water (actual)	4000
	Target Specific Density	**1.41**	Calculated density	1.41

Check final solution pH and record. **pH=** 13.88 Readjust if significantly different from target.

Comments: record any difficulties or discrepancies add 10 g of NaOH to get pH > 13

QA APPROVED
NAME: CP Quan
DATE: 3-6-08

AP105-PSC

Base Solution 2007 Version

Batch Size: 4 L
pH: 13+

AP105-PSC

Balance Device ID: 020 NIST Weight (20 g): 20.0000
Balance Device ID: 018 NIST Weight (500 g): 500.0

Technician: Noy Kelley **Date:** 3/11/08 **Tracking :** 82

Add **2400 L** mL DI water to a beaker.
Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate.
Turn on heater and adjust to 60°C (±10°C).
Add the following chemicals and record their actual weights:

Chemical	Formula	Required Mass (g)	Actual Mass (g)	Comments
Sodium Aluminate	$NaAlO_2.2H_2O$	70.71	70.71	
Sodium Chloride	NaCl	7.20	7.20	
Sodium Fluoride	NaF	1.53	1.58	
Sodium Chromate	$Na_2CrO_4.4H_2O$	9.92	9.94	
Sodium Sulfate	Na_2SO_4	26.82	27.0	
Sodium Phosphate, 12-Hydrate	$Na_3PO_4.12H_2O$	45.77	45.80	
Sodium Formate	NaHCOO	2.72	2.74	
Sodium Acetate Trihydrate	$NaCH_3COO.3H_2O$	4.08	4.08	
Sodium Oxalate	$Na_2C_2O_4$	4.02	4.02	
Sodium Carbonate	Na_2CO_3	138.21	138.2	
Sodium Nitrate	$NaNO_3$	1211.75	1212	
Potassium Nitrate	KNO_3	5.38	5.40	
Sodium Nitrite	$NaNO_2$	74.52	74.7	
Glycolic Acid	$C_2H_4O_3$	3.23	3.24	
Sodium Hydroxide	NaOH	28.18	28.31	

* Sodium fluoride is highly toxic. Handle with caution.

Adjust total solution volume to **3400** mL by adding DI water.
Adjust solution temperature to 50°C to 60°C.
Filter solution by vacuum through medium glass filter. ***Handle with caution, hot and caustic solution.***
Rinse beaker with approximately 50 mL of DI water
Rinse filter with approximately 50 mL of DI water
Transfer final filtrate and rinse solutions to large beaker with stir bar.
Measure and record initial pH 13.16
Check the pH to make sure it is **13+**

Transfer to volumetric flask and include rinse with DI water. Allow solution to cool

Adjust final solution to volume of **4 L** with DI water, and mix thoroughly.

QA APPROVED NAME: Cadum DATE: 3-26-08

SUM	Total chemicals (target)	**1634.03 g**	Total chemicals (actual)	1634.91
	Total water (target)	**4 L**	Total water (actual)	4000
	Target Specific Density	**1.41**	Calculated density	1.41

Check final solution pH and record. **pH=** 13.15 Readjust if significantly different from target.

Comments: record any difficulties or discrepancies

SY103-PIL

Base Solution 2008 Version

Batch Size: 4 L
pH: 13+

SY103-PIL

Balance Device ID: 0020 NIST Weight (20 g): 19.999
Balance Device ID: 0018 NIST Weight (1000 g): 1000

Technician: Emily **Date:** 3/19/08 **Tracking :** 85

Add the following chemicals and record their actual weights:

Chemical	Formula	Required Mass (g)	Actual Mass (g)	Comments
In the first container measure		**2400** mL DI water, heat to 80-90°C using hot-plate		
Sodium Aluminate	Na_2AlO_2	675.680	675.7	
Sodium Hydroxide	NaOH	388.800	388.9	
In a separate container measure		**1000** mL DI water		
Copper Nitrate 2.5-hydrate	$Cu(NO_3)_2.2.5H_2O$	0.186	0.183	
Ferric Nitrate 9-hydrate	$Fe(NO_3)_3.9H_2O$	0.808	0.809	
Add the following Organics (to the second container)				
Sodium Acetate 3-hydrate	$NaCH_3COO.3H_2O$	23.896	23.902	
Sodium Formate	NaHCOO	51.144	51.146	
Glycolic Acid	$C_2H_4O_3$	14.39	14.38	
Sodium Oxalate	$Na_2C_2O_4$	2.358	2.359	
Citric Acid 1-hydrate	$C_6H_8O_7.H_2O$	16.643	16.641	
Disodium EDTA	$Na_2C_{10}H_{14}O_8.2H_2O$	13.103	13.103	
HEDTA	$C_{10}H_{18}N_2O_7$	4.897	4.891	
Nitrilotriacetic Acid	$C_6H_9NO_6$	1.682	1.683	
Iminodiacetic Acid	$C_4H_7NO_2$	10.542	10.544	
Combine the two solutions into one container, maintain a temperature of 50°C. Add the remaining chemicals.				
Boric Acid	H_3BO_3	3.263	3.266	
Sodium Chromate	$Na_2CrO_4.4H_2O$	0.936	0.930	
Potassium Molybdate	K_2MoO_4	1.714	1.714	
Potassium Nitrate	KNO_3	51.712	51.703	
Sodium Chloride	NaCl	115.945	116.0	
Sodium Nitrate	$NaNO_3$	625.600	625.6	
Sodium Nitrite	$NaNO_2$	803.160	803.2	
Sodium Phosphate, 12-Hydrate	$Na_3PO_4.12H_2O$	41.800	41.799	
Sodium Sulfate	Na_2SO_4	9.486	9.484	
Sodium Carbonate	Na_2CO_3	52.152	52.2	

Filter solution by vacuum through medium glass filter. ***Handle with caution, caustic solution.***
Rinse beaker with approximately 50 mL of DI water
Rinse filter with approximately 50 mL of DI water
Transfer final filtrate and rinse solutions to large beaker with stir bar.
Transfer to volumetric flask and include rinse with DI water.

Adjust final solution to volume of **4 L** with DI water, and mix thoroughly.

SUM	Total chemicals (targe	**2910 g**	Total chemicals (actual)	2910.091
	Total water (target)	**4 L**	Total water (actual)	4000
	Target Specific Densit	**1.73**	Calculated density	1.173

Check final solution pH and recon **pH=** 14.06 Readjust if significantly different from target.

Comments: record any difficulties or discrepancies

QA APPROVED
NAME: Qdam
DATE: 3-26-08

AW105 Interstitial

Base Solution 2008 Version

Batch Size: 4 L
pH: 13+

AW105-PIL

Balance Device ID: 0020 NIST Weight (20 g): 20.000
Balance Device ID: 0018 NIST Weight (1000 g): 1000.0

Technician: [signature] **Date:** 3-20 **Tracking :** 86

Add the following chemicals and record their actual weights:

Chemical	Formula	Required Mass (g)	Actual Mass (g)	Comments
In the first container measure		**2400 mL**	DI water, heat to 80-90°C using hot-plate	
Sodium Aluminate	Na_2AlO_2	5.248	5.264	
Sodium Hydroxide	NaOH	72.032	72.06	
In a separate container measure		**1000 mL**	DI water	
Cobaltous Nitrate 6-hydrate	$Co(NO_3)_2.6H_2O$	0.028	0.029	
Nickel Nitrate 6-hydrate	$Ni(NO_3)_2.6H_2O$	0.081	0.083	
Add the following Organics (to the second container)				
Sodium Acetate 3-hydrate	$NaCH_3COO.3H_2O$	3.369	3.370	
Sodium Formate	NaHCOO	0.884	0.891	
Sodium Oxalate	$Na_2C_2O_4$	1.726	1.725	
Tributyl Phosphate	$C_{12}H_{27}O_4P$	5.192	5.133	
1-Butanol	C_4H_9OH	3.705	3.706	
Dibutyl Phosphate	$C_8H_{19}O_4P$	10.500	10.51	
Combine the two solutions into one container, maintain a temperature of 50°C. Add the remaining chemicals.				
Boric Acid	H_3BO_3	0.156	6.165	
Sodium Chromate	$Na_2CrO_4.4H_2O$	0.192	0.194	
Potassium Molybdate	$K2MoO_4$	0.029	.0292	
Potassium Nitrate	KNO_3	88.072	88.2	
Zirconyl Nitrate 1-hydrate	$ZrO(NO_3)_2.H_2O$	0.005	0.007	
Sodium Chloride	NaCl	2.384	2.342	
Sodium Fluoride	NaF	97.608	97.5	
Sodium Nitrate	$NaNO_3$	68.340	68.0	
Sodium Nitrite	$NaNO_2$	34.224	34.3	
Sodium Phosphate, 12-Hydrate	$Na_3PO_4.12H_2O$	4.864	4.856	
Sodium Sulfate	Na_2SO_4	7.895	7.883	
Sodium Carbonate	Na_2CO_3	40.958	41.0	

Filter solution by vacuum through medium glass filter. ***Handle with caution, hot and caustic solution.***
Rinse beaker with approximately 50 mL of DI water
Rinse filter with approximately 50 mL of DI water
Transfer final filtrate and rinse solutions to large beaker with stir bar.
Transfer to volumetric flask and include rinse with DI water. Allow solution to cool

Adjust final solution to volume of **4 L** with DI water, and mix thoroughly.

SUM	Total chemicals (target)	**447.49 g**	Total chemicals (actual)	447.46
	Total water (target)	**4 L**	Total water (actual)	4000
	Target Specific Density	**1.11**	Calculated density	1.11

Check final solution pH and record. **pH=** 13.6 Readjust if significantly different from target.

Comments: record any difficulties or discrepancies

QA APPROVED NAME: Qadeer DATE: 3-26-08

AP105-PSC

Base Solution 2007 Version

Batch Size: 4 L
pH: 13+

AP105-PSC
3.85M nitate, no nitrite

Balance Device ID: 0020 NIST Weight (10 g): 10.0000 →
Balance Device ID: 0018 NIST Weight (50 g): 49.9999 →

Technician: Jesse Rhodes **Date:** 4/1/08 **Tracking :** 87

Add **2400 L** mL DI water to a beaker.
Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate.
Turn on heater and adjust to 60°C (±10°C).
Add the following chemicals and record their actual weights:

Chemical	Formula	Required Mass (g)	Actual Mass (g)	Comments
Sodium Aluminate	$NaAlO_2.2H_20$	70.71	70.70	
Sodium Chloride	NaCl	7.20	7.203	
Sodium Fluoride	NaF	1.53	1.530	
Sodium Chromate	$Na_2CrO_4.4H_2O$	9.92	9.922	
Sodium Sulfate	Na_2SO_4	26.82	26.80	
Sodium Phosphate, 12-Hydrate	$Na_3PO_4.12H_2O$	45.77	45.80	
Sodium Formate	NaHCOO	2.72	2.719	
Sodium Acetate Trihydrate	$NaCH_3COO.3H_2O$	4.08	4.081	
Sodium Oxalate	$Na_2C_2O_4$	4.02	4.022	
Sodium Carbonate	Na_2CO_3	138.21	138.20	
Sodium Nitrate	$NaNO_3$	1211.75	1211.80	
Potassium Nitrate	KNO_3	114.57	114.60	
Sodium Nitrite	$NaNO_2$	0.00		
Glycolic Acid	$C_2H_4O_3$	3.23	3.241	
Sodium Hydroxide	NaOH	28.18	28.20	

* Sodium fluoride is highly toxic. Handle with caution.

Adjust total solution volume to **3400** mL by adding DI water.
Adjust solution temperature to 50°C to 60°C.
Filter solution by vacuum through medium glass filter. ***Handle with caution, hot and caustic solution.***
Rinse beaker with approximately 50 mL of DI water
Rinse filter with approximately 50 mL of DI water
Transfer final filtrate and rinse solutions to large beaker with stir bar.
Measure and record initial pH 14.04
Check the pH to make sure it is **13+**

Transfer to volumetric flask and include rinse with DI water. Allow solution to cool

Adjust final solution to volume of **4 L** with DI water, and mix thoroughly.

SUM	Total chemicals (target)	**1668.70 g**	Total chemicals (actual)	1668.82
	Total water (target)	**4 L**	Total water (actual)	4L
	Target Specific Density	**1.42**	Calculated density	1.42

Check final solution pH and record. **pH=** 13.95 Readjust if significantly different from target.

Comments: record any difficulties or discrepancies
~~5934, 5609.8~~ QR

QA APPROVED
NAME:
DATE: 4-14-08

AP105-PSC

Base Solution 2007 Version

Batch Size: 4 L
pH: 13+

AP105-PSC

Balance Device ID: 0020 NIST Weight (10 g): 10.0000
Balance Device ID: 0018 NIST Weight (50 g): 49.9999

Technician: Jesse Rhodes **Date:** 4/2/08 **Tracking :** 88

Add **2400 L** mL DI water to a beaker.
Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate.
Turn on heater and adjust to 60°C (±10°C).
Add the following chemicals and record their actual weights:

Chemical	Formula	Required Mass (g)	Actual Mass (g)	Comments
Sodium Aluminate	$NaAlO_2.2H_20$	70.71	70.70	
Sodium Chloride	NaCl	7.20	7.201	
Sodium Fluoride	NaF	1.53	1.530	
Sodium Chromate	$Na_2CrO_4.4H_2O$	9.92	9.919	
Sodium Sulfate	Na_2SO_4	26.82	26.80	
Sodium Phosphate, 12-Hydrate	$Na_3PO_4.12H_2O$	45.77	45.80	
Sodium Formate	NaHCOO	2.72	2.721	
Sodium Acetate Trihydrate	$NaCH_3COO.3H_2O$	4.08	4.078	
Sodium Oxalate	$Na_2C_2O_4$	4.02	4.019	
Sodium Carbonate	Na_2CO_3	138.21	138.20	
Sodium Nitrate	$NaNO_3$	1211.75	1211.80	
Potassium Nitrate	KNO_3	5.38	5.378	
Sodium Nitrite	$NaNO_2$	74.52	74.50	
Glycolic Acid	$C_2H_4O_3$	3.23	3.233	
Sodium Hydroxide	NaOH	28.18	28.10	

* Sodium fluoride is highly toxic. Handle with caution.

Adjust total solution volume to **3400** mL by adding DI water.
Adjust solution temperature to 50°C to 60°C.
Filter solution by vacuum through medium glass filter. ***Handle with caution, hot and caustic solution.***
Rinse beaker with approximately 50 mL of DI water
Rinse filter with approximately 50 mL of DI water
Transfer final filtrate and rinse solutions to large beaker with stir bar.
Measure and record initial pH 14.40
Check the pH to make sure it is **13+**

Transfer to volumetric flask and include rinse with DI water. Allow solution to cool

Adjust final solution to volume of **4 L** with DI water, and mix thoroughly.

SUM	Total chemicals (target)	**1634.03 g**	Total chemicals (actual)	1633.98
	Total water (target)	**4 L**	Total water (actual)	4L
	Target Specific Density	**1.41**	Calculated density	QR ~~1.40~~ 1.41

Check final solution pH and record. **pH=**14.19 Readjust if significantly different from target.

Comments: record any difficulties or discrepancies
~~5739; 5546.1~~ QR

QA APPROVED
NAME: Chau
DATE: 4-14-08

AP105 - Mixed Supernate

Base Solution 2008 Version

Batch Size: 4 L
pH: 13+

AP105-Mixed Super

Balance Device ID: 020 NIST Weight (20g): 20.0000
Balance Device ID: 018 NIST Weight (500g): 500.0

Technician: Noy Kelley **Date:** 4/9/08 **Tracking :** 89

Add **2400 L** mL DI water to a beaker.
Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate.
Turn on heater and adjust to 60°C (±10°C).
Add the following chemicals and record their actual weights:

Chemical	Formula	Required Mass (g)	Actual Mass (g)	Comments
Sodium Aluminate	$NaAlO_2.2H_2O$	92.04	92.2	Cloundy then clear
Sodium Chloride	NaCl	9.12	9.13	
Sodium Fluoride	NaF	4.37	4.39	
Sodium Chromate 4-hydrate	$Na_2CrO_4.4H_2O$	7.49	7.50	Yellow
Sodium Sulfate	Na_2SO_4	22.73	22.73	
Sodium Phosphate, 12-Hydrate	$Na_3PO_4.12H_2O$	45.61	45.7	
Sodium Formate	NaHCOO	3.13	3.15	
Sodium Acetate Trihydrate	$NaCH_3COO.3H_2O$	5.72	5.74	
Sodium Oxalate	$Na_2C_2O_4$	6.16	6.17	
Sodium Carbonate	Na_2CO_3	116.17	116.2	cloundy
Sodium Nitrate	$NaNO_3$	927.07	927.2	
Potassium Nitrate	KNO_3	52.57	52.5	
Sodium Nitrite	$NaNO_2$	113.99	114.0	
Glycolic Acid (70% solution)	$C_2H_4O_3$	4.96	4.98	1/2 Precipitation
Sodium Hydroxide	NaOH	152.32	152.4	clear all precipitation
Ammonium Acetate	NH_4CH_3COO	1.23	1.29	

* Sodium fluoride is highly toxic. Handle with caution.

small amount of white chemical left on filter

Adjust total solution volume to **3400** mL by adding DI water.
Adjust solution temperature to 50°C to 60°C.
Filter solution by vacuum through medium glass filter. ***Handle with caution, hot and caustic solution.***
Rinse beaker with approximately 50 mL of DI water
Rinse filter with approximately 50 mL of DI water
Transfer final filtrate and rinse solutions to large beaker with stir bar.
Measure and record initial pH 13.63
Check the pH to make sure it is **13+**

Transfer to volumetric flask and include rinse with DI water. Allow solution to cool

Adjust final solution to volume of **4 L** with DI water, and mix thoroughly.

SUM	Total chemicals (target)	**1564.67 g**	Total chemicals (actual)	1565.28	g
	Total water (target)	**4 L**	Total water (actual)	4000	mL
	Target Specific Density	**1.39**	Calculated density	1.39	

Check final solution pH and record. **pH=** 13+ Readjust if significantly different from target.

Comments: record any difficulties or discrepancies

QA APPROVED
NAME: Qdun
DATE: 4-14-08

#1

AP105-PSC

Base Solution 2007 Version

Batch Size: 4 L
pH: 13+

AP105-PSC

Balance Device ID: 020 NIST Weight (20 g): 20.0000
Balance Device ID: 018 NIST Weight (500 g): 500.0

Technician: Noy Kelley **Date:** 4/14/08 **Tracking :** 90

Add **2400** mL DI water to a beaker.
Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate.
Turn on heater and adjust to 60°C (±10°C).
Add the following chemicals and record their actual weights:

Chemical	Formula		Required Mass (g)	Actual Mass (g)	Comments
Sodium Aluminate	$NaAlO_2.2H_2O$		70.71	70.70	cloudy
Sodium Chloride	NaCl		7.20	9.22	"
Sodium Fluoride	NaF		1.53	1.56	"
Sodium Chromate	$Na_2CrO_4.4H_2O$		9.92	9.96	"
Sodium Sulfate	Na_2SO_4		26.82	26.84	"
Sodium Phosphate, 12-Hydrate	$Na_3PO_4.12H_2O$		45.77	46.0	"
Sodium Formate	NaHCOO		2.72	2.84	"
Sodium Acetate Trihydrate	$NaCH_3COO.3H_2O$		4.08	4.09	"
Sodium Oxalate	$Na_2C_2O_4$		4.02	4.02	"
Sodium Carbonate	Na_2CO_3		138.21	138.4	"
Sodium Nitrate	$NaNO_3$		1211.75	1211.8	"
Potassium Nitrate	KNO_3		5.38	5.40	"
Sodium Nitrite	$NaNO_2$		74.52	74.5	"
Glycolic Acid	$C_2H_4O_3$		3.23	3.24	"
Sodium Hydroxide	NaOH		28.18	28.23	"

* Sodium fluoride is highly toxic. Handle with caution.

solution clear when filter

Adjust total solution volume to **3400** mL by adding DI water.
Adjust solution temperature to 50°C to 60°C.
Filter solution by vacuum through medium glass filter. ***Handle with caution, hot and caustic solution.***
Rinse beaker with approximately 50 mL of DI water
Rinse filter with approximately 50 mL of DI water
Transfer final filtrate and rinse solutions to large beaker with stir bar.
Measure and record initial pH 13.18
Check the pH to make sure it is **13+**

QA APPROVED
NAME: Cleun
DATE: 4-18-08

Transfer to volumetric flask and include rinse with DI water. Allow solution to cool

Adjust final solution to volume of **4 L** with DI water, and mix thoroughly.

SUM	Total chemicals (target)	**1634.03 g**	Total chemicals (actual)	1634.8	g
	Total water (target)	**4 L**	Total water (actual)	4000	mL
	Target Specific Density	**1.41**	Calculated density	1.41	

Check final solution pH and record. **pH=** 13.18 Readjust if significantly different from target.

Comments: record any difficulties or discrepancies solution cloudy but clear when filter. About 7.5 g of white powder chemical left on filter $CrNaH_2.2H_2O$?

Evaporated Supernate

Base Solution 2008 Version

Batch Size: 2 L
pH: 14

Evaporated Supernate

Balance Device ID: 020 NIST Weight (20 g): 20.0000
Balance Device ID: 018 NIST Weight (500 g): 500.0

Technician: Noy Kelley **Date:** 4/15/08 **Tracking :** 91

Add **1200** mL DI water to a beaker.
Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate.
Turn on heater and adjust to 60°C (±10°C).
Add the following chemicals and record their actual weights:

Chemical	Formula	Required Mass (g)	Actual Mass (g)	Comments
Sodium Aluminate	$NaAlO_2.2H_2O$	81.89	81.9	
Sodium Chloride	NaCl	8.06	8.07	
Sodium Fluoride	NaF	3.95	3.97	
Sodium Chromate 4-hydrate	$Na_2CrO_4.4H_2O$	6.55	6.55	
Sodium Sulfate	Na_2SO_4	20.45	20.45	
Sodium Phosphate, 12-Hydrate	$Na_3PO_4.12H_2O$	40.29	40.34	AK 4/15/08
Sodium Formate	NaHCOO	2.18	2.18	
Sodium Oxalate	$Na_2C_2O_4$	4.29	4.30	
Sodium Carbonate	Na_2CO_3	103.66	103.7	
Sodium Nitrate	$NaNO_3$	825.59	826.0	
Potassium Nitrate	KNO_3	46.51	46.50	
Sodium Nitrite	$NaNO_2$	101.57	101.50	
Sodium Hydroxide	NaOH	133.60	134.0	
Ammonium Acetate	NH_4CH_3COO	1.23	1.24	
			1380.7	

* Sodium fluoride is highly toxic. Handle with caution.

Adjust total solution volume to **1700** mL by adding DI water.
Adjust solution temperature to 50°C to 60°C. Stir solution to dissolve all chemicals
Handle with caution, hot and caustic solution.
Adjust final solution to volume of **2 L** with DI water, and mix thoroughly.

Maintain solution temperature to 50°C to 60°C.

Check the pH to make sure it is 14+ **14**

QA APPROVED
NAME: Olden
DATE: 4-18-08

SUM	Total chemicals (target)	**1379.83 g**	Total chemicals (actual)	1380.7	g
	Total water (target)	**2 L**	Total water (actual)	2000	mL
	Target Specific Density	**1.69**	Calculated density	1.69	

Check final solution pH and record. **pH=** 14+ Readjust if significantly different from target.

Comments: record any difficulties or discrepancies
Keep solution at 50°C at all the time

AY101-PSC

Base Solution 2007 Version

Batch Size: 2 L
pH: >13

AY-101-PSC

Balance Device ID: 020 NIST Weight (20 g): 20.0000
Balance Device ID: 018 NIST Weight (150 g): 150.0

Technician: Noy Kelley **Date:** 5/2/08 **Tracking :** 92

Add **1200** mL DI water to a beaker.
Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate.
Turn on heater and adjust to 60°C (±10°C).
Add the following chemicals and record their actual weights:

Chemical	Formula	Required Mass (g)	Actual Mass (g)	Comments
Sodium Aluminate	$NaAlO_2.2H_2O$	25.25	25.31	
Sodium Chloride	NaCl	2.13	2.15	
Sodium Fluoride	NaF	1.16	1.17	
Sodium Chromate	$Na_2CrO_4.4H_2O$	1.33	1.33	
Sodium Sulfate	Na_2SO_4	5.65	5.65	
Sodium Phosphate, 12-Hydrate	$Na_3PO_4.12H_2O$	37.71	37.71	
Sodium Formate	NaHCOO	1.73	1.74	
Sodium Acetate Trihydrate	$NaCH_3COO.3H_2O$	2.41	2.43	
Sodium Oxalate	$Na_2C_2O_4$	1.34	1.36	
Sodium Carbonate	Na_2CO_3	42.61	42.61	
Sodium Nitrate	$NaNO_3$	226.07	226.0	
Sodium Nitrite	$NaNO_2$	28.29	28.30	
Sodium Silicate	$Na_2SiO_3.9H_2O$	0.99	1.00	*
Glycolic Acid	$C_2H_4O_3$	1.60	1.60	
Sodium Hydroxide	NaOH	56.88	56.94	

* Sodium fluoride is highly toxic. Handle with caution.

Adjust total solution volume to **1700** mL by adding DI water.
Adjust solution temperature to 50°C to 60°C.
Filter solution by vacuum through medium glass filter. ***Handle with caution, hot and caustic solution.***
Rinse beaker with approximately 50 mL of DI water
Rinse filter with approximately 50 mL of DI water
Transfer final filtrate and rinse solutions to large beaker with stir bar.
Measure and record initial pH 13
Check the pH to make sure it is **>13** non-standard pH

Transfer to volumetric flask and include rinse with DI water. Allow solution to cool

Adjust final solution to volume of **2 L** with DI water, and mix thoroughly.

SUM	Total chemicals (target)	**435.15 g**	Total chemicals (actual)	435.29	g
	Total water (target)	**2 L**	Total water (actual)	2000	mL
	Target Specific Density	**1.22**	Calculated density	1.22	

Check final solution pH and record. **pH=** 13 Readjust if significantly different from target.

Comments: record any difficulties or discrepancies Precipitation ocurre after adding $Na_2SiO_3.9H_2O$ but dissovle more after adding NaOH ~ 1 g of solid left on filter

QA APPROVED
NAME: Cldun
DATE: 6-18-08

AZ102

Base Solution 2008 Version

Batch Size: 4 L
pH: 12

AZ102

Balance Device ID: 020 NIST Weight (20 g): 20.0000
Balance Device ID: 018 NIST Weight (500 g): 500.0

Technician: Noy Kelley **Date:** 6/6/08 **Tracking :** 93

Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate.
Turn on heater and adjust to 60°C (±10°C).
Add **2400** mL DI water to a beaker or carboy as appropriate

Add the following chemicals and record their actual weights:

Chemical	Formula	Required Mass (g)	Actual Mass (g)	Comments
Sodium Aluminate	$NaAlO_2$	2.296	2.319	
Sodium Chromate 4-Hydrate	$Na_2CrO_4.4H_2O$	12.168	12.176	
Potassium Molybdate	K_2MoO_4	0.476	0.481	
Potassium Nitrate	KNO_3	28.684	28.696	
Sodium Fluoride	NaF	8.736	8.756	
Sodium Hydroxide	NaOH *	0.000	0.00	
Sodium Nitrate	$NaNO_3$	11.560	11.571	
Sodium Nitrite	$NaNO_2$	243.708	243.70	
Sodium Sulfate	Na_2SO_4	105.648	106.0	
Sodium Carbonate	Na_2CO_3	257.368	257.4	
Sodium bicarbonate	$NaHCO_3$	4.032	4.08	
Organics				
Sodium Oxalate	$Na_2C_2O_4$	9.112	9.122	

Adjust total solution volume to **3400** mL by adding DI water.
Adjust solution temperature to 50°C to 60°C.
Filter solution by vacuum through medium glass filter. ***Handle with caution, hot and caustic solution.***
Rinse beaker with approximately 50 mL of DI water
Rinse filter with approximately 50 mL of DI water pH initial 11.15
Transfer final filtrate and rinse solutions to large beaker with stir bar.
Transfer to volumetric flask and include rinse with DI water. Allow solution to cool

Adjust final solution to volume of **4 L** with DI water, and mix thoroughly.

SUM	Total chemicals (target)	**683.79 g**	Total chemicals (actual)	684.295 g
	Total water (target)	**4 L**	Total water (actual)	4000 mL
	Target Specific Density	**1.17**	Calculated density	1.17

Check final solution pH and record. **pH=** 12.25 Adjust to required pH using NaOH

Comments: record any difficulties or discrepancies
add 5 g of NaOH to bring pH 11.15 to 12.25

OCP 18 ho
CPP

QA APPROVED
NAME: Cldun
DATE: 6-18-08

Evaporated Supernate

Base Solution 2008 Version

Batch Size: 2 L
pH: 14

Nitrite/Nitrate=0.1

Balance Device ID: 020 NIST Weight (20 g): 20.0000
Balance Device ID: 018 NIST Weight (500g): 500.0

Technician: Noy Kelley **Date:** 5/18/08 **Tracking :** 94

Add **1200** mL DI water to a beaker.
Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate.
Turn on heater and adjust to 60°C (±10°C).
Add the following chemicals and record their actual weights:

Chemical	Formula	Required Mass (g)	Actual Mass (g)	Comments
Sodium Aluminate	$NaAlO_2.2H_2O$	81.89	82.0	
Sodium Chloride	NaCl	8.06	8.08	
Sodium Fluoride	NaF	3.95	3.99	
Sodium Chromate 4-hydrate	$Na_2CrO_4.4H_2O$	6.55	6.55	
Sodium Sulfate	Na_2SO_4	20.45	20.47	
Sodium Phosphate, 12-Hydrate	$Na_3PO_4.12H_2O$	40.29	40.32	
Sodium Formate	NaHCOO	2.18	2.19	
Sodium Oxalate	$Na_2C_2O_4$	4.29	4.29	
Sodium Carbonate	Na_2CO_3	103.66	101.0	
Sodium Nitrate	$NaNO_3$	825.59	825.6	
Potassium Nitrate	KNO_3	46.51	46.6	
Sodium Nitrite	$NaNO_2$	70.38	70.40	
Sodium Hydroxide	NaOH	133.60	134.0	
Ammonium Acetate	NH_4CH_3COO	1.23	1.24	

* Sodium fluoride is highly toxic. Handle with caution.

Adjust total solution volume to **1700** mL by adding DI water.
Adjust solution temperature to 50°C to 60°C. Stir solution to dissolve all chemicals
Handle with caution, hot and caustic solution
Adjust final solution to volume of **2 L** with DI water, and mix thoroughly.

Maintain solution temperature to 50°C to 60°C.

Check the pH to make sure it is **14**

SUM	Total chemicals (target)	**1348.64 g**	Total chemicals (actual)	1349.73	g
	Total water (target)	**2 L**	Total water (actual)	2000	mL
	Target Specific Density	**1.67**	Calculated density	1.67	

Check final solution pH and record. **pH=** 14.0 Readjust if significantly different from target.

Comments: record any difficulties or discrepancies

QA APPROVED
NAME: Cedeno
DATE: 6-18-08

Evaporated Supernate

Base Solution 2008 Version

Batch Size: 1 L
pH: ~~12+~~ 11+

No aluminate
No NaOH

Balance Device ID: 020 — NIST Weight (20 g): (EG) 19.9999
Balance Device ID: 018 — NIST Weight (500 g): 05/14/08 500.0

Technician: Noy Kelley **Date:** 5/15/08 **Tracking :** 95

Add **600** mL DI water to a beaker.
Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate.
Turn on heater and adjust to 60°C (±10°C).
Add the following chemicals and record their actual weights:

Chemical	Formula	Required Mass (g)	Actual Mass (g)	Comments
Sodium Aluminate	$NaAlO_2 2H_2O$	0.00	0.00	
Sodium Chloride	NaCl	4.03	4.03	
Sodium Fluoride	NaF	1.97	1.97	
Sodium Chromate 4-hydrate	$Na_2CrO_4.4H_2O$	3.28	3.28	
Sodium Sulfate	Na_2SO_4	10.23	10.23	
Sodium Phosphate, 12-Hydrate	$Na_3PO_4.12H_2O$	20.15	20.18	
Sodium Formate	NaHCOO	1.09	1.10	
Sodium Oxalate	$Na_2C_2O_4$	2.14	2.15	
Sodium Carbonate	Na_2CO_3	51.83	51.84	
Sodium Nitrate	$NaNO_3$	412.80	413.0	
Potassium Nitrate	KNO_3	23.25	23.24	
Sodium Nitrite	$NaNO_2$	51.06	51.05	
Sodium Hydroxide	NaOH	0.00	0.00	
Ammonium Acetate	NH_4CH_3COO	0.62	0.62	

* Sodium fluoride is highly toxic. Handle with caution.

Adjust total solution volume to **850** mL by adding DI water.
Adjust solution temperature to 50°C to 60°C. Stir solution to dissolve all chemicals
Handle with caution, hot and caustic solution.
Adjust final solution to volume of **1 L** with DI water, and mix thoroughly.

Maintain solution temperature to 50°C to 60°C.

Check the pH to make sure it is ~~12+~~ 11+ (EG) 05/14/08 non-standard pH

* limited sample use all sample for OCP & CPP *

SUM	Total chemicals (target)	**582.44 g**	Total chemicals (actual)	
	Total water (target)	**1 L**	Total water (actual)	
	Target Specific Density	**1.58**	Calculated density	

Check final solution pH and record. **pH=** ___ Readjust if significantly different from target.

Comments: record any difficulties or discrepancies no sample left

QA APPROVED
NAME: Cedum
DATE: 6-18-08

AP105 - Mixed Supernate

Base Solution 2008 Version

Batch Size: 2 L
pH: 13+

Nitrite/Nitrate=0.1

Balance Device ID: 020 NIST Weight (20 g): 20.0000
Balance Device ID: 018 NIST Weight (500 g): 500.1

Technician: Noy Kelley **Date:** 5/13/08 **Tracking :** 96

Add **1200** mL DI water to a beaker.
Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate.
Turn on heater and adjust to 60°C (±10°C).
Add the following chemicals and record their actual weights:

Chemical	Formula	Required Mass (g)	Actual Mass (g)	Comments
Sodium Aluminate	$NaAlO_2.2H_2O$	46.02	46.06	
Sodium Chloride	NaCl	4.56	4.65	
Sodium Fluoride	NaF	2.18	2.18	
Sodium Chromate 4-hydrate	$Na_2CrO_4.4H_2O$	3.74	3.75	
Sodium Sulfate	Na_2SO_4	11.36	11.38	
Sodium Phosphate, 12-Hydrate	$Na_3PO_4.12H_2O$	22.81	22.80	
Sodium Formate	NaHCOO	1.56	1.58	
Sodium Acetate Trihydrate	$NaCH_3COO.3H_2O$	2.86	2.86	
Sodium Oxalate	$Na_2C_2O_4$	3.08	3.10	
Sodium Carbonate	Na_2CO_3	58.08	58.07	
Sodium Nitrate	$NaNO_3$	463.54	463.8	
Potassium Nitrate	KNO_3	26.29	26.25	
Sodium Nitrite	$NaNO_2$	38.64	38.63	
Glycolic Acid (70% solution)	$C_2H_4O_3$	2.48	2.50	Precipitation occure
Sodium Hydroxide	NaOH	76.16	76.20	
Ammonium Acetate	NH_4CH_3COO	0.62	0.62	

* Sodium fluoride is highly toxic. Handle with caution.

Adjust total solution volume to **1700** mL by adding DI water.
Adjust solution temperature to 50°C to 60°C.
Filter solution by vacuum through medium glass filter. ***Handle with caution, hot and caustic solution.***
Rinse beaker with approximately 50 mL of DI water
Rinse filter with approximately 50 mL of DI water
Transfer final filtrate and rinse solutions to large beaker with stir bar.
Measure and record initial pH 13.50
Check the pH to make sure it is 13+

Transfer to volumetric flask and include rinse with DI water. Allow solution to cool

Adjust final solution to volume of **2 L** with DI water, and mix thoroughly.

SUM	Total chemicals (target)	**763.98 g**	Total chemicals (actual)	764.43 g
	Total water (target)	**2 L**	Total water (actual)	2000 mL
	Target Specific Density	**1.38**	Calculated density	1.38

Check final solution pH and record. **pH=** 12.80 Readjust if significantly different from target.

Comments: record any difficulties or discrepancies

QA APPROVED
NAME: Cleve
DATE: 6-18-08

AW105 Supernate

Base Solution 2008 Version

Batch Size: 4 L
pH: 13+

AW105-PSC

Balance Device ID: 020 NIST Weight (20 g): 20.000
Balance Device ID: 018 NIST Weight (500 g): 500.0

Technician: Noy Kelley **Date:** 5/27/08 **Tracking :** 97

Add **2400 L** mL DI water to a beaker.
Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate.
Turn on heater and adjust to 60°C (±10°C).

Add the following chemicals and record their actual weights:

Chemical	Formula	Required Mass (g) 3.097	Actual Mass (g)	Comments
Sodium Aluminate	Na_2AlO_2	~~2.799~~	2.80 +0.26 g per CS	OK 5/29/08
Sodium Hydroxide	NaOH	42.080	42.15	
Boric Acid	H_3BO_3	0.079	0.10	
Sodium Chromate	$Na_2CrO_4.4H_2O$	0.037	0.040	
Potassium Molybdate	K2MoO4	0.010	0.015	
Potassium Nitrate	KNO_3	58.338	56.38	
Zinc Nitrate 6-hydrate	$Zn(NO_3)_2.6H_2O$	0.036	0.040	
Sodium Chloride	NaCl	1.931	1.95	
Sodium Fluoride	NaF	26.208	26.19	
Sodium Nitrate	$NaNO_3$	100.504	100.50	
Sodium Nitrite	$NaNO_2$	17.609	17.57	
Sodium Phosphate, 12-Hydrate	$Na_3PO_4.12H_2O$	6.794	6.80	
Sodium Sulfate	Na_2SO_4	2.988	3.00	
Sodium Carbonate	Na_2CO_3	45.622	45.65	
Glycolic Acid	$C_2H_4O_3$	0.437	0.45	
Sodium Acetate 3-hydrate	$NaCH_3COO.3H_2O$	1.252	1.27	
Sodium Formate	NaHCOO	0.558	0.56	
Sodium Oxalate	$Na_2C_2O_4$	0.884	0.890	
			308.355 +0.26	

Filter solution by vacuum through medium glass filter. ***Handle with caution, hot and caustic solution.***
Rinse beaker with approximately 50 mL of DI water
Rinse filter with approximately 50 mL of DI water
Transfer final filtrate and rinse solutions to large beaker with stir bar.
Transfer to volumetric flask and include rinse with DI water. Allow solution to cool

Adjust final solution to volume of **4 L** with DI water, and mix thoroughly. add 0.26 g

SUM	Total chemicals (target)	**308.17 g**	Total chemicals (actual)	308.355 g	308.615 g
	Total water (target)	**4 L**	Total water (actual)	~~1000~~ mL	1000 mL
	Target Specific Density	**1.08**	Calculated density	1.08	1.08

Check final solution pH and record. **pH=** ___ Readjust if significantly different from target.

Comments: record any difficulties or discrepancies.
add more $NaAlO_2$ 0.26 g per Collin Scott
As requested. Cdi S

QA APPROVED
NAME: Collin
DATE: 6-24-08

SY101

Base Solution 2008 Version

Batch Size: 4 L
pH: 13+

SY101

Balance Device ID: 020 NIST Weight (20 g): 20.0000
Balance Device ID: 018 NIST Weight (500 g): 500.0

Technician: Noy Kelley **Date:** 5/28/08 **Tracking :** 98

Add **2400** mL DI water to a beaker.
Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate.
Turn on heater and adjust to 60°C (±10°C).
Add the following chemicals and record their actual weights:

Chemical	Formula	Required Mass (g)	Actual Mass (g)	Comments
Sodium Aluminate	$NaAlO_2.2H_2O$	66.41	66.42	
Sodium Chloride	NaCl	5.32	5.32	
Sodium Fluoride *	NaF	4.65	4.66	
Sodium Chromate	$Na_2CrO_4.4H_2O$	1.92	1.92	
Sodium Sulfate	Na_2SO_4	11.16	11.16	
Sodium Phosphate, 12-Hydrate	$Na_3PO_4.12H_2O$	149.54	149.6	
Sodium Oxalate	$Na_2C_2O_4$	13.08	13.11	
Sodium Carbonate	Na_2CO_3	56.30	56.31	
Iron Nitrate, 9-hydrate	$Fe(NO_3)_2.9H_2O$	0.04	0.05	
Zinc Nitrate, 6-hydrate	$Zn(NO_3)_2.6H_2O$	0.08	0.08	
Calcium Nitrate	$Ca(NO_3)_2.4H_2O$	0.50	0.55	
Sodium Nitrate	$NaNO_3$	314.26	314.3	
Potassium Nitrate	KNO_3	2.79	2.80	
Sodium Nitrite	$NaNO_2$	55.95	55.95	
Sodium Hydroxide	NaOH	104.88	105.0	
Boric Acid	H_3BO_3	0.21	0.22	

* Sodium fluoride is highly toxic. Handle with caution.

787.45

Adjust total solution volume to **3400** mL by adding DI water.
Adjust solution temperature to 50°C to 60°C.
Filter solution by vacuum through medium glass filter. ***Handle with caution, hot and caustic solution***.
Rinse beaker with approximately 50 mL of DI water
Rinse filter with approximately 50 mL of DI water
Transfer final filtrate and rinse solutions to large beaker with stir bar.
Measure and record initial pH 13.30
Check the pH to make sure it is **13+**

Transfer to volumetric flask and include rinse with DI water. Allow solution to cool

Adjust final solution to volume of **4 L** with DI water, and mix thoroughly.

SUM	Total chemicals (target)	**786.88 g**	Total chemicals (actual)	787.45 g
	Total water (target)	**4 L**	Total water (actual)	1000 mL
	Target Specific Density	**1.20**	Calculated density	1.20

Check final solution pH and record. **pH=**13.30 Readjust if significantly different from target.

Comments: record any difficulties or discrepancies
about <0.5 g of Boron x solid left on the filter
g of White

QA APPROVED
NAME: Cloun
DATE: 6-11-08

AY101-CSL

Base Solution 2008 Version

Batch Size: 4 L
pH: 11.82

AY101-CSL

Balance Device ID: 020 NIST Weight (20 g): 19.9999
Balance Device ID: 018 NIST Weight (100 g): 100.00

Technician: Noy Kelley **Date:** 3/29/08 **Tracking :** 99

Add **2400** mL DI water to a beaker.
Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate.
Turn on heater and adjust to 60°C (±10°C).
Add the following chemicals and record their actual weights:

Chemical	Formula	Required Mass (g)	Actual Mass (g)	Comments
Sodium Aluminate	$NaAlO_2.2H_2O$	7.22	7.22	
Sodium Chloride	NaCl	1.50	1.49	
Sodium Fluoride	NaF	0.25	0.25	
Sodium Chromate	$Na_2CrO_4.4H_2O$	0.28	0.28	
Sodium Sulfate	Na_2SO_4	1.19	1.20	
Sodium Phosphate, 12-Hydrate	$Na_3PO_4.12H_2O$	8.97	9.0	
Sodium Oxalate	$Na_2C_2O_4$	0.75	0.75	
Sodium Carbonate	Na_2CO_3	62.49	62.49	
Sodium Nitrate	$NaNO_3$	6.15	6.15	
Sodium Nitrite	$NaNO_2$	10.16	10.16	
Sodium Hydroxide	NaOH	0.82	0.82	

* Sodium fluoride is highly toxic. Handle with caution.

Adjust total solution volume to **3400** mL by adding DI water.
Adjust solution temperature to 50°C to 60°C.
Filter solution by vacuum through medium glass filter. ***Handle with caution, hot and caustic solution.***
Rinse beaker with approximately 50 mL of DI water
Rinse filter with approximately 50 mL of DI water
Transfer final filtrate and rinse solutions to large beaker with stir bar.

Transfer to volumetric flask and include rinse with DI water. Allow solution to cool

Adjust final solution to volume of **4 L** with DI water, and mix thoroughly.

SUM	Total chemicals (target)	**99.78 g**	Total chemicals (actual)	99.81
	Total water (target)	**4 L**	Total water (actual)	4000
	Target Specific Density	**1.02**	Calculated density	1.02

Check final solution pH and record. **pH=** 11.85 Readjust if significantly different from target.

Comments: record any difficulties or discrepancies

QA APPROVED
NAME: Oldum
DATE: 6-18-08

AY101-CSL

Base Solution 2008 Version

Batch Size: 4 L
pH: 11.82

AY101-CSL

Balance Device ID: 020 NIST Weight (g): 20.0000
Balance Device ID: 018 NIST Weight (100 g): 100.0

Technician: Noy Kelley **Date:** 6/16/08 **Tracking :** 100

Add **2400** mL DI water to a beaker.
Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate.
Turn on heater and adjust to 60°C (±10°C).
Add the following chemicals and record their actual weights:

Chemical	Formula	Required Mass (g)	Actual Mass (g)	Comments
Sodium Aluminate	$NaAlO_2.2H_2O$	7.22	7.22	
Sodium Chloride	NaCl	1.50	1.52	
Sodium Fluoride	NaF	0.25	0.25	
Sodium Chromate	$Na_2CrO_4.4H_2O$	0.28	0.28	
Sodium Sulfate	Na_2SO_4	1.19	1.19	
Sodium Phosphate, 12-Hydrate	$Na_3PO_4.12H_2O$	8.97	9.00	
Sodium Oxalate	$Na_2C_2O_4$	0.75	0.75	
Sodium Carbonate	Na_2CO_3	62.49	62.49	
Sodium Nitrate	$NaNO_3$	61.53	61.55	
Sodium Nitrite	$NaNO_2$	10.16	10.16	
Sodium Hydroxide	NaOH	0.82	0.84	

* Sodium fluoride is highly toxic. Handle with caution.

Adjust total solution volume to **3400** mL by adding DI water.
Adjust solution temperature to 50°C to 60°C.
Filter solution by vacuum through medium glass filter. ***Handle with caution, hot and caustic solution.***
Rinse beaker with approximately 50 mL of DI water
Rinse filter with approximately 50 mL of DI water
Transfer final filtrate and rinse solutions to large beaker with stir bar.

Transfer to volumetric flask and include rinse with DI water. Allow solution to cool

Adjust final solution to volume of **4 L** with DI water, and mix thoroughly.

SUM	Total chemicals (target)	**155.16 g**	Total chemicals (actual)	155.28	g
	Total water (target)	**4 L**	Total water (actual)	4000	mL
	Target Specific Density	**1.04**	Calculated density	1.04	

Check final solution pH and record. **pH=** 11.82 Readjust if significantly different from target.

Comments: record any difficulties or discrepancies

QA APPROVED
NAME: Adam
DATE: 6-18-08

AW105 Supernate

Base Solution 2008 Version

Batch Size: 2 L
pH: 13+

AW105-PSC

Balance Device ID: 020 NIST Weight (20 g): 20.0000
Balance Device ID: 018 NIST Weight (100 g): 100.0

Technician: Noy Kelley **Date:** 7/8/08 **Tracking :** 102

Add **1200 L** mL DI water to a beaker.
Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate.
Turn on heater and adjust to 60°C (±10°C).

Add the following chemicals and record their actual weights:

Chemical	Formula	Required Mass (g)	Actual Mass (g)	Comments
Sodium Aluminate	$Na_2AlO_2.2H_2O$	1.529	1.56 ✓	
Sodium Hydroxide	NaOH	21.040	21.06 ✓	
Boric Acid	H_3BO_3	0.040	0.05 ✓	
Sodium Chromate	$Na_2CrO_4.4H_2O$	0.019	0.03 ✓	
Potassium Molybdate	K2MoO4	0.005	0.008 ✓	
Potassium Nitrate	KNO_3	29.169	29.169 ✓	
Zinc Nitrate 6-hydrate	$Zn(NO_3)_2.6H_2O$	0.018	0.022 ✓	
Sodium Chloride	NaCl	0.965	0.967 ✓	
Sodium Fluoride	NaF	13.104	13.13 ✓	
Sodium Nitrate	$NaNO_3$	50.252	30.25 ✓	
Sodium Nitrite	$NaNO_2$	8.804	8.88 ✓	
Sodium Phosphate, 12-Hydrate	$Na_3PO_4.12H_2O$	3.397	3.39 ✓	
Sodium Sulfate	Na_2SO_4	1.494	1.50 ✓	
Sodium Carbonate	Na_2CO_3	22.811	22.83 ✓	
Glycolic Acid	$C_2H_4O_3$	0.219	0.287	
Sodium Acetate 3-hydrate	$NaCH_3COO.3H_2O$	0.626	0.629	
Sodium Formate	NaHCOO	0.279	0.281	
Sodium Oxalate	$Na_2C_2O_4$	0.442	0.455	

Filter solution by vacuum through medium glass filter. ***Handle with caution, hot and caustic solution.***
Rinse beaker with approximately 50 mL of DI water
Rinse filter with approximately 50 mL of DI water
Transfer final filtrate and rinse solutions to large beaker with stir bar.
Transfer to volumetric flask and include rinse with DI water. Allow solution to cool

QA APPROVED
NAME: Cldun
DATE: 8-20-08

Adjust final solution to volume of **2 L** with DI water, and mix thoroughly.

SUM	Total chemicals (target)	**154.21 g**	Total chemicals (actual)	154.498	g
	Total water (target)	**2 L**	Total water (actual)	2000	mL
	Target Specific Density	**1.08**	Calculated density	1.08	

Check final solution pH and record. **pH=** 13.17 Readjust if significantly different from target.

Comments: record any difficulties or discrepancies

AY101-CSL

Base Solution 2008 Version

Batch Size: 2 L
pH: 12.82

AY101-CSL

Balance Device ID: 020
Balance Device ID: 018

NIST Weight (20 g): 20.0000
NIST Weight (100 g): 100.0

Technician: Noy Kelley **Date:** 7/8/08 **Tracking :** 103

Add **1200** mL DI water to a beaker.
Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate.
Turn on heater and adjust to 60°C (±10°C).
Add the following chemicals and record their actual weights:

Chemical	Formula	Required Mass (g)	Actual Mass (g)	Comments
Sodium Aluminate	$NaAlO_2.2H_2O$	3.61	3.66 ✓	
Sodium Chloride	NaCl	0.75	0.75 ✓	
Sodium Fluoride	NaF	0.13	0.13 ✓	
Sodium Chromate	$Na_2CrO_4.4H_2O$	0.14	0.14 ✓	
Sodium Sulfate	Na_2SO_4	0.60	0.68 ✓	
Sodium Phosphate, 12-Hydrate	$Na_3PO_4.12H_2O$	4.49	4.50 ✓	
Sodium Oxalate	$Na_2C_2O_4$	0.38	0.37 ✓	
Sodium Carbonate	Na_2CO_3	31.25	31.27 ✓	
Sodium Nitrate	$NaNO_3$	30.77	30.80 ✓	
Sodium Nitrite	$NaNO_2$	5.08	5.09	
Sodium Hydroxide	NaOH	0.41	0.46	

* Sodium fluoride is highly toxic. Handle with caution.

Adjust total solution volume to **1700** mL by adding DI water.
Adjust solution temperature to 50°C to 60°C.
Filter solution by vacuum through medium glass filter. ***Handle with caution, hot and caustic solution.***
Rinse beaker with approximately 50 mL of DI water
Rinse filter with approximately 50 mL of DI water
Transfer final filtrate and rinse solutions to large beaker with stir bar.

initial 11.84 **QA APPROVED**
NAME: [illegible]
DATE: 8-20-08

Transfer to volumetric flask and include rinse with DI water. Allow solution to cool

Adjust final solution to volume of **2 L** with DI water, and mix thoroughly.

SUM	Total chemicals (target)	**77.58 g**	Total chemicals (actual)	77.79	g
	Total water (target)	**2 L**	Total water (actual)	2000	mL
	Target Specific Density	**1.04**	Calculated density	1.04	

Check final solution pH and record. **pH=** 12.82 Readjust if significantly different from target.

Comments: record any difficulties or discrepancies Add ≈ 1 g of NaOH to adjust pH to 12.82

AW105 Supernate

Base Solution 2008 Version

Batch Size: 2 L | 0.032M Nitrite
pH: 13+ | AW105-PSC

Balance Device ID: 0020 07-599236-4 NIST Weight (20 g): 19.9999
Balance Device ID: 0018 " " NIST Weight (20 g): 20.1 g

Technician: Noy & Erin **Date:** 7/23/08 **Tracking :** 103

Add **1200 L** mL DI water to a beaker.
Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate.
Turn on heater and adjust to 60°C (±10°C).

(Check Log 8)

Add the following chemicals and record their actual weights:

Chemical	Formula	Required Mass (g)	Actual Mass (g)	Comments
Sodium Aluminate	$Na_2AlO_2 2H_2O$	1.529	1.5299	
Sodium Hydroxide	NaOH	21.040	21.0558	
Boric Acid	H_3BO_3	0.040	0.0397	
Sodium Chromate	$Na_2CrO_4 4H_2O$	0.019	0.0193	
Potassium Molybdate	K2MoO4	0.005	0.0058	
Potassium Nitrate	KNO_3	29.169	29.1707	
Zinc Nitrate 6-hydrate	$Zn(NO_3)_2 6H_2O$	0.018	0.0157	
Sodium Chloride	NaCl	0.965	0.9905	
Sodium Fluoride	NaF	13.104	13.1152	
Sodium Nitrate	$NaNO_3$	50.252	50.2649	
Sodium Nitrite	$NaNO_2$	4.416	4.4202	
Sodium Phosphate, 12-Hydrate	$Na_3PO_4 12H_2O$	3.397	3.3995	
Sodium Sulfate	Na_2SO_4	1.494	1.5171	
Sodium Carbonate	Na_2CO_3	22.811	22.8224	
Glycolic Acid	$C_2H_4O_3$	0.219	0.2906	
Sodium Acetate 3-hydrate	$NaCH_3COO.3H_2O$	0.626	0.6488	
Sodium Formate	NaHCOO	0.279	0.2606	0.2606 EWJ 7/23/08
Sodium Oxalate	$Na_2C_2O_4$	0.442	0.4571	

Filter solution by vacuum through medium glass filter. ***Handle with caution, hot and caustic solution***
Rinse beaker with approximately 50 mL of DI water
Rinse filter with approximately 50 mL of DI water
Transfer final filtrate and rinse solutions to large beaker with stir bar.
Transfer to volumetric flask and include rinse with DI water. Allow solution to cool

QA APPROVED
NAME: Cldun
DATE: 8-20-08

Adjust final solution to volume of **2 L** with DI water, and mix thoroughly.

SUM	Total chemicals (target)	**149.82 g**	Total chemicals (actual)	150.6726
	Total water (target)	**2 L**	Total water (actual)	2000
	Target Specific Density	**1.07**	Calculated density	1.0753

Check final solution pH and record. **pH=** 13.32 Readjust if significantly different from target.

Comments: record any difficulties or discrepancies

AY101-CSL

Base Solution 2008 Version

Batch Size: 2 L
pH: 12.3

AY101-CSL
pH=12.3

Balance Device ID: 020
Balance Device ID: 078

NIST Weight (20 g): 20.0000
NIST Weight (100 g): 100.0

Technician: Nay / Kevin **Date:** 8/21/08 **Tracking :** 105

Add **1200** mL DI water to a beaker.
Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate.
Turn on heater and adjust to 60°C (±10°C).
Add the following chemicals and record their actual weights:

Chemical	Formula	Required Mass (g)	Actual Mass (g)	Comments
Sodium Aluminate	$NaAlO_2.2H_2O$	3.61	3.6130	
Sodium Chloride	NaCl	0.75	.7517	
Sodium Fluoride	NaF	0.13	.1298	
Sodium Chromate	$Na_2CrO_4.4H_2O$	0.14	.1430	
Sodium Sulfate	Na_2SO_4	0.60	.6026	
Sodium Phosphate, 12-Hydrate	$Na_3PO_4.12H_2O$	4.49	4.4895	
Sodium Oxalate	$Na_2C_2O_4$	0.38	.3801	
Sodium Carbonate	Na_2CO_3	31.25	31.2491	
Sodium Nitrate	$NaNO_3$	30.77	30.7680	
Sodium Nitrite	$NaNO_2$	5.08	5.0814	
Sodium Hydroxide	NaOH	0.41	.3998	

* Sodium fluoride is highly toxic. Handle with caution.

Adjust total solution volume to **1700** mL by adding DI water.
Adjust solution temperature to 50°C to 60°C.
Filter solution by vacuum through medium glass filter. ***Handle with caution, hot and caustic solution.***
Rinse beaker with approximately 50 mL of DI water
Rinse filter with approximately 50 mL of DI water
Transfer final filtrate and rinse solutions to large beaker with stir bar. Initial pH 11.76
Final pH 12.30

QA APPROVED
NAME: Odum
DATE: 8-20-08

Transfer to volumetric flask and include rinse with DI water. Allow solution to cool

Adjust final solution to volume of **2 L** with DI water, and mix thoroughly.

SUM	Total chemicals (target)	**77.58 g**	Total chemicals (actual)	77.61	g
	Total water (target)	**2 L**	Total water (actual)	2000	mL
	Target Specific Density	**1.04**	Calculated density	1.04	

Check final solution pH and record. **pH=** 12.30 Readjust if significantly different from target.

Comments: record any difficulties or discrepancies
adjusting pH from 11.76 to pH 12.30 with NaOH

AW105 Supernate

Base Solution 2008 Version

Batch Size: 2 L | 6X
pH: 13+ | AW105-PSC

Balance Device ID: 020 | NIST Weight (20 g): 20.0000
Balance Device ID: 018 | NIST Weight (100 g): 100.0

Technician: Nay Kelley **Date:** 8/6/08 **Tracking :** 106

Add **1200 L** mL DI water to a beaker.
Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate.
Turn on heater and adjust to 60°C (±10°C).

Add the following chemicals and record their actual weights:

Chemical	Formula	Required Mass (g)	Actual Mass (g)	Comments
Sodium Aluminate	$Na_2AlO_2.2H_2O$	1.529	1.5289	
Sodium Hydroxide	NaOH	21.040	21.0791	
Boric Acid	H_3BO_3	0.040	.0402	
Sodium Chromate	$Na_2CrO_4.4H_2O$	0.019	.0192	
Potassium Molybdate	K2MoO4	0.005	.0049	
Potassium Nitrate	KNO_3	29.169	29.1690	
Zinc Nitrate 6-hydrate	$Zn(NO_3)_2.6H_2O$	0.018	.0180	
Sodium Chloride	NaCl	0.965	.9651	
Sodium Fluoride	NaF	13.104	13.1042	
Sodium Nitrate	$NaNO_3$	424.252	424.3	
Sodium Nitrite	$NaNO_2$	26.496	26.4957	
Sodium Phosphate, 12-Hydrate	$Na_3PO_4.12H_2O$	3.397	3.3969	
Sodium Sulfate	Na_2SO_4	1.494	1.4939	
Sodium Carbonate	Na_2CO_3	22.811	22.8106	
Glycolic Acid	$C_2H_4O_3$	0.219	.2189	
Sodium Acetate 3-hydrate	$NaCH_3COO.3H_2O$	0.626	.6264	
Sodium Formate	NaHCOO	0.279	.2786	
Sodium Oxalate	$Na_2C_2O_4$	0.442	.4420	

Filter solution by vacuum through medium glass filter. ***Handle with caution, hot and caustic solution.***
Rinse beaker with approximately 50 mL of DI water
Rinse filter with approximately 50 mL of DI water
Transfer final filtrate and rinse solutions to large beaker with stir bar.
Transfer to volumetric flask and include rinse with DI water. Allow solution to cool

QA APPROVED
NAME: Oldum
DATE: 8-20-08

Adjust final solution to volume of **2 L** with DI water, and mix thoroughly.

SUM	Total chemicals (target)	545.90 g	Total chemicals (actual)	545.99
	Total water (target)	2 L	Total water (actual)	2000mL
	Target Specific Density	1.27	Calculated density	1.27

AK 8/9/08
Check final solution pH and record. pH=~~13.04~~ 13.15 Readjust if significantly different from target.

Comments: record any difficulties or discrepancies

GFS Chemicals, Inc.
Columbus, Ohio 43223

LOT ANALYSIS

ITEM: 1099 SODIUM OXALATE, REAGENT (ACS) **LOT#: P568829**

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 99.5% min	PASS	101.8 %
2. Insoluble 0.005%	PASS	< 0.005 %
3. Loss on drying @ 105 C 0.01%	PASS	0.004 %
4. Neutrality - Pass Test	PASS	Passes Test
5. Chloride 0.002%	PASS	< 0.002 %
6. Sulfate 0.002%	PASS	< 0.002 %
7. Ammonium 0.002%	PASS	< 0.002 %
8. Heavy metals (Pb) 0.002%	PASS	< 0.002 %
9. Iron 0.001%	PASS	< 0.0001 %
10. Potassium 0.005%	PASS	< 0.002 %
11. Substances darkened by H2SO4 pass test	PASS	Passes Test

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:

Reported by: Kenneth L. Shafer Date: 9/15/2005

QC Supervisor: Joan Plowman Retest Date: 9/15/2010

GFS Chemicals, Inc.
Columbus, Ohio 43223

LOT ANALYSIS
ITEM: 705 SODIUM CARBONATE, ANHYDROUS, POWDER, REAGENT (ACS) **LOT#: P675164**

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 99.5% min	PASS	100.00%
2. Insoluble 0.01%	PASS	0.004%
3. Loss on heating at 285 C 1.0% max	PASS	0.4%
4. Chloride 0.001%	PASS	0.0006%
5. Phosphate 0.001%	PASS	0.0003%
6. Silica 0.005%	PASS	0.001%
7. Sulfur compounds (as SO4) 0.003%	PASS	0.001%
8. Heavy metals (Pb) 0.0005%	PASS	0.0002%
9. Iron 0.0005%	PASS	0.0002%
10. Calcium 0.03%	PASS	0.005%
11. Magnesium 0.005%	PASS	0.002%
12. Potassium 0.005%	PASS	0.002%

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:
Reported by: Joan E Plowman Date: 5/3/2006

QC Supervisor: Joan Plowman Retest Date: 5/3/2011

GFS Chemicals, Inc.
Columbus, Ohio 43223

LOT ANALYSIS

ITEM: 1099 SODIUM OXALATE, REAGENT (ACS) **LOT#: P453301**

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 99.5% min	PASS	102.7%
2. Insoluble 0.005%	PASS	<0.005%
3. Loss on drying @ 105 C 0.01%	PASS	<0.01%
4. Neutrality - Pass Test	PASS	passes test
5. Chloride 0.002%	PASS	<0.002%
6. Sulfate 0.002%	PASS	<0.002%
7. Ammonium 0.002%	PASS	<0.002%
8. Heavy metals (Pb) 0.002%	PASS	<0.002%
9. Iron 0.001%	PASS	<0.001%
10. Potassium 0.005%	PASS	<0.005%
11. Substances darkened by H2SO4 pass test	PASS	passes test

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:

Reported by: Daniel Merkoziaj Date: 2/17/2004

QC Supervisor: Joan Plowman Retest Date: 2/17/2006

GFS Chemicals, Inc.
Columbus, Ohio 43223

LOT ANALYSIS

ITEM: 656 SODIUM ACETATE, TRIHYDRATE, REAGENT (ACS) **LOT#: L350643**

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 99.0-101%	PASS	99.99%
2. Insoluble 0.005%	PASS	<0.005%
3. pH of 5% solution 7.5-9.2 @ 25 C	PASS	8.0
4. Chloride 0.001%	PASS	<0.001%
5. Phosphate 0.0005%	PASS	<0.0005%
6. Sulfate 0.002%	PASS	<0.002%
7. Calcium 0.005%	PASS	<0.0005%
8. Magnesium 0.002%	PASS	<0.0001%
9. Heavy metals (as Pb) 0.0005%	PASS	<0.0005%
10. Iron 0.0005%	PASS	<0.0001%
11. Substances reducing permanganate - Pass Test	PASS	passes test
12. Potassium 0.005%	PASS	<0.0016%

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:

Reported by: Daniel Merkoziaj Date: 10/1/2003

QC Supervisor: Joan Plowman Retest Date: 24 Month after shipment

GFS Chemicals, Inc.
Columbus, Ohio 43223

LOT ANALYSIS

ITEM: 658 SODIUM NITRATE, REAGENT (ACS) **LOT#: L136875**

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 99.0% min.	PASS	99.7 %
2. pH of 5% solution 5.5-8.3 @ 25 C	PASS	5.9
3. Insoluble 0.005%	PASS	< 0.005 %
4. Chloride 0.001%	PASS	< 0.001 %
5. Iodate 0.0005%	PASS	< 0.0005 %
6. Nitrite 0.001%	PASS	< 0.001 %
7. Phosphate 0.0005%	PASS	< 0.0005 %
8. Sulfate 0.003%	PASS	< 0.003 %
9. Calcium 0.005%	PASS	< 0.005 %
10. Magnesium 0.002%	PASS	< 0.002 %
11. Heavy metals (Pb) 0.0005%	PASS	< 0.0005 %
12. Iron 0.0003%	PASS	< 0.0003 %

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:

Reported by: Kenneth L. Shafer Date: 9/24/2001

QC Supervisor: Joan Plowman Retest Date: 24 Month after shipment

GFS Chemicals, Inc.
Columbus, Ohio 43223

LOT ANALYSIS

ITEM: 658 SODIUM NITRATE, REAGENT (ACS) **LOT#: L137057**

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 99.0% min.	PASS	100.1 %
2. pH of 5% solution 5.5-8.3 @ 25 C	PASS	5.9
3. Insoluble 0.005%	PASS	< 0.005 %
4. Chloride 0.001%	PASS	< 0.001 %
5. Iodate 0.0005%	PASS	< 0.0005 %
6. Nitrite 0.001%	PASS	< 0.001 %
7. Phosphate 0.0005%	PASS	< 0.0005 %
8. Sulfate 0.003%	PASS	< 0.003 %
9. Calcium 0.005%	PASS	< 0.0005 %
10. Magnesium 0.002%	PASS	< 0.0005 %
11. Heavy metals (Pb) 0.0005%	PASS	< 0.0005 %
12. Iron 0.0003%	PASS	< 0.0003 %

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:

Reported by: Kenneth L. Shafer Date: 9/26/2001

QC Supervisor: Joan Plowman Retest Date: 24 Month after shipment

GFS Chemicals, Inc.
Columbus, Ohio 43223

LOT ANALYSIS

ITEM: 559 SODIUM NITRITE, REAGENT (ACS) **LOT#: P673156**

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 97.0% min.	PASS	98.6%
2. Chloride 0.005%	PASS	< 0.005%
3. Sulfate 0.01%	PASS	< 0.01%
4. Calcium 0.01%	PASS	< 0.01%
5. Heavy metals (as Pb) 0.001%	PASS	< 0.001%
6. Iron 0.001%	PASS	< 0.001%
7. Potassium 0.005%	PASS	< 0.005%
8. Insoluble 0.01%	PASS	< 0.01%
9. pH of 5% solution 5.5-8.3 @ 25 C	PASS	7.2
10. Appearance - White to pale yellow	PASS	Pale Yellow

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:

Reported by: Robert Kramer Date: 2/28/2006

QC Supervisor: Joan Plowman Retest Date: 2/28/2011

GFS Chemicals, Inc.
Columbus, Ohio 43223

LOT ANALYSIS

ITEM: 559 SODIUM NITRITE, REAGENT (ACS) **LOT#: P676266**

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 97.0% min.	PASS	97.3 %
2. Chloride 0.005%	PASS	< 0.005 %
3. Sulfate 0.01%	PASS	< 0.01 %
4. Calcium 0.01%	PASS	< 0.01 %
5. Heavy metals (as Pb) 0.001%	PASS	< 0.001 %
6. Iron 0.001%	PASS	< 0.001 %
7. Potassium 0.005%	PASS	< 0.005 %
8. Insoluble 0.01%	PASS	< 0.01 %
9. pH of 5% solution 5.5-8.3 @ 25 C	PASS	7.4
10. Appearance - White to pale yellow	PASS	pale yellow

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:

Reported by: Kenneth L. Shafer Date: 6/14/2006

QC Supervisor: Joan Plowman Retest Date: 6/14/2011

GFS Chemicals, Inc.
Columbus, Ohio 43223

LOT ANALYSIS

ITEM: 559 SODIUM NITRITE, REAGENT (ACS) **LOT#: P568476**

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 97.0% min.	PASS	97.9 %
2. Chloride 0.005%	PASS	< 0.005 %
3. Sulfate 0.01%	PASS	< 0.01 %
4. Calcium 0.01%	PASS	< 0.001 %
5. Heavy metals (as Pb) 0.001%	PASS	< 0.001 %
6. Iron 0.001%	PASS	< 0.0005 %
7. Potassium 0.005%	PASS	< 0.001 %
8. Insoluble 0.01%	PASS	< 0.01 %
9. pH of 5% solution 5.5-8.3 @ 25 C	PASS	7.6
10. Appearance - White to pale yellow	PASS	pale yellow

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:

Reported by: Kenneth L. Shafer Date: 8/17/2005

QC Supervisor: Joan Plowman Retest Date: 8/17/2010

GFS Chemicals, Inc.
Columbus, Ohio 43223

LOT ANALYSIS

ITEM: 2454 SODIUM SULFATE, ANHYDROUS, POWDER, REAGENT (ACS) **LOT#: P675142**

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 99.0% min.	PASS	99.75%
2. pH of 5% solution @ 25C 5.2-9.2	PASS	5.92
3. Insoluble matter 0.01%	PASS	0.003%
4. Loss on ignition 0.5%	PASS	0.22%
5. Chloride 0.001%	PASS	<0.0005%
6. Nitrogen compounds (as N) 0.0005%	PASS	<0.0003%
7. Phosphate 0.001%	PASS	<0.0005%
8. Calcium 0.01%	PASS	0.001%
9. Magnesium 0.005%	PASS	0.0005%
10. Heavy metals (as Pb) 0.0005%	PASS	<0.0003%
11. Iron 0.001%	PASS	<0.0005%
12. Potassium 0.01%	PASS	0.0015%

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:

Reported by: Nicholas E. Dangler Date: 5/5/2006

QC Supervisor: Joan Plowman Retest Date: 5/5/2011

GFS Chemicals, Inc.
Columbus, Ohio 43223

LOT ANALYSIS
ITEM: 2454 SODIUM SULFATE, ANHYDROUS, POWDER, REAGENT (ACS) **LOT#: P571317**

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 99.0% min.	PASS	100.3%
2. pH of 5% solution @ 25C 5.2-9.2	PASS	5.4
3. Insoluble matter 0.01%	PASS	< 0.01%
4. Loss on ignition 0.5%	PASS	< 0.5%
5. Chloride 0.001%	PASS	< 0.001%
6. Nitrogen compounds (as N) 0.0005%	PASS	< 0.0005%
7. Phosphate 0.001%	PASS	< 0.001%
8. Calcium 0.01%	PASS	< 0.01%
9. Magnesium 0.005%	PASS	< 0.005%
10. Heavy metals (as Pb) 0.0005%	PASS	< 0.0005%
11. Iron 0.001%	PASS	< 0.001%
12. Potassium 0.01%	PASS	< 0.01%

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:
Reported by: Robert Kramer Date: 12/14/2005

QC Supervisor: Joan Plowman Retest Date: 12/14/2010

GFS Chemicals, Inc.
Columbus, Ohio 43223

LOT ANALYSIS

ITEM: 1035 SODIUM PHOSPHATE, TRIBASIC, DODECAHYDRATE, REAGENT (ACS) **LOT#: P562445**

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 98.0-102.0%	PASS	99.2%
2. Excess alkali (NaOH) 2.5%	PASS	1.8%
3. Insoluble 0.01%	PASS	0.005%
4. Chloride 0.001%	PASS	0.000 8%
5. Sulfate 0.01%	PASS	0.002%
6. Heavy metals (as Pb) 0.001%	PASS	0.000 5%
7. Iron 0.001%	PASS	0.000 3%

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:

Reported by: Date: 1/27/2005

QC Supervisor: Joan Plowman Retest Date: 1/27/2010

GFS Chemicals, Inc.
Columbus, Ohio 43223

LOT ANALYSIS

ITEM: 657 SODIUM CHLORIDE, REAGENT (ACS) **LOT#: P569640**

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 99.0% min.	PASS	100.0%
2. Insoluble 0.005%	PASS	<0.005%
3. pH of 5% solution 5.0-9.0 @ 25 C	PASS	5.8
4. Iodide 0.002%	PASS	<0.002%
5. Bromide 0.01%	PASS	<0.01%
6. Chlorate and nitrate (as NO3) 0.003%	PASS	<0.003%
7. Phosphate 0.0005%	PASS	<0.0005%
8. Sulfate 0.004%	PASS	0.004%
9. Barium - pass test	PASS	pass test
10. Heavy Metals (as Pb) 0.0005%	PASS	<0.0005%
11. Iron 0.0002%	PASS	<0.0002%
12. Calcium 0.002%	PASS	0.0003%
13. Magnesium 0.001%	PASS	<0.0001%
14. Potassium 0.005%	PASS	<0.005%

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:

Reported by: Daniel Merkoziaj Date: 10/9/2005

QC Supervisor: Joan Plowman Retest Date: 10/9/2010

GFS Chemicals, Inc.
Columbus, Ohio 43223

LOT ANALYSIS

ITEM: 630 SODIUM HYDROXIDE, REAGENT (ACS) **LOT#: P569567**

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 97.0% min	PASS	99.0%
2. Sodium carbonate 1.0% max	PASS	0.4%
3. Chloride 0.005%	PASS	<0.001%
4. Nitrogen compounds (N) 0.001%	PASS	<0.0003%
5. Phosphate 0.001%	PASS	<0.0002%
6. Sulfate 0.003%	PASS	0.0005%
7. Heavy metals (as Ag) 0.002%	PASS	<0.001%
8. Iron 0.001%	PASS	<0.0003%
9. Mercury 0.00001%	PASS	0.00001%
10. Nickel 0.001%	PASS	0.0001%
11. Calcium 0.005%	PASS	0.0003%
12. Magnesium 0.002%	PASS	0.002%
13. Potassium 0.02%	PASS	<0.01%

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:

Reported by: Joan E Plowman Date: 10/5/2005

QC Supervisor: Joan Plowman Retest Date: 10/5/2010

GFS Chemicals, Inc.
Columbus, Ohio 43223

LOT ANALYSIS

ITEM: 656 SODIUM ACETATE, TRIHYDRATE, REAGENT (ACS) **LOT#: L350643**

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 99.0-101%	PASS	99.99%
2. Insoluble 0.005%	PASS	<0.005%
3. pH of 5% solution 7.5-9.2 @ 25 C	PASS	8.0
4. Chloride 0.001%	PASS	<0.001%
5. Phosphate 0.0005%	PASS	<0.0005%
6. Sulfate 0.002%	PASS	<0.002%
7. Calcium 0.005%	PASS	<0.0005%
8. Magnesium 0.002%	PASS	<0.0001%
9. Heavy metals (as Pb) 0.0005%	PASS	<0.0005%
10. Iron 0.0005%	PASS	<0.0001%
11. Substances reducing permanganate - Pass Test	PASS	passes test
12. Potassium 0.005%	PASS	<0.0016%

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:

Reported by: Daniel Merkoziaj Date: 10/1/2003

QC Supervisor: Joan Plowman Retest Date: 24 Month after shipment

GFS Chemicals, Inc.
Columbus, Ohio 43223

LOT ANALYSIS

ITEM: 1935 SODIUM ACETATE, TRIHYDRATE, BIO-REFINED **LOT#: P677274**

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 99.5% min.	PASS	99.7%
2. Substances reducing KMnO4 0.005%	PASS	<0.005%
3. pH (0.5M in water @ 20 deg. C) 7.5-9.0	PASS	8.3
4. Insoluble matter 0.005%	PASS	<0.005%
5. Chloride (Cl) 0.0005%	PASS	<0.0005%
6. Phosphate (PO4) 0.0005%	PASS	<0.0005%
7. Sulfate (SO4) 0.002%	PASS	<0.0001%
8. Absorbance (0.50M in H2O) @ 260 nm <0.004	PASS	<0.004
9. Absorbance (0.50M in H2O) @ 280 nm <0.003	PASS	<0.003

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:

Reported by: Joan E Plowman Date: 7/26/2006

QC Supervisor: Joan Plowman Retest Date: 7/26/2011

GFS Chemicals, Inc.
Columbus, Ohio 43223

LOT ANALYSIS

ITEM: 1935 SODIUM ACETATE, TRIHYDRATE, BIO-REFINED **LOT#: P460400**

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 99.5% min.	PASS	100.6 %
2. Substances reducing KMnO4 0.005%	PASS	< 0.005 %
3. pH (0.5M in water @ 20 deg. C) 7.5-9.0	PASS	8.5
4. Insoluble matter 0.005%	PASS	< 0.005 %
5. Chloride (Cl) 0.0005%	PASS	< 0.0005 %
6. Phosphate (PO4) 0.0005%	PASS	< 0.0005 %
7. Sulfate (SO4) 0.002%	PASS	0.0003 %
8. Absorbance @ 260nm/280nm (.5M in H2O)<0.004/<0.003	PASS	<0.001 / <0.001

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:

Reported by: Kenneth L. Shafer Date: 10/27/2004

QC Supervisor: Joan Plowman Retest Date: 10/27/2009

GFS Chemicals, Inc.
Columbus, Ohio 43223

LOT ANALYSIS

ITEM: 655 POTASSIUM NITRATE, REAGENT (ACS) **LOT#: L346711**

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 99.0% min	PASS	99.7%
2. Insoluble 0.005%	PASS	<0.005%
3. pH of 5% solution 4.5-8.5 @ 25C	PASS	5.8
4. Chloride 0.002%	PASS	<0.002%
5. Iodate 0.0005%	PASS	<0.000 5%
6. Nitrite 0.001%	PASS	<0.001%
7. Phosphate 0.0005%	PASS	<0.000 5%
8. Sulfate 0.003%	PASS	<0.003%
9. Calcium 0.005%	PASS	<0.005%
10. Magnesium 0.002%	PASS	<0.002%
11. Heavy metals (as Pb) 0.0005%	PASS	<0.000 5%
12. Iron 0.0003%	PASS	<0.000 3%
13. Sodium 0.005%	PASS	<0.005%

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:

Reported by: Date: 3/28/2003

QC Supervisor: Joan Plowman Retest Date: 24 Month after shipment

Fisher Scientific Company
Chemical Manufacturing Division
1 Reagent Lane
Fairlawn, NJ 07410
Phone: (201) 796-7100 Fax: (201) 796-1329

Certificate of Analysis

Fisher Scientific's Quality System is Certified to ISO9002 (1994) standard by DNV Cert. # 96-HOU-AQ-8052

Catalog Number	S392	**Report Date**	8/4/03	**Mfg. Date**	7/23/03
Lot Number	035270	**Sample ID**	S392..035270.CQS		
Description	SODIUM HYDROXIDE NF/FCC/EP/BP/JP				

This is to certify that units of the above mentioned lot number were tested and found to comply with the specifications of the grade listed. Certain data have been supplied by third parties. Fisher Scientific expressly disclaims all warranties, expressed or implied, including the implied warranties of merchantability and fitness for a particular purpose. Unless otherwise statec, these products are not intended for dialysis, parenteral or injectable use without further processing. The following are the actual analytical results obtained:

Result Name	Specifications	Units	Test Value
APPEARANCE	White Pellets	REPORT	WHITE PELLETS
National Formulary Requirements:			
ASSAY	95.0 - 100.5	%	99.6000
ENDOTOXIN TESTING	Report	EU/g	<0.4
HEAVY METALS(AS Pb)	0.003 Maximum	%	0.0020
IDENTIFICATION	Pass test	PASS/FAIL	PASS
INSOLUBLE SUBSTANCES & ORGANIC MATTER	Pass test	PASS/FAIL	PASS
POTASSIUM	Pass test	PASS/FAIL	PASS
SODIUM CARBONATE	3.0 Maximum	%	0.100
FCC Requirements:			
ARSENIC (As)	3 Maximum	mg/kg	3
ASSAY - FCC	95.0 - 100.5	%	99.6
CARBONATE (as Na2CO3)	3.0 Maximum	%	0.1
HEAVY METALS-FCC	0.002 Maximum	%	0.002
IDENTIFICATION - FCC	Pass test	PASS/FAIL	PASS
INSOL SUBT & ORG MAT	Pass test	PASS/FAIL	PASS
LEAD	10 Maximum	mg/kg	1
MERCURY (Hg)	0.1 Maximum	mg/kg	0.1

CERTIFIED BY

Edgar E. Hess — Lab Manager Fair Lawn

Joel Ballard — Lab Manager BPF

Note: The data listed is valid for all package sizes of this lot of product, expressed as a extension of the catalog number listed above. If there are any questions with this certificate, please call Chemical Services at (800) 227-6701

Fisher Scientific Company
Chemical Manufacturing Division
1 Reagent Lane
Fairlawn, NJ 07410
Phone: (201) 796-7100 Fax: (201) 796-1329

Certificate of Analysis

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Catalog Number	S392	**Report Date**	8/4/03	**Mfg. Date**	7/23/03
Lot Number	035270	**Sample ID**	S392..035270.CQS		
Description	SODIUM HYDROXIDE NF/FCC/EP/BP/JP				

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Result Name	Specifications	Units	Test Value
European Pharmacopoeia Requirements:			
APPEARANCE OF SOLN	Pass test	PASS/FAIL	PASS
ASSAY	97.0 - 100.5	%	98.8
CARBONATE	2.0 Maximum	%	0.6
CHLORIDE	50 Maximum	PPM	17
Bacterial Endotoxins	Report	EU/g	<0.4
HEAVY METALS	20 Maximum	PPM	7
IDENTIFICATION	Pass test	PASS/FAIL	PASS
IRON	10 Maximum	PPM	3
SULFATE	50 Maximum	PPM	13
British Pharmacopoeia Requirements:			
APPEARANCE OF SOLN	Pass test	PASS/FAIL	PASS
ASSAY	97.0 - 100.5	%	98.8
CARBONATE	2.0 Maximum	%	0.6
CHLORIDE	50 Maximum	PPM	17
HEAVY METALS	20 Maximum	PPM	7
IDENTIFICATION	Pass test	PASS/FAIL	PASS
IRON	10 Maximum	PPM	3
SULFATE	50 Maximum	PPM	13
Japanese Pharmacopoeia Requirements:			

CERTIFIED BY

Edgar E. Hess — Lab Manager Fair Lawn

Joel Boland — Lab Manager BPF

Note: The data listed is valid for all package sizes of this lot of product, expressed as a extension of the catalog number listed above. If there are any questions with this certificate, please call Chemical Services at (800) 227-6701

Fisher Scientific Company
Chemical Manufacturing Division

1 Reagent Lane
Fairlawn, NJ 07410
Phone: (201) 796-7100 Fax: (201) 796-1329

Certificate of Analysis

Fisher Scientific's Quality System is Certified to ISO9002 (1994) standard by DNV Cert. # 96-HOU-AQ-8052

Catalog Number	S392	**Report Date**	8/4/03	**Mfg. Date**	7/23/03
Lot Number	035270	**Sample ID**	S392..035270.CQS		
Description	SODIUM HYDROXIDE NF/FCC/EP/BP/JP				

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Result Name	Specifications	Units	Test Value
appearance of solution	Pass test	PASS/FAIL	PASS
ASSAY	95.0 Minimum	%	97.8
SODIUM CARBONATE	2.0 Maximum	%	1.6
CHLORIDE	0.050 Maximum	%	0.004
HEAVY METALS	30 Maximum	PPM	8
IDENTIFICATION	Pass test	PASS/FAIL	PASS
MERCURY	Pass test	PASS/FAIL	PASS
POTASSIUM	Pass test	PASS/FAIL	PASS

CERTIFIED BY

Edgar E. Hess — Lab Manager Fair Lawn

Joel Boland — Lab Manager BPF

Note: The data listed is valid for all package sizes of this lot of product, expressed as a extension of the catalog number listed above. If there are any questions with this certificate, please call Chemical Services at (800) 227-6701

GFS Chemicals, Inc.
Columbus, Ohio 43223

LOT ANALYSIS

ITEM: 1031 SODIUM FLUORIDE, REAGENT (ACS) **LOT#: L239673**

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 99% min.	PASS	101.5%
2. Insoluble 0.02%	PASS	<0.02%
3. Loss on drying @ 150 C 0.3%	PASS	0.2%
4. Chloride 0.005%	PASS	<0.005%
5. Titrable acid 0.03 meq/g	PASS	<0.03 meq/g
6. Titrable base 0.01 meq/g	PASS	<0.01 meq/g
7. Sodium fluosilicate 0.1%	PASS	<0.1%
8. Sulfate 0.03%	PASS	<0.03%
9. Sulfite 0.005%	PASS	<0.005%
10. Heavy metals (as Pb) 0.003%	PASS	<0.003%
11. Iron 0.003%	PASS	<0.003%
12. Potassium 0.02%	PASS	<0.02%

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:
Reported by: Date: 3/13/2002

QC Supervisor: Joan Plowman Retest Date: 24 Month after shipment

GFS Chemicals, Inc.
Columbus, Ohio 43223

LOT ANALYSIS

ITEM: 682 BUFFER SOLUTION, pH 10.00 **LOT#: P676271**

TEST	PASS/FAIL	NUMERICAL RESULT
1. pH (@ 25 C) 10.00 +/- 0.01	PASS	10.01
2. NIST Traceable	PASS	As Stated

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:
Reported by: Nicholas E. Dangler Date: 6/20/2006

QC Supervisor: Joan Plowman Retest Date: 6/20/2008

GFS Chemicals, Inc.
Columbus, Ohio 43223

LOT ANALYSIS

ITEM: 681 BUFFER SOLUTION, pH 7.00 **LOT#: P678527**

TEST	PASS/FAIL	NUMERICAL RESULT
1. pH (@ 25 C) 7.00 +/- 0.01	PASS	7.01
2. NIST Traceable	PASS	As Stated

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:
Reported by: Robert Kramer Date: 10/3/2006

QC Supervisor: Joan Plowman Retest Date: 10/3/2008

GFS Chemicals, Inc.
Columbus, Ohio 43223

LOT ANALYSIS

ITEM: 1031 SODIUM FLUORIDE, REAGENT (ACS) **LOT#: P676464**

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 99% min.	PASS	99.24%
2. Insoluble 0.02%	PASS	0.0057%
3. Loss on drying @ 150 C 0.3%	PASS	0.042%
4. Chloride 0.005%	PASS	0.003%
5. Titrable acid 0.03 meq/g	PASS	<0.03 meg/g
6. Titrable base 0.01 meq/g	PASS	0.004 meg/g
7. Sodium fluosilicate 0.1%	PASS	NIL
8. Sulfate 0.03%	PASS	0.02%
9. Sulfite 0.005%	PASS	0.0035%
10. Heavy metals (as Pb) 0.003%	PASS	0.0025%
11. Iron 0.003%	PASS	0.0024%
12. Potassium 0.02%	PASS	0.0049%

GFS Chemicals, Inc.
Columbus, Ohio 43223

LOT ANALYSIS

ITEM: 630 SODIUM HYDROXIDE, REAGENT (ACS) **LOT#: P780673**

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 97.0% min	PASS	99.4%
2. Sodium carbonate 1.0% max	PASS	0.93%
3. Chloride 0.005%	PASS	<0.005%
4. Nitrogen compounds (N) 0.001%	PASS	<0.001%
5. Phosphate 0.001%	PASS	<0.001%
6. Sulfate 0.003%	PASS	<0.003%
7. Heavy metals (as Ag) 0.002%	PASS	<0.002%
8. Iron 0.001%	PASS	<0.0005%
9. Mercury 0.00001%	PASS	<0.000 01%
10. Nickel 0.001%	PASS	<0.0002%
11. Calcium 0.005%	PASS	<0.0005%
12. Magnesium 0.002%	PASS	<0.0002%
13. Potassium 0.02%	PASS	<0.02%

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:

Reported by: Robert Kramer Date: 1/31/2007

QC Supervisor: Joan Plowman Retest Date: 1/31/2012

GFS Chemicals, Inc.
Columbus, Ohio 43223

LOT ANALYSIS

ITEM: 705 SODIUM CARBONATE, ANHYDROUS, POWDER, REAGENT (ACS) **LOT#: P781010**

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 99.5% min	PASS	99.99%
2. Insoluble 0.01%	PASS	0.004%
3. Loss on heating at 285 C 1.0% max	PASS	0.2%
4. Chloride 0.001%	PASS	0.0004%
5. Phosphate 0.001%	PASS	0.0003%
6. Silica 0.005%	PASS	0.001%
7. Sulfur compounds (as SO4) 0.003%	PASS	0.0009%
8. Heavy metals (Pb) 0.0005%	PASS	0.0003%
9. Iron 0.0005%	PASS	0.0003%
10. Calcium 0.03%	PASS	0.005%
11. Magnesium 0.005%	PASS	0.002%
12. Potassium 0.005%	PASS	0.002%

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:

Reported by: Joan E Plowman Date: 2/20/2007

QC Supervisor: Joan Plowman Retest Date: 2/20/2012

GFS Chemicals, Inc.
Columbus, Ohio 43223

LOT ANALYSIS

ITEM: 1099 SODIUM OXALATE, REAGENT (ACS) **LOT#: P568829**

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 99.5% min	PASS	101.8 %
2. Insoluble 0.005%	PASS	< 0.005 %
3. Loss on drying @ 105 C 0.01%	PASS	0.004 %
4. Neutrality - Pass Test	PASS	Passes Test
5. Chloride 0.002%	PASS	< 0.002 %
6. Sulfate 0.002%	PASS	< 0.002 %
7. Ammonium 0.002%	PASS	< 0.002 %
8. Heavy metals (Pb) 0.002%	PASS	< 0.002 %
9. Iron 0.001%	PASS	< 0.0001 %
10. Potassium 0.005%	PASS	< 0.002 %
11. Substances darkened by H2SO4 pass test	PASS	Passes Test

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:

Reported by: Kenneth L. Shafer Date: 9/15/2005

QC Supervisor: Joan Plowman Retest Date: 9/15/2010

GFS Chemicals, Inc.
Columbus, Ohio 43223

LOT ANALYSIS

ITEM: 658 SODIUM NITRATE, REAGENT (ACS) **LOT#: L136875**

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 99.0% min.	PASS	99.7 %
2. pH of 5% solution 5.5-8.3 @ 25 C	PASS	5.9
3. Insoluble 0.005%	PASS	< 0.005 %
4. Chloride 0.001%	PASS	< 0.001 %
5. Iodate 0.0005%	PASS	< 0.0005 %
6. Nitrite 0.001%	PASS	< 0.001 %
7. Phosphate 0.0005%	PASS	< 0.0005 %
8. Sulfate 0.003%	PASS	< 0.003 %
9. Calcium 0.005%	PASS	< 0.005 %
10. Magnesium 0.002%	PASS	< 0.002 %
11. Heavy metals (Pb) 0.0005%	PASS	< 0.0005 %
12. Iron 0.0003%	PASS	< 0.0003 %

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:

Reported by: Kenneth L. Shafer Date: 9/24/2001

QC Supervisor: Joan Plowman Retest Date: 24 Month after shipment

GFS Chemicals, Inc.
Columbus, Ohio 43223

LOT ANALYSIS

ITEM: 655 POTASSIUM NITRATE, REAGENT (ACS) **LOT#: L346711**

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 99.0% min	PASS	99.7%
2. Insoluble 0.005%	PASS	<0.005%
3. pH of 5% solution 4.5-8.5 @ 25C	PASS	5.8
4. Chloride 0.002%	PASS	<0.002%
5. Iodate 0.0005%	PASS	<0.000 5%
6. Nitrite 0.001%	PASS	<0.001%
7. Phosphate 0.0005%	PASS	<0.000 5%
8. Sulfate 0.003%	PASS	<0.003%
9. Calcium 0.005%	PASS	<0.005%
10. Magnesium 0.002%	PASS	<0.002%
11. Heavy metals (as Pb) 0.0005%	PASS	<0.000 5%
12. Iron 0.0003%	PASS	<0.000 3%
13. Sodium 0.005%	PASS	<0.005%

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:
Reported by: Date: 3/28/2003

QC Supervisor: Joan Plowman Retest Date: 24 Month after shipment

GFS Chemicals, Inc.
Columbus, Ohio 43223

LOT ANALYSIS

ITEM: 704 SODIUM BICARBONATE, REAGENT (ACS) **LOT#: P459685**

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay (dried basis) 99.7-100.3%	PASS	99.9 %
2. Insoluble 0.015%	PASS	< 0.015 %
3. Chloride 0.003%	PASS	< 0.003 %
4. Phosphate 0.001%	PASS	< 0.001 %
5. Sulfur compounds (as SO4) 0.003%	PASS	< 0.003 %
6. Ammonium 0.0005%	PASS	< 0.0005 %
7. Calcium 0.02%	PASS	0.004 %
8. Magnesium 0.005%	PASS	< 0.001 %
9. Heavy metals (as Pb) 0.0005%	PASS	< 0.0005 %
10. Iron 0.001%	PASS	0.0001 %
11. Potassium 0.005%	PASS	< 0.003 %

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:

Reported by: Kenneth L. Shafer Date: 9/29/2004

QC Supervisor: Joan Plowman Retest Date: 9/29/2009

GFS Chemicals, Inc.
Columbus, Ohio 43223

LOT ANALYSIS

ITEM: 559 SODIUM NITRITE, REAGENT (ACS) **LOT#: P677335**

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 97.0% min.	PASS	98.2%
2. Chloride 0.005%	PASS	<0.005%
3. Sulfate 0.01%	PASS	<0.01%
4. Calcium 0.01%	PASS	<0.001%
5. Heavy metals (as Pb) 0.001%	PASS	<0.001%
6. Iron 0.001%	PASS	<0.001%
7. Potassium 0.005%	PASS	<0.001%
8. Insoluble 0.01%	PASS	<0.01%
9. pH of 5% solution 5.5-8.3 @ 25 C	PASS	8.0
10. Appearance - White to pale yellow	PASS	pale yellow

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:

Reported by: Jon Brandon Kennedy Date: 7/31/2007

QC Supervisor: Joan Plowman Retest Date: 8/2/2011

GFS Chemicals, Inc.
Columbus, Ohio 43223

LOT ANALYSIS
ITEM: 2454 SODIUM SULFATE, ANHYDROUS, POWDER, REAGENT (ACS) **LOT#: P785319**

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 99.0% min.	PASS	99.1%
2. pH of 5% solution @ 25C 5.2-9.2	PASS	6.0
3. Insoluble matter 0.01%	PASS	< 0.01%
4. Loss on ignition 0.5%	PASS	< 0.5%
5. Chloride 0.001%	PASS	< 0.001%
6. Nitrogen compounds (as N) 0.0005%	PASS	< 0.0005%
7. Phosphate 0.001%	PASS	< 0.001%
8. Calcium 0.01%	PASS	< 0.001%
9. Magnesium 0.005%	PASS	< 0.0005%
10. Heavy metals (as Pb) 0.0005%	PASS	< 0.0005%
11. Iron 0.001%	PASS	< 0.0001%
12. Potassium 0.01%	PASS	0.001%

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:
Reported by: Robert Kramer Date: 1/31/2008

QC Supervisor: Joan Plowman Retest Date: 9/17/2012

GFS Chemicals, Inc.
Columbus, Ohio 43223

LOT ANALYSIS

ITEM: 1078 SODIUM CHROMATE, TETRAHYDRATE, REAGENT **LOT#: P568182**

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 99.0-102.0%	PASS	100.9%
2. Insoluble 0.005%	PASS	<0.005%
3. pH of 5% solution 8.0-9.5	PASS	9.1
4. Chloride 0.005%	PASS	<0.005%
5. Sulfate 0.01%	PASS	<0.01%
6. Aluminum 0.002%	PASS	<0.002%
7. Calcium 0.005%	PASS	<0.005%

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:

Reported by: Nicholas E. Dangler Date: 1/31/2008

QC Supervisor: Joan Plowman Retest Date: 8/16/2010

GFS Chemicals, Inc.
Columbus, Ohio 43223

LOT ANALYSIS

ITEM: 1035 SODIUM PHOSPHATE, TRIBASIC, DODECAHYDRATE, REAGENT (ACS) **LOT#: P678823**

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 98.0-102.0%	PASS	101.4 %
2. Excess alkali (NaOH) 2.5%	PASS	1.0 %
3. Insoluble 0.01%	PASS	< 0.01 %
4. Chloride 0.001%	PASS	< 0.001 %
5. Sulfate 0.01%	PASS	< 0.01 %
6. Heavy metals (as Pb) 0.001%	PASS	< 0.001 %
7. Iron 0.001%	PASS	< 0.001 %

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:

Reported by: Kenneth L. Shafer Date: 1/31/2008

QC Supervisor: Joan Plowman Retest Date: 10/22/2011

GFS Chemicals, Inc.
Columbus, Ohio 43223

LOT ANALYSIS
ITEM: 705 SODIUM CARBONATE, ANHYDROUS, POWDER, REAGENT (ACS) **LOT#: P784287**

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 99.5% min	PASS	99.99%
2. Insoluble 0.01%	PASS	<0.01%
3. Loss on heating at 285 C 1.0% max	PASS	<1.0%
4. Chloride 0.001%	PASS	<0.001%
5. Phosphate 0.001%	PASS	<0.001%
6. Silica 0.005%	PASS	<0.005%
7. Sulfur compounds (as SO4) 0.003%	PASS	<0.003%
8. Heavy metals (Pb) 0.0005%	PASS	<0.0005%
9. Iron 0.0005%	PASS	<0.0005%
10. Calcium 0.03%	PASS	<0.03%
11. Magnesium 0.005%	PASS	0.005%
12. Potassium 0.005%	PASS	<0.005%

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:
Reported by: Joan Plowman Date: 2/1/2008

QC Supervisor: Joan Plowman Retest Date: 7/24/2012

SIGMA-ALDRICH

Certificate of Analysis

Product Name	Cerium(III) nitrate hexahydrate, 99% (metals basis)
Product Number	238538
Product Brand	Aldrich
CAS Number	10294-41-4
Molecular Formula	$Ce(NO_3)_3 \cdot 6H_2O$
Molecular Weight	434.22

TEST	SPECIFICATION	LOT 06703CC RESULTS
APPEARANCE	MOIST WHITE TO OFF-WHITE CRYSTALS AND/OR	MOIST WHITE CRYSTALS
TITRATION	96.5% - 103.5% (OR 31.1% - 33.4% CE)	32.2% CE (COMPLEXOMETRIC)
TRACE ANALYSIS, ICP		B 192 PPM; MG 11.4 PPM; CA 6.5 PPM
ICP ASSAY	CONFIRMS CERIUM COMPONENT.	CONFIRMS CERIUM COMPONENT
SOLUBILITY	5% IN H2O; CLEAR, COLORLESS SOLUTION	5% IN H2O; CLEAR, COLORLESS SOLUTION
PURITY	PURITY BASED ON TRACE METALS ANALYSIS	>99% BASED ON TRACE METAL ANALYSIS
QUALITY CONTROL ACCEPTANCE DATE		MARCH, 2004

Barbara Rajzer, Supervisor
Quality Control
Milwaukee, Wisconsin USA

GFS Chemicals, Inc.
Columbus, Ohio 43223

LOT ANALYSIS

ITEM: 619 SODIUM FORMATE, REAGENT (ACS) **LOT#: P673902**

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 99.0% min.	PASS	99.6%
2. Insoluble 0.005%	PASS	<0.005%
3. Chloride 0.001%	PASS	<0.001%
4. Sulfate 0.001%	PASS	<0.001%
5. Calcium 0.005%	PASS	<0.0005%
6. Heavy Metals (as Pb) 0.0005%	PASS	<0.0005%
7. Iron 0.0005%	PASS	<0.0005%

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:

Reported by: Joan Plowman Date: 2/4/2008

QC Supervisor: Joan Plowman Retest Date: 3/24/2011

EMD

Certificate of Analysis

EMD Chemicals Inc.
480 S. Democrat Road
Gibbstown, NJ 08027
Phone 856-423-6300
Fax 856-423-4389

Name: Sodium Aluminate, Hydrated Technical
Formula: $NaAlO_2 \cdot xH_2O$
Item Number: SX0275/3
Formula Wt: 81.97*
Lot Number: 44281541
Data Order No: 000089319

CHARACTERISTIC	REQUIREMENT		RESULTS	UNITS
	Min.	Max.		
Assay (complexometric)	65.0		78.5	%
Color			White	
Form			Granular powder	

Charles M. Wilson,
Quality Assurance Manager
Release Date: 10/13/2004

EMD Chemicals Inc.
(Formerly EM Science, A Division of EM Industries, Inc.)
An Affiliate of Merck KGaA, Darmstadt, Germany

Certificate of Analysis

Sodium meta-Silicate, 9-Hydrate, Crystal
`BAKER ANALYZED® Reagent

Product No. **3868**

Lot No. **V38144**

Formula $Na_2SiO_3 \cdot 9H_2O$ F.W. **284.20**

Release Date **09/28/2001**

TEST	SPECIFICATION	RESULT
Appearance	Passes Test	Passes Test
Chloride (Cl)	0.01 % max.	< 0.005 %
Sulfate (SO_4)	0.01 % max.	0.005 %
Heavy Metals (as Pb)	0.001 % max.	< 0.0005 %
Iron (Fe)	0.005 % max.	< 0.003 %

The following information is derived from testing completed after the original Certificate of Analysis was prepared. The information was added 06/25/2004.

Assay	Information Only %	96.4 %

Country of Origin: USA

ISO 9000
Phillipsburg, NJ 9001
Paris, KY 9002
Mexico City, Mexico 9002
Deventer, Holland 9001
Kuala Lumpur, Malaysia 9002

Kent R. Weber
Director of Total Quality

J.T. Baker - A Division of Mallinckrodt Baker, Inc. - 222 Red School Lane - Phillipsburg, NJ 08865 - Phone: 908-859-2151 - Fax: 908-859-9505

SIGMA-ALDRICH

Certificate of Analysis

Product Name	Glycolic acid solution, technical grade, 70 wt. % in H_2O
Product Number	420603
Product Brand	Aldrich
CAS Number	79-14-1
Molecular Formula	$HOCH_2COOH$
Molecular Weight	76.05

TEST	SPECIFICATION	LOT 10915KD RESULTS
APPEARANCE	COLORLESS TO AMBER LIQUID	COLORLESS LIQUID
PROTON NMR SPECTRUM	CONFORMS TO STRUCTURE.	CONFORMS TO STRUCTURE.
VENDOR INFORMATION	70.0%-72.0% TOTAL ACID AS GLYCOLIC ACID *	70.80% TOTAL ACID AS GLYCOLIC ACID *
	3 GARDNER COLOR (MAXIMUM) *	0.798% FORMIC ACID *
	<1% FORMIC ACID *	1 GARDNER (COLOR) *
	800 PPM SO4 (MAXIMUM) *	111.2 PPM SULFATES *
	6.0 NTU (MAXIMUM) *	TURBIDITY: 0.55 NTU *
	* DUPONT SPECIFICATION	PRODUCT OF DUPONT
	REVISED FEBRUARY 15, 2005 RJM	PRODUCT OF DUPONT
	* DUPONT SPECIFICATION	*SUPPLIER DATA
	REVISED FEBRUARY 15, 2005 RJM	*SUPPLIER DATA
QUALITY CONTROL ACCEPTANCE DATE		SEPTEMBER 2005

Barbara Rajzer, Supervisor
Quality Control
Milwaukee, Wisconsin USA

GFS Chemicals, Inc.
Columbus, Ohio 43223

LOT ANALYSIS

ITEM: 624 ACETIC ACID, GLACIAL, REAGENT (ACS) **LOT#: P780790**

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 99.7% min.	PASS	101.3%
2. Color (APHA) 10 max	PASS	< 10
3. Dilution Test Pass test	PASS	Passed Test
4. Residue after evaporation 0.001%	PASS	0.0002%
5. Acetic Anhydride 0.01%	PASS	< 0.01%
6. Chloride 0.0001%	PASS	< 0.0001%
7. Sulfate 0.0001%	PASS	< 0.0001%
8. Heavy metals 0.00005%	PASS	< 0.00005%
9. Iron 0.00002%	PASS	< 0.00002%
10. Substances reducing dichromate-Pass test	PASS	Passed Test
11. Substances reducing permanganate-Pass test	PASS	Passed Test
12. Titrable base 0.0004 meq/g	PASS	< 0.0004 meq/g

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:

Reported by: Robert Kramer Date: 2/4/2008

QC Supervisor: Joan Plowman Retest Date: 2/12/2012

GFS Chemicals, Inc.
Columbus, Ohio 43223

LOT ANALYSIS

ITEM: 681 BUFFER SOLUTION, pH 7.00 **LOT#: P678527**

TEST	PASS/FAIL	NUMERICAL RESULT
1. pH (@ 25 C) 7.00 +/- 0.01	PASS	7.01
2. NIST Traceable	PASS	As Stated

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:
Reported by: Robert Kramer Date: 2/4/2008

QC Supervisor: Joan Plowman Retest Date: 10/3/2008

GFS Chemicals, Inc.
Columbus, Ohio 43223

LOT ANALYSIS

ITEM: 682 BUFFER SOLUTION, pH 10.00 **LOT#: P676271**

TEST	PASS/FAIL	NUMERICAL RESULT
1. pH (@ 25 C) 10.00 +/- 0.01	PASS	10.01
2. NIST Traceable	PASS	As Stated

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:
Reported by: Nicholas E. Dangler Date: 2/4/2008

QC Supervisor: Joan Plowman Retest Date: 6/20/2008

ARES Chem

G F S CHEMICALS, INC.
Columbus, Ohio 43222

LOT ANALYSIS

ITEM: 920 ETHYLENE GLYCOL, REAGENT **LOT#: P783656**

TEST	PASS/ FAIL	NUMERICAL RESULT
1. Boiling range 194-200 C	PASS	194-200 C
2. Specific gravity @ 20 C 1.115-1.116 g/ml	PASS	1.1151
3. Acidity (CH3COOH) 0.01%	PASS	0.00005
4. Water 0.2%	PASS	0.014
5. Residue 0.005%	PASS	<0.005
6. Chloride 0.0005%	PASS	0.00001
7. Iron 0.00002%	PASS	<0.00002

TRACEABLE TO N.I.S.T. (Y/N)? N

Comment:

Reported by: Silaja Nacharaju C/A Print Date: 3/14/08

QC Supervisor: Silaja Nacharaju Quality Assured to Retest Point: 60 months from shipment

Not for direct use in food, cosmetic or pharmaceuticals.
Consult warranty limitations at www.gfschemicals.com/terms.asp.
For resale by GFS authorized distributors only.

G F S CHEMICALS, INC.
Columbus, Ohio 43222

LOT ANALYSIS

ITEM: 658 SODIUM NITRATE, REAGENT (ACS) **LOT#: P786671**

TEST	PASS/ FAIL	NUMERICAL RESULT
1. Assay 99.0% min.	PASS	100.7%
2. pH of 5% solution 5.5-8.3 @ 25 C	PASS	6.2
3. Insoluble 0.005%	PASS	<0.005%
4. Chloride 0.001%	PASS	<0.001%
5. Iodate 0.0005%	PASS	<0.0005%
6. Nitrite 0.001%	PASS	<0.001%
7. Phosphate 0.0005%	PASS	<0.0005%
8. Sulfate 0.003%	PASS	<0.003%
9. Calcium 0.005%	PASS	<0.005%
10. Magnesium 0.002%	PASS	<0.002%
11. Heavy metals (Pb) 0.0005%	PASS	<0.0005%
12. Iron 0.0003%	PASS	<0.0003%

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:

Reported by: Robert Kramer C/A Print Date: 3/19/08

QC Supervisor: Joan Plowman Quality Assured to Retest Point: 60 months from shipment

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G F S CHEMICALS, INC.
Columbus, Ohio 43222

LOT ANALYSIS

ITEM: 559 SODIUM NITRITE, REAGENT (ACS) **LOT#: P786739**

TEST	PASS/ FAIL	NUMERICAL RESULT
1. Assay 97.0% min.	PASS	99.1 %
2. Chloride 0.005%	PASS	< 0.005 %
3. Sulfate 0.01%	PASS	< 0.01 %
4. Calcium 0.01%	PASS	< 0.001 %
5. Heavy metals (as Pb) 0.001%	PASS	< 0.001 %
6. Iron 0.001%	PASS	< 0.001 %
7. Potassium 0.005%	PASS	< 0.001 %
8. Insoluble 0.01%	PASS	< 0.01 %
9. pH of 5% solution 5.5-8.3 @ 25 C	PASS	7.4
10. Appearance - White to pale yellow	PASS	As Stated

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:

Reported by: Kenneth L. Shafer C/A Print Date: 3/19/08

QC Supervisor: Joan Plowman Quality Assured to Retest Point: 60 months from shipment

G F S CHEMICALS, INC.
Columbus, Ohio 43222

LOT ANALYSIS

ITEM: 619 SODIUM FORMATE, REAGENT (ACS) **LOT#: P673902**

TEST	PASS/ FAIL	NUMERICAL RESULT
1. Assay 99.0% min.	PASS	99.6%
2. Insoluble 0.005%	PASS	<0.005%
3. Chloride 0.001%	PASS	<0.001%
4. Sulfate 0.001%	PASS	<0.001%
5. Calcium 0.005%	PASS	<0.0005%
6. Heavy Metals (as Pb) 0.0005%	PASS	<0.0005%
7. Iron 0.0005%	PASS	<0.0005%

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:

Reported by: Joan Plowman C/A Print Date: 3/19/08

QC Supervisor: Joan Plowman Quality Assured to Retest Point: 60 months from shipment

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G F S CHEMICALS, INC.
Columbus, Ohio 43222

LOT ANALYSIS

ITEM: 1078 SODIUM CHROMATE, TETRAHYDRATE, REAGENT **LOT#: P568182**

TEST	PASS/ FAIL	NUMERICAL RESULT
1. Assay 99.0-102.0%	PASS	100.9%
2. Insoluble 0.005%	PASS	<0.005%
3. pH of 5% solution 8.0-9.5	PASS	9.1
4. Chloride 0.005%	PASS	<0.005%
5. Sulfate 0.01%	PASS	<0.01%
6. Aluminum 0.002%	PASS	<0.002%
7. Calcium 0.005%	PASS	<0.005%

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:

Reported by: Nicholas E. Dangler C/A Print Date: 3/19/08

QC Supervisor: Joan Plowman Quality Assured to Retest Point: 60 months from shipment

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ARES Chem

G F S CHEMICALS, INC.
Columbus, Ohio 43222

LOT ANALYSIS

ITEM: 920 ETHYLENE GLYCOL, REAGENT **LOT#: P783656**

TEST	PASS/ FAIL	NUMERICAL RESULT
1. Boiling range 194-200 C	PASS	194-200 C
2. Specific gravity @ 20 C 1.115-1.116 g/ml	PASS	1.1151
3. Acidity (CH3COOH) 0.01%	PASS	0.00005
4. Water 0.2%	PASS	0.014
5. Residue 0.005%	PASS	<0.005
6. Chloride 0.0005%	PASS	0.00001
7. Iron 0.00002%	PASS	<0.00002

TRACEABLE TO N.I.S.T. (Y/N)? N

Comment:

Reported by: Silaja Nacharaju C/A Print Date: 3/14/08

QC Supervisor: Silaja Nacharaju Quality Assured to Retest Point: 60 months from shipment

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G F S CHEMICALS, INC.
Columbus, Ohio 43222

LOT ANALYSIS

ITEM: 658 SODIUM NITRATE, REAGENT (ACS) **LOT#: P786671**

TEST	PASS/ FAIL	NUMERICAL RESULT
1. Assay 99.0% min.	PASS	100.7%
2. pH of 5% solution 5.5-8.3 @ 25 C	PASS	6.2
3. Insoluble 0.005%	PASS	<0.005%
4. Chloride 0.001%	PASS	<0.001%
5. Iodate 0.0005%	PASS	<0.0005%
6. Nitrite 0.001%	PASS	<0.001%
7. Phosphate 0.0005%	PASS	<0.0005%
8. Sulfate 0.003%	PASS	<0.003%
9. Calcium 0.005%	PASS	<0.005%
10. Magnesium 0.002%	PASS	<0.002%
11. Heavy metals (Pb) 0.0005%	PASS	<0.0005%
12. Iron 0.0003%	PASS	<0.0003%

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:

Reported by: Robert Kramer C/A Print Date: 3/19/08

QC Supervisor: Joan Plowman Quality Assured to Retest Point: 60 months from shipment

Not for direct use in food, cosmetic or pharmaceuticals.
Consult warranty limitations at www.gfschemicals.com/terms.asp.
For resale by GFS authorized distributors only.

G F S CHEMICALS, INC.
Columbus, Ohio 43222

LOT ANALYSIS

ITEM: 559 SODIUM NITRITE, REAGENT (ACS) **LOT#: P786739**

TEST	PASS/ FAIL	NUMERICAL RESULT
1. Assay 97.0% min.	PASS	99.1 %
2. Chloride 0.005%	PASS	< 0.005 %
3. Sulfate 0.01%	PASS	< 0.01 %
4. Calcium 0.01%	PASS	< 0.001 %
5. Heavy metals (as Pb) 0.001%	PASS	< 0.001 %
6. Iron 0.001%	PASS	< 0.001 %
7. Potassium 0.005%	PASS	< 0.001 %
8. Insoluble 0.01%	PASS	< 0.01 %
9. pH of 5% solution 5.5-8.3 @ 25 C	PASS	7.4
10. Appearance - White to pale yellow	PASS	As Stated

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:

Reported by: Kenneth L. Shafer C/A Print Date: 3/19/08

QC Supervisor: Joan Plowman Quality Assured to Retest Point: 60 months from shipment

Potentiodynamic/Potentiostatic Polarization Test Information Form			
Project Name:	ARES	**Project#:**	81170134
Test Type:	Cyclic Potentiodynamic Polarization	**Date Start:**	11/14/07
Specimen ID:	EL1196-54	**Time Start:**	12:00pm
Data Files:	OCP: EL1196-54-OCP.DTA		
	CPP: EL1196-54-OCP.DTA		

Solution:	AP105-PSC	**Atmosphere:**	Nitrogen purging
Temperature:	50 °C	**Reference Electrode:**	SCE
Initial pH:	>13	**Final pH:**	DB
Starting Potential:	-0.1 V vs. OCP	**Reversal Potential:**	1 V vs. SCE
Scan Rate:	0.17 mV/s	**Final Potential:**	-0.1 V vs. OCP
Reverse Current	0.79 mA*		
Sample Length:	3.18 cm	**Sample Diameter:**	0.68 cm
Sample Area:	6.79 cm^2		

ARES AY102 Solution Batch ID:	AP105-PSC pH>13 Tracking # 68
Potentiostat:	Gamry Ref 600
Potentiostat ID:	1437
Comments:	

Test Performed by:	Feng Gui	**Home Phone:**	614-777-9599
Project Manager:	Sean Brossia		
Date end:	11/15/07	**Time end:**	3:00pm

* Set a value such that the reversal current density is 1mA/cm^2;

QA APPROVED
NAME: Olson
DATE: 4-18-08

Potentiodynamic/Potentiostatic Polarization Test Information Form					
Project Name:	ARES		**Project#:**	81170134	
Test Type:	Cyclic Potentiodynamic Polarization		**Date Start:**	12/03/07	
Specimen ID:	EL1196-60		**Time Start:**	12:00pm	
Data Files:	OCP:	EL1196-60-OCP.DTA			
	CPP:	EL1196-60-CPP.DTA			
Solution:	AP105-PSC		**Atmosphere:**	Nitrogen purging	
Temperature:	50 °C		**Reference Electrode:**	SCE	
Initial pH:	>13		**Final pH:**	>13	
Starting Potential:	-0.1	V vs. OCP	**Reversal Potential:**	1	V vs. SCE
Scan Rate:	0.17	mV/s	**Final Potential:**	-0.1	V vs. OCP
Reverse Current	4.78	mA*			
Sample Length:	3.17	cm	**Sample Diameter:**	0.68	cm
Sample Area:	4.78	cm^2			
ARES AY102 Solution Batch ID:	AP105-PSC pH >13 Tracking #: 68				
Potentiostat:	Gamry Ref 600				
Potentiostat ID:	1637				
Comments:					
Test Performed by:	Feng Gui		**Home Phone:**	614-777-9599	
Project Manager:	Sean Brossia				
Date end:	12/04/07		**Time end:**	3:00pm	

* Set a value such that the reversal current density is 1mA/cm^2;

QA APPROVED
NAME: Cedun
DATE: 1-18-08

Potentiodynamic/Potentiostatic Polarization Test Information Form					
Project Name:	ARES		Project#:	81170135	
Test Type:	Potentiostatic		Date Start:	12/17/2007	
Specimen ID:	EL1196-63		Time Start:	12:00pm	
Data Files:	OCP:	EL1196-63-OCP.mpr			
	CPP:	EL1196-63-PS.mpr			
Solution:	AP105-PSC		Atmosphere:	N_2 purging	
Temperature:	50 °C		Reference Electrode:	SCE	
Initial pH:	>13		Final pH:	>13	
Starting Potential:	N/A V vs. OCP		Reversal Potential:	N/A V vs. SCE	
Scan Rate:	N/A mV/s		Final Potential:	V vs. OCP	
Reverse Current	N/A mA*		Applied potential for potentiostatic test:	0 V vs. SCE	
Sample Length:	3.18 cm		Sample Diameter:	0.98 cm	
Sample Area:	4.79 cm^2		Sample initial/final weight:	N/A N/A g	
Solution Batch ID:	AP105-PSC PH>13				
Potentiostat:	VMP3				
Potentiostat ID:	568				
Comments:	AP105-PSC. PH>13.				
Test Performed by:	Feng Gui		Home Phone:	777-9999	
Project Manager:	Sean Brossia				
Date end:	12/20/2007		Time end:	12:00pm	

* Set a value such that the reversal current density is 1mA/cm^2;

QA APPROVED
NAME: Clum
DATE: 4-18-08

Potentiodynamic/Potentiostatic Polarization Test Information Form			
Project Name:	ARES 2008	Project#:	81170135
Test Type:	CPP	Date Start:	01/21/2008
Specimen ID:	#EL1196-64	Time Start:	12:00pm
Data Files:	OCP: #EL1196-64 - OCP. mpr		
	CPP: EL1196-64 -CPP.		

Solution:	AP105-PSC	Atmosphere:	Nitrogen purging
Temperature:	50 °C	Reference Electrode:	SCE
Initial pH:	>13	Final pH:	>13
Starting Potential:	-0.1 V vs. SCE	Reversal Potential:	1 V vs. SCE
Scan Rate:	0.167 mV/s	Final Potential:	-0.1 V vs. SCE
Reverse Current	4.79 mA*		
Sample Length:	3.18 cm	Sample Diameter:	0.68 cm
Sample Area:	4.79 cm^2		
ARES AY102 Solution Batch ID:	AP105-PSC tracking# 76 pb13		
Potentiostat:	OCP LVMP33		
Potentiostat ID:	1568		

Comments: a crevice was formed using a PTFE tubing section.

Test Performed by:	Feng Gui	Home Phone:	614-777-9599
Project Manager:	Sean Brossia		
Date end:	01/22/2008	Time end:	4:50pm

* Set a value such that the reversal current density is 1mA/cm^2;

QA APPROVED
NAME: CQdum
DATE: 4-18-08

Potentiodynamic/Potentiostatic Polarization Test Information Form					
Project Name:	ARES 2008		**Project#:**	81170135	
Test Type:	Potentiostatic @ 0mV (SCE)		**Date Start:**	01/23/2008	
Specimen ID:	EL1196-65		**Time Start:**	12:00 pm	
Data Files:	OCP: EL1196-65-ocp.mpr				
	~~OPP:~~ EL1196-65-ps.mpr				
Solution:	AP105-PSC		**Atmosphere:**	Nitrogen purging	
Temperature:	50 °C		**Reference Electrode:**	SCE	
Initial pH:	>13		**Final pH:**	713	
Starting Potential:	N/A V vs. SCE		**Reversal Potential:**	N/A V vs. SCE	
Scan Rate:	N/A mV/s		**Final Potential:**	V vs. SCE	
Reverse Current	mA*				
Sample Length:	3.18 cm		**Sample Diameter:**	0.48 cm	
Sample Area:	4.80 cm^2				
ARES AY102 Solution Batch ID:	AP105-PSC pH>13 Tracking # 76				
Potentiostat:	VMP3				
Potentiostat ID:					
Comments:	potentiostatic test @ 0mV vs. SCE w/ a PTFE Tubing Section as Crevice former				
Test Performed by:	Feng Gui		**Home Phone:**	614-777-9599	
Project Manager:	Sean Brossia				
Date end:	01/25/2008		**Time end:**	12:00pm	

* Set a value such that the reversal current density is 1mA/cm^2;

QA APPROVED
NAME: Odum
DATE: 4-18-08

Potentiodynamic/Potentiostatic Polarization Test Information Form			
Project Name:	ARES 2008	**Project#:**	81170135
Test Type:	Potentiostatic @ 0 mV/SCE	**Date Start:**	1/31/08
Specimen ID:	EL1196-66	**Time Start:**	~ 11.00 AM
Data Files:	OCP: EL1196-66-OCP.mpr		
	~~CPP~~: EL1196-66-PS.mpr		

Solution:	AP105 - PSC	**Atmosphere:**	open air ~~Nitrogen purging~~
Temperature:	50 °C	**Reference Electrode:**	SCE
Initial pH:	> 13	**Final pH:**	13.45
Starting Potential:	NA V vs. SCE	**Reversal Potential:**	N/A V vs. SCE
Scan Rate:	NA mV/s	**Final Potential:**	V vs. SCE
Reverse Current	mA*		
Sample Length:	3.18 cm	**Sample Diameter:**	0.48 cm
Sample Area:	1.80 cm^2		

ARES AY102 Solution Batch ID:	AP 105 - PSC pH > 13 Tracking # 76
Potentiostat:	UMP3
Potentiostat ID:	1568

Comments: Potentiostatic test @ 0mV vs. SCE aqueous ~~Gas~~ interface on CPP sample

Test Performed by:	Feng Gui	**Home Phone:**	614-777-9599
Project Manager:	Sean Brossia		
Date end:	2/1/08	**Time end:**	9:00 AM

* Set a value such that the reversal current density is 1mA/cm^2;

QA APPROVED
NAME: Olsen
DATE: 4-14-08

Potentiodynamic/Potentiostatic Polarization Test Information Form			
Project Name:	ARES 2008	**Project#:**	81170135
Test Type:	Potentiostatic @ 0 mV/SCE	**Date Start:**	2/15/08
Specimen ID:	EL 1196-72 2/15/08 AR	**Time Start:**	9:00 AM
Data Files:	OCP: EL 1196-72 OCP.mpr		
	CPP:		
			open air
Solution:	AP105-PSC #80	**Atmosphere:**	~~Nitrogen purging~~
Temperature:	50 °C	**Reference Electrode:**	SCE
Initial pH:	13.52	**Final pH:**	13.26
Starting Potential:	N/A V vs. SCE	**Reversal Potential:**	NA V vs. SCE
Scan Rate:	mV/s	**Final Potential:**	V vs. SCE
Reverse Current	N/A mA*		
Sample Length:	cm	**Sample Diameter:**	0.48 cm
Sample Area:	2.916 cm^2		
ARES AY102 Solution Batch ID:	AP 105 - PSC #80 pH 13.52		
Potentiostat:	VMP 3		
Potentiostat ID:	1568		
Comments:	Potentiostatic test @ 0 mv/SCE OCP for 18 hrs (1/2 coupon in solutions; 12.5 mm² exposed to open air)		
Test Performed by:	Feng Gui	**Home Phone:**	614-777-9599
Project Manager:	Sean Brossia		
Date end:	2/19/08	**Time end:**	11:00 AM

* Set a value such that the reversal current density is 1mA/cm^2;

QA APPROVED
NAME: Coburn
DATE: 4-14-08

Potentiodynamic/Potentiostatic Polarization Test Information Form					
Project Name:	ARES 2008		**Project#:**	81170135	
Test Type:	Potentiostatic @ 0-mV/SCE		**Date Start:**	2/15/08	
Specimen ID:	EL 1196-~~70~~ 73 AK 2/15/08		**Time Start:**	9:00 AM	
Data Files:	OCP: EL 1196-73 AK 2/15/08				
	CPP:				
Solution:	AP 105- PSC#79 pH 13.45		**Atmosphere:**	Nitrogen purging	
Temperature:	50 °C		**Reference Electrode:**	SCE	
Initial pH:	13.45		**Final pH:** 13.30		
Starting Potential:		V vs. SCE	**Reversal Potential:**	NA	V vs. SCE
Scan Rate:	NA	mV/s	**Final Potential:**	NA	V vs. SCE
Reverse Current		mA*			
Sample Length:	1.59	cm	**Sample Diameter:**	0.48	cm
Sample Area:	2.3888	cm^2			
ARES AY102 Solution Batch ID:	AP-105 PSC #79 pH 13.52				
Potentiostat:	VMP3				
Potentiostat ID:	1568				
Comments:	Potentiostatic test @ 0 mV/SCE ½ coupon immersion OCP for 18 hrs 16.0 mm expose to air				
Test Performed by:	Feng Gui		**Home Phone:**	614-777-9599	
Project Manager:	Sean Brossia				
Date end:	2/19/08		**Time end:**	11:00 AM	

* Set a value such that the reversal current density is 1mA/cm^2;

QA APPROVED
NAME: Cadum
DATE: 4-14-08

Potentiodynamic/Potentiostatic Polarization
Test Information Form

Project Name:	ARES 2008	**Project#:**	81170135
Test Type:	CPP	**Date Start:**	2/20/08
Specimen ID:	EL 1196-75	**Time Start:**	11:00 AM
Data Files:	OCP: EL 1196-75 OCP. mpr		
	CPP: EL 1196-75 CPP. corr		

Solution:	AP 105 - PSC #79	**Atmosphere:**	open air ~~Nitrogen purging~~
Temperature:	50 °C	**Reference Electrode:**	SCE
Initial pH:	13.45	**Final pH:**	13.20
	OCP		
Starting Potential:	-0.1 V vs. ~~SCE~~	**Reversal Potential:**	1 V vs. SCE
Scan Rate:	0.17 mV/s	**Final Potential:**	-0.1 V vs. ~~SCE~~ OCP
Reverse Current	2.41 mA*		
Sample Length:	1.60 cm	**Sample Diameter:**	0.48 cm
Sample Area:	2.41 cm^2		

ARES AY102 Solution Batch ID:	AP 105 - PSC #79 (Tracking #) pH 13.45

Potentiostat:	OCP VMP 3	CPP Par 273
Potentiostat ID:	1868	1347

Comments:

½ coupon immersion
OCP on VMP3
CPP on Par 273

Test Performed by:	Feng Gui	**Home Phone:**	614-777-9599
Project Manager:	Sean Brossia		
Date end:	2/22/08	**Time end:**	9:00 AM

* Set a value such that the reversal current density is 1mA/cm^2;

QA APPROVED
NAME: Cleun
DATE: 4-14-08

Potentiodynamic/Potentiostatic Polarization Test Information Form					
Project Name:	ARES 2008		**Project#:**	81170135	
Test Type:	Potentiostatic @ 0 mv / SCE		**Date Start:**	2/22/08	
Specimen ID:	EL 1196 - 76		**Time Start:**	12:00	
Data Files:	OCP: EL 1196-76 OCP- MPR				
	CPP:				
					open air
Solution:	AP 105 - PSC # 79		**Atmosphere:**		~~Nitrogen purging~~
Temperature:	Room temperature.		**Reference Electrode:**		SCE
Initial pH:	13.45		**Final pH:**	13.26	
Starting Potential:	N/A	V vs. SCE	**Reversal Potential:**	N/A	V vs. SCE
Scan Rate:		mV/s	**Final Potential:**		V vs. SCE
Reverse Current		mA*			
Sample Length:	2.42	cm	**Sample Diameter:**	0.48	cm
Sample Area:	3.65	cm^2			
ARES AY102 Solution Batch ID:	AP 105 - PSC # 79 pH 13.45				
Potentiostat:	OCP VMP3				
Potentiostat ID:	1568				
Comments:	Potentiostast @ 0 mv / SCE at Rom temperature OCP for 18 hrs 7.6 mm expose to air at room temperature				
Test Performed by:	Feng Gui		**Home Phone:**	614-777-9599	
Project Manager:	Sean Brossia				
Date end:	2/25/07		**Time end:**	9:00 AM	

* Set a value such that the reversal current density is $1 mA/cm^2$;

QA APPROVED
NAME: Cleaver
DATE: 4-14-08

Potentiodynamic/Potentiostatic Polarization Test Information Form					
Project Name:	ARES 2008		Project#:	81170135	
Test Type:	Potentiostatic @ 100 mV/s ocp		Date Start:	2/25/08	
Specimen ID:	EL1196-77		Time Start:	11:00 AM	
Data Files:	OCP: EL1196-77-OCP.mpr.				
	~~CPP~~: EL1196-77-PS.mpr,				
				open air	
Solution:	AP 105 - PSC #79		Atmosphere:	~~Nitrogen purging~~	AK 2/25/08
Temperature:	50 °C		Reference Electrode:	SCE	
Initial pH:	13.25		Final pH:	13.30	
Starting Potential:	N/A	V vs. SCE	Reversal Potential:	N/A	V vs. SCE
Scan Rate:		mV/s	Final Potential:		V vs. SCE
Reverse Current	N/A	mA*			
Sample Length:	1.28	cm	Sample Diameter:	0.18	cm
Sample Area:	1.93	cm^2			
ARES AY102 Solution Batch ID:	AP 105 - PSC #79 pH 13.45				
Potentiostat:	VMP 3				
Potentiostat ID:	1568				
Comments:	Potentiostatic at 100 mv VS OCP ~~Room~~ 50°C AK 2/25/08				
	OCP for 18 hrs at 50°C				
	1/2 imession coupon 19.1 mm expose to air				
Test Performed by:	Feng Gui		Home Phone:	614-777-9599	
Project Manager:	Sean Brossia				
Date end:	2/28/08		Time end:	9:00 AM	

* Set a value such that the reversal current density is 1mA/cm^2;

sent solution for NO_3^- NO_2^- at DAT

QA APPROVED
NAME: Cedum
DATE: 4-14-08

Potentiodynamic/Potentiostatic Polarization Test Information Form					
Project Name:	ARES 2008		Project#:	81170135	
Test Type:	CPP		Date Start:	9/3/08	
Specimen ID:	EL 1196-81		Time Start:	11:00 AM	
Data Files:	OCP:	EL 1196-81 ocp.mps			
	CPP:	EL 1196-81 CPP.cor			
				open air	
Solution:	AP 105-PSC #81		Atmosphere:	~~Nitrogen purging~~	
Temperature:	Room Temperature		Reference Electrode:	SCE	
Initial pH:	13.38		Final pH: 13.20		
		9/3/08 OCP			
Starting Potential:	-0.1	V vs. ~~SCE~~	Reversal Potential:	1 V vs. SCE	AK 9/3/08
Scan Rate:	0.17	mV/s	Final Potential:	-0.1 V vs. ~~SCE~~	OCP
Reverse Current	1.716	mA*			
Sample Length:	3.17	cm	Sample Diameter:	cm	
Sample Area:	1.716	cm^2			
ARES AY102 Solution Batch ID:	AP 105-PSC pH 13.38 Tracking #~~86~~ 81 AK 9/16/08				
Potentiostat:	VMP3	Pad 273 (CPP)			
Potentiostat ID:	1568	1347			
Comments:	OCP for 18 hrs. open to air full coupon immersion CPP on Pad 273 open air full immersion				
Test Performed by:	Feng Gui		Home Phone:	614-777-9599	
Project Manager:	Sean Brossia				
Date end:	9/5/08		Time end:	8:00 AM	

* Set a value such that the reversal current density is 1mA/cm^2;

QA APPROVED
NAME: Cedam
DATE: 4-14-08

Potentiodynamic/Potentiostatic Polarization Test Information Form					
Project Name:	ARES		Project#:	81170135	
Test Type:	CPP		Date Start:	03/24/08	
Specimen ID:	#EL1196-89		Time Start:	1:00pm	
Data Files:	OCP:	#EL1196-89-OCP.mpr			
	CPP:	#EL1196-89-CPP.Cor			
Solution:	SY103-PIL		Atmosphere:	N_2 Purging	
Temperature:	50 °C		Reference Electrode:	SCE	
Initial pH:	13.1		Final pH:	13.1	
Starting Potential:	-0.1 V vs. OCP		Reversal Potential:	1 V vs. SCE	
Scan Rate:	0.17 mV/s		Final Potential:	-0.1 V vs. OCP	
Reverse Current	6.77 mA*		Applied potential for potentiostatic test:	N/A V vs. SCE	
Sample Length:	3.18 cm		Sample Diameter:	0.48 cm	
Sample Area:	4.77 cm^2		Sample initial/final weight:	3.5330 g/ g	
Solution Batch ID:	ARES SY103-PIL Tracking #85				
Potentiostat:	VMP3 (OCP)		PAR 273 (CPP)		
Potentiostat ID:	1568		1367		
Comments:	full immersion				
Test Performed by:	Fang Gui		Home Phone:	727-9599	
Project Manager:	Sean Brossia				
Date end:	03/27/08		Time end:	8:40AM	

* Set a value such that the reversal current density is 1mA/cm^2;

QA APPROVED
NAME: Coleen
DATE: 4-14-08

Potentiodynamic/Potentiostatic Polarization Test Information Form					
Project Name:	ARES		**Project#:**	81170135	
Test Type:	CPP		**Date Start:**	03/24/08	
Specimen ID:	#EU196-90-		**Time Start:**	1:00 pm	
Data Files:	OCP:	#EU196-90-OCP.mpr			
	CPP:	#EU196-90-CPP.cor			
Solution:	AW105-pH		**Atmosphere:**	N_2 purging	
Temperature:	50 °C		**Reference Electrode:**	SCE	
Initial pH:	13+		**Final pH:**	13+	
Starting Potential:	-0.1 V vs. OCP		**Reversal Potential:**	1 V vs. SCE	
Scan Rate:	0.17 mV/s		**Final Potential:**	-0.1 V vs. OCP	
Reverse Current	4.75 mA*		**Applied potential for potentiostatic test:**	N/A V vs. SCE	
Sample Length:	3.46 cm		**Sample Diameter:**	0.68 cm	
Sample Area:	4.75 cm^2		**Sample initial/final weight:**	5.5451/g g	
Solution Batch ID:	ARES AW105-pH Tracking# 86				
Potentiostat:	VMP3 (OCP)		PAR273 (CPP)		
Potentiostat ID:	1568		C1367		
Comments:	full immersion				
Test Performed by:	Feng Gui		**Home Phone:**	222-9599	
Project Manager:	Sean Brossia				
Date end:	03/26/08		**Time end:**	8:30 AM	

* Set a value such that the reversal current density is 1mA/cm^2;

QA APPROVED
NAME: Cleum
DATE: 4-11-08

Potentiodynamic/Potentiostatic Polarization Test Information Form			
Project Name:	ARES	**Project#:**	81170135
Test Type:	Potentiostatic	**Date Start:**	03/27/08
Specimen ID:	EL1196-91	**Time Start:**	10:30am
Data Files:	OCP: EL1196-91-ocp.mpr		
	CPP:		

Solution:	AP105-PSC	**Atmosphere:**	quiescent
Temperature:	50 °C	**Reference Electrode:**	SCE
Initial pH:	13+	**Final pH:**	13+
Starting Potential:	N/A V vs. OCP	**Reversal Potential:**	N/A V vs. SCE
Scan Rate:	mV/s	**Final Potential:**	N/A V vs. OCP
Reverse Current	N/A mA*	**Applied potential for potentiostatic test:**	0 V vs. SCE
Sample Length:	3.17 cm	**Sample Diameter:**	cm
Sample Area:	0.48 cm^2	**Sample initial/final weight:**	3.1230 g/ g

Solution Batch ID:	AP105-PSC Tracking#: 82

Potentiostat:	VMP3
Potentiostat ID:	1368

Comments:
Potentiostatic @ 0 mv vs. SCE, quiescent. 50 hours
check weight loss, half immersion.
0.81" exposed

Test Performed by:	Fern Gui	**Home Phone:**	7779599
Project Manager:	Sean Brossia		
Date end:	03/31/08	**Time end:**	8:30 pm

* Set a value such that the reversal current density is 1mA/cm^2;

QA APPROVED
NAME: Cleum
DATE: 4-14-08

Potentiodynamic/Potentiostatic Polarization
Test Information Form

Project Name:	ARES	**Project#:**	81170135
Test Type:	Potentiostatic	**Date Start:**	03/27/08
Specimen ID:	EL1196-92	**Time Start:**	10:30am
Data Files:	OCP: EL1196-92-ocp.mpr		
	CPP:		

Solution:	AP105-psc	**Atmosphere:**	quiescent
Temperature:	RT 0mec	**Reference Electrode:**	SCE
Initial pH:	13+	**Final pH:**	13+
Starting Potential:	N/A V vs. OCP	**Reversal Potential:**	N/A V vs. SCE
Scan Rate:	N/A mV/s	**Final Potential:**	V vs. OCP
Reverse Current	N/A mA*	**Applied potential for potentiostatic test:**	~~-0.5~~ +0.05 OCP V vs. ~~SCE~~ (FG) 03/28/08
Sample Length:	3.17 cm	**Sample Diameter:**	cm
Sample Area:	0.168 cm^2	**Sample initial/final weight:**	g/ g

Solution Batch ID:	AP105-psc Tracking #: 82
Potentiostat:	VMP3
Potentiostat ID:	1568

Comments: potentiostatic @ +50 mV vs. OCP. room T. quiescent, half immersion, 50 hours

0.77" exposed

Test Performed by:	Feng Gui	**Home Phone:**	777-9599
Project Manager:	Sean Brossia		
Date end:	03/31/08	**Time end:**	8:30am

* Set a value such that the reversal current density is 1mA/cm^2;

QA APPROVED
NAME: Cedum
DATE: 4-14-08

Potentiodynamic/Potentiostatic Polarization Test Information Form			
Project Name:	ARES	**Project#:**	81170135
Test Type:	CPP	**Date Start:**	04/01/08
Specimen ID:	#EU196-93	**Time Start:**	3:40pm
Data Files:	OCP: #EU196-93-OCP.mpr		
	CPP:		
No Nitrite, 3.85M Nitrate			
Solution:	AP105-PSC	**Atmosphere:**	N_2 Sparging
Temperature:	50 °C	**Reference Electrode:**	SCE
Initial pH:	+13	**Final pH:**	
Starting Potential:	−0.1 V vs. OCP	**Reversal Potential:**	1 V vs. SCE
Scan Rate:	0.17 mV/s	**Final Potential:**	−0.1 V vs. OCP
Reverse Current	4.76 mA*	**Applied potential for potentiostatic test:**	V vs. SCE
Sample Length:	3.17 cm	**Sample Diameter:**	0.628 cm
Sample Area:	4.76 cm^2	**Sample initial/final weight:**	3.5295 g/ g
Solution Batch ID:	AP105-PSC Tracking # 87	NO NO_2^- 3.85M NO_3^-	PH 13+
Potentiostat:	VMP3 (OCP3)		
Potentiostat ID:	1568		
Comments:			
Test Performed by:	Feng Gui	**Home Phone:**	727-9599
Project Manager:	Sean Brossia		
Date end:	04/03/08	**Time end:**	12:00pm

* Set a value such that the reversal current density is 1mA/cm^2;

QA APPROVED

NAME: Cldunn

DATE: 4-14-08

Potentiodynamic/Potentiostatic Polarization Test Information Form					
Project Name:	ARES		Project#:	81170135	
Test Type:	CPP		Date Start:	4/9/08	
Specimen ID:	# EL 1196-98		Time Start:	15.00	
Data Files:	OCP:	# EL 1196-98 .mpr (ocp)			
	CPP:	EL 1196-98CPP ~~.DTA~~ DTA AK 4/11/08			
Solution:	AP105-Mixed Supernate		Atmosphere:		N_2 Purging
Temperature:	30 °C		Reference Electrode:		SCE
Initial pH:	13+		Final pH:	13+	13+
Starting Potential:	-0.1 V vs. OCP		Reversal Potential:		1 V vs. SCE
Scan Rate:	0.17 mV/s		Final Potential:		-0.1 V vs. OCP
Reverse Current	4.76 mA*		Applied potential for potentiostatic test:		V vs. SCE
Sample Length:	3.17 cm		Sample Diameter:		0.48 cm
Sample Area:	4.76 cm^2		Sample initial weight:		3.5230 g
Solution Batch ID:	AP 105 Mixed Supernate tracking # 89 pH > 13				
Potentiostat:	VMP 3 (OCP)	AK 4/10/08 ~~Pot 273 (CPP)~~	Gamry		
Potentiostat ID:	1568	~~1317~~	1408		
Comments:	Full immersion				
Test Performed by:	Amnoyporn Kelley		Home Phone:	614-889-7980	
Project Manager:	Sean Brossia				
Date end:	4/11/08		Time end:	8:30 AM	

* Set a value such that the reversal current density is 1mA/cm^2;

QA APPROVED
NAME: Cldun
DATE: 8-7-08

Potentiodynamic/Potentiostatic Polarization Test Information Form					
Project Name:	ARES		**Project#:**	81170135	
Test Type:	Potentiostatic @ 0 mv VS SCE		**Date Start:**	4/11/08	
Specimen ID:	EL 1196-99		**Time Start:**	1:00 PM	
Data Files:	OCP: EL 1196-99 OCP.mpr				
	~~CPP:~~ EL 1196-99 PS. mpr				
Solution:	AP-105 PSC #90	**Atmosphere:**		N_2 at head space	
Temperature:	50 °C	**Reference Electrode:**		SCE	
Initial pH:	13.18	**Final pH:**	13.47		
Starting Potential:	N/A V vs. OCP	**Reversal Potential:**		N/A V vs. SCE	
Scan Rate:	N/A mV/s	**Final Potential:**		V vs. OCP	
Reverse Current	N/A mA*	**Applied potential for potentiostatic test:**		0 V vs. SCE	
Sample Length:	1.52 cm	**Sample Diameter:**		0.48 cm	
Sample Area:	2.3 cm^2	**Sample initial/final weight:**		3.5A3 g/ g	
Solution Batch ID:	AP 105 - PSC Tracking #90 pit 13+				
Potentiostat:	OCP mpr	PS mpr			
Potentiostat ID:	1568	1568			
Comments:	- 50°C , N_2 Purging above head space - 18 hrs OCP - Potentiostatic @ 0 mV 50 hrs - Half immersion 16.5 mm expose to air				
Test Performed by:	Noy Kelley		**Home Phone:**	44 889-7980	
Project Manager:	Sean Brossia				
Date end:	4/18/08		**Time end:**	7:00 AM	

* Set a value such that the reversal current density is 1mA/cm^2;

* Corrosion Product pluck plugging probe when finished

QA APPROVED
NAME: Cloem
DATE: 8-2-08

Potentiodynamic/Potentiostatic Polarization Test Information Form					
Project Name:	ARES		**Project#:**	81170135	
Test Type:	CPP		**Date Start:**	4/15/08	
Specimen ID:	EL 1196-100		**Time Start:**	1:00 PM	
Data Files:	OCP:	EL 1196-100 OCP. DTA AK 4/15/08			
	CPP:	EL 1196-100 CPP. DTA			
Solution:	Evaporate Supernate		**Atmosphere:**	N_2	
Temperature:	50 °C		**Reference Electrode:**	SCE	
Initial pH:	14		**Final pH:**	14.05	
Starting Potential:	-0.1 V vs. OCP		**Reversal Potential:**	1 V vs. SCE	
Scan Rate:	0.17 mV/s		**Final Potential:**	-0.1 V vs. OCP	
Reverse Current	4.76 mA*		**Applied potential for potentiostatic test:**	N/A V vs. SCE	
Sample Length:	3.17 cm		**Sample Diameter:**	0.48 cm	
Sample Area:	4.76 cm^2		**Sample initial weight:**	3.527 g	
Solution Batch ID:	Evaporate Supernate Tracking # 891 NK 4/15/08 pH 14				
Potentiostat:	(OCP) Gamry		(CPP) Gamry		
Potentiostat ID:	1008		1008		
Comments:	Full immesion; OCP for 18 hrs. CPP @ ± 0.1 VS EOC		QA APPROVED NAME: Cldun DATE: 8-7-08		
Test Performed by:	Amnoyporn Kelley		**Home Phone:**	614-889-7980	
Project Manager:	Sean Brossia				
Date end:	4/17/08		**Time end:**	3:00 PM	

* Set a value such that the reversal current density is 1mA/cm^2;

- Solution cloundy when start experiment but turn clear after run OCP over night (top part)
- when finish run CPP saturated chemical settle down in the bottom of the cell

Potentiodynamic/Potentiostatic Polarization Test Information Form					
Project Name:	ARES		Project#:	81170135	
Test Type:	CPP		Date Start:	4/17/08	
Specimen ID:	EL1196-101		Time Start:	2:00 PM	
Data Files:	OCP:	EL 1196-101 OCP.DTA			
	CPP:	EL 1196-101 CPP.DTA			
Solution:	AP 105 #86		Atmosphere:	N_2 in solution	
Temperature:	Room °C		Reference Electrode:	SCE	
Initial pH:	13.95		Final pH:	13.50	
Starting Potential:	-0.1 V vs. OCP		Reversal Potential:	1 V vs. SCE	
Scan Rate:	0.17 mV/s		Final Potential:	-0.1 V vs. OCP	
Reverse Current	4.76 mA*		Applied potential for potentiostatic test:	V vs. SCE	
Sample Length:	3.17 cm		Sample Diameter:	0.18 cm	
Sample Area:	4.76 cm^2		Sample initial weight:	3.5393 g	
Solution Batch ID:	AP 105 PSC Tracking #87 3.85 M Nitrate pH 13.95				
Potentiostat:	OCP Gamry		CPP Gamry		
Potentiostat ID:	1408		1408		
Comments:	- Full immersion - OCP 18 hrs. - CPP				
Test Performed by:	Amnoyporn Kelley		Home Phone:	614-889-7980	
Project Manager:	Sean Brossia				
Date end:	4/18/08		Time end:	3:00 PM	

* Set a value such that the reversal current density is 1mA/cm^2;

No corrosion product

QA APPROVED
NAME: CQdew
DATE: 8-7-08

Potentiodynamic/Potentiostatic Polarization Test Information Form					
Project Name:	ARES		**Project#:**	81170135	
Test Type:	CPP		**Date Start:**	1/18/08	
Specimen ID:	EL 1196-102		**Time Start:**	10:00 AM	
Data Files:	OCP:	EL 1196-102 OCP.mpr			
	CPP:	EL 1196-102 CPP.DTA			
Solution:	AP 10S PSC		**Atmosphere:**	open to air	
Temperature:	50 °C		**Reference Electrode:**	SCE	
Initial pH:	13.18		**Final pH:**	13.20	
Starting Potential:	-0.1 V vs. OCP		**Reversal Potential:**	1.0 V vs. SCE	
Scan Rate:	0.17 mV/s		**Final Potential:**	-0.1 V vs. OCP	
Reverse Current	mA*		**Applied potential for potentiostatic test:**	N/A V vs. SCE	
Sample Length:	3.17 cm		**Sample Diameter:**	0.48 cm	
Sample Area:	4.76 cm^2		**Sample initial weight:**	3.524 g	
Solution Batch ID:	AP 10S -PSC; Tracking # 90 pH 13.18				
	AK 1/18/08				
Potentiostat:	OCP ~~VMP3~~ VMP3		CPP Gamry		
Potentiostat ID:	1568		1408		
Comments:	- Full immersion - OCP 18 hrs - CPP				
Test Performed by:	Amnoyporn Kelley		**Home Phone:**	614-889-7980	
Project Manager:	Sean Brossia				
Date end:	1/21/08		**Time end:**	8:00 AM	

* Set a value such that the reversal current density is 1mA/cm^2;

QA APPROVED
NAME: Qdum
DATE: 8-7-08

Potentiodynamic/Potentiostatic Polarization Test Information Form					
Project Name:	ARES		**Project#:**	81170135	
Test Type:	CPP		**Date Start:**	5/7/08	
Specimen ID:	EL 1196-103		**Time Start:**	9:00 AM	
Data Files:	OCP: EL1196-103 OCP.mpr				
	CPP: EL1196-103 CPP.DTA				
Solution:	AZ 102 pH 12	**Atmosphere:**		N_2 Purging	
Temperature:	77 °C	**Reference Electrode:**		SCE	
Initial pH:	12.25	**Final pH:**		12.16	
Starting Potential:	-0.1 V vs. OCP	**Reversal Potential:**		1 V vs. SCE	
Scan Rate:	0.17 mV/s	**Final Potential:**		-0.1 V vs. OCP	
Reverse Current	4.76 mA*	**Applied potential for potentiostatic test:**		N/A V vs. SCE	
Sample Length:	3.17 cm	**Sample Diameter:**		0.48 cm	
Sample Area:	4.76 cm^2	**Sample initial weight:**		3.533 g	
Solution Batch ID:	AZ 102 Tracking # 93 pH 12 (pH 12.25)				
Potentiostat:	OCP VMP3	CPP Gamry			
Potentiostat ID:	1568	1408			
Comments:	Full immersion; OCP for 18 hrs and then CCP test at 77 °C Not corrode end off CPP				
Test Performed by:	Amnoyporn Kelley		**Home Phone:**	614-889-7980	
Project Manager:	Sean Brossia				
Date end:	5/8/08		**Time end:**	2:PM	

* Set a value such that the reversal current density is 1mA/cm^2;

QA APPROVED
NAME: Cldun
DATE: 8-7-08

Potentiodynamic/Potentiostatic Polarization Test Information Form					
Project Name:	ARES		**Project#:**	81170135	
Test Type:	CPP		**Date Start:**	5/18/08 AK 11/6/08	
Specimen ID:	EL 1196 - 104		**Time Start:**	1:30 PM	
Data Files:	OCP: EL1196-104A OCP.mpr				
	CPP: EL1196-104 CPP				
Solution:	Evaporate Supernate	**Atmosphere:**		N_2 Purging	
Temperature:	50 °C	**Reference Electrode:**		SCE	
Initial pH:	14	**Final pH:**			
Starting Potential:	-0.1 V vs. OCP	**Reversal Potential:**		1 V vs. SCE	
Scan Rate:	0.17 mV/s	**Final Potential:**		-0.1 V vs. OCP	
Reverse Current	4.76 mA*	**Applied potential for potentiostatic test:**		NA V vs. SCE	
Sample Length:	3.17 cm	**Sample Diameter:**		0.48 cm	
Sample Area:	4.76 cm^2	**Sample Initial weight:**		3.536 g	
Solution Batch ID:	Evaporate supernate ; pH 14 ; Tracking # 94				
Potentiostat:	OCP (VMP3)				
Potentiostat ID:	1568				
Comments:	OCP 18 hrs and CPP sample full immersion ; T = 50°C N_2 Purging * Ran out of N_2 not beable to complete the test; rerun the test on coupon # EL 1196-105 *				
Test Performed by:	Amnoyporn Kelley		**Home Phone:**	614-889-7980	
Project Manager:	Sean Brossia				
Date end:			**Time end:**		

* Set a value such that the reversal current density is 1mA/cm^2;

QA APPROVED
NAME: Qdww
DATE: 8-7-08

Potentiodynamic/Potentiostatic Polarization Test Information Form					
Project Name:	ARES			Project#:	81170135
Test Type:	CPP			Date Start:	1/19/08
Specimen ID:	EL 1196 - 105			Time Start:	9:00 AM
Data Files:	OCP:	EL 1196-105 OCP.mpr			
	CPP:	EL 1196-105 OCP.DTA			
Solution:	Evaporate Supernate		Atmosphere:		N_2 Purging
Temperature:	50 °C		Reference Electrode:		SCE
Initial pH:	14		Final pH:		14.16
Starting Potential:	-0.1 V vs. OCP		Reversal Potential:		1 V vs. SCE
Scan Rate:	0.17 mV/s		Final Potential:		0.1 V vs. OCP
Reverse Current	0.475 mA* AK		Applied potential for potentiostatic test:		NA V vs. SCE
Sample Length:	3.17 cm		Sample Diameter:		0.48 cm
Sample Area:	0.475 cm² AK		Sample initial weight:		3.525 g
Solution Batch ID:	Evaporate Supernate ; pH 14 ; Tracking # 94				
Potentiostat:	OCP (VMP3)	CPP. Ramsey			
Potentiostat ID:	1568	1408			
Comments:	. Full immersion - OCP for 18hr. - CPP - 50 °C N_2 Purging				
Test Performed by:	Amnoyporn Kelley			Home Phone:	614-889-7980
Project Manager:	Sean Brossia				
Date end:	1/24/08			Time end:	2:00 PM

* Set a value such that the reversal current density is 1mA/cm²;

QA APPROVED
NAME: Cldun
DATE: 8-7-08

Potentiodynamic/Potentiostatic Polarization Test Information Form					
Project Name:	ARES		**Project#:**	81170135	
Test Type:	CPP		**Date Start:**	5/14/08	
Specimen ID:	EL 1196-106		**Time Start:**	9:00 A M	
Data Files:	OCP:	EL1196-106 OCP. mpr.			
	CPP:	EL1196-106 CPP			
Solution:	AP 105 Mixed supernate		**Atmosphere:**	N_2 purging	
Temperature:	50 °C		**Reference Electrode:**	SCE	
Initial pH:	13+		**Final pH:**	13+	
Starting Potential:	-0.1 V vs. OCP		**Reversal Potential:**	0.1 V vs. SCE	
Scan Rate:	0.17 mV/s		**Final Potential:**	-0.1 V vs. OCP	
Reverse Current	4.75 mA*		**Applied potential for potentiostatic test:**	NA V vs. SCE	
Sample Length:	3.17 cm		**Sample Diameter:**	0.48 cm	
Sample Area:	4.75 cm^2		**Sample initial weight:**	3.528 g	
Solution Batch ID:	AP 105 Mixed Supernate tracking # 96 pH 13+				
Potentiostat:	VMP3 (OCP)	CPP (Gamry)			
Potentiostat ID:	1568	1408			
Comments:	- Full immersion ; 50 °C ; N_2 Purging - OCP and CPP				
Test Performed by:	Amnoyporn Kelley		**Home Phone:**	614-889-7980	
Project Manager:	Sean Brossia				
Date end:	5/15/08		**Time end:**	12:00 P M	

* Set a value such that the reversal current density is 1mA/cm^2;

QA APPROVED
NAME: Cleaver
DATE: 8-2-08

Potentiodynamic/Potentiostatic Polarization Test Information Form					
Project Name:	ARES		**Project#:**	81170135	
Test Type:	CPP		**Date Start:**	5/15/08	
Specimen ID:	EL 1196-107		**Time Start:**	11:00 AM	
Data Files:	OCP:	EL 1196-107 OCP.mpr			
	CPP:	EL 1196-107 CPP.DTA			
	AP105				
Solution:	Evaporate Supernate		**Atmosphere:**	N_2 Purging	
Temperature:	50 °C		**Reference Electrode:**	SCE	
Initial pH:	11.0		**Final pH:**	11.47	
				1.0 AK	
Starting Potential:	-0.1 V vs. OCP		**Reversal Potential:**	~~0.7~~ V vs. SCE	
Scan Rate:	0.17 mV/s		**Final Potential:** AK	-0.0 V vs. OCP	
Reverse Current	4.76 mA*		**Applied potential for potentiostatic test:**	NA V vs. SCE	
Sample Length:	3.17 cm		**Sample Diameter:**	0.78 cm	
Sample Area:	1.76 cm^2		**Sample initial weight:**	3.519 g	
Solution Batch ID:	AP105 Evaporate Supernate; Tracking # 95 pH 11.0; No NaOH; No $NaAlO_2 \times H_2O$				
	VMP3		CPP (Gamry)		
Potentiostat:	OCP (~~MVP 3~~) AK				
Potentiostat ID:	1568		1408		
Comments:	- Full immersion - OCP and CPP - N_2 Purging - 50°C				
Test Performed by:	Amnoyporn Kelley		**Home Phone:**	614-889-7980	
Project Manager:	Sean Brossia				
Date end:	5/16/08		**Time end:**	9:00 AM	

* Set a value such that the reversal current density is 1mA/cm^2;

QA APPROVED
NAME: cldunn
DATE: 8-7-08

Potentiodynamic/Potentiostatic Polarization Test Information Form					
Project Name:	ARES		Project#:	81170135	
Test Type:	CPP		Date Start:	5/27/08	
Specimen ID:	EL 1196-108		Time Start:	3:00 PM	
Data Files:	OCP:	EL 1196-108 OCP.mpr			
	CPP:	EL 1196-108 CPP-DTA			
Solution:	AW 105 Supernate	Atmosphere:		N2 purging	
Temperature:	50 °C	Reference Electrode:		SCE	
Initial pH:	13.02	Final pH:		13.14	
Starting Potential:	-0.1 V vs. OCP	Reversal Potential:		1 V vs. SCE	
Scan Rate:	0.17 mV/s	Final Potential:		-0.1 V vs. OCP	
Reverse Current	1.074 mA*	Applied potential for potentiostatic test:		V vs. SCE	
Sample Length:	3.17 cm	Sample Diameter:		0.48 cm	
Sample Area:	1.074 cm²	Sample initial weight:		3.343 g	
Solution Batch ID:	AW 105 Supernate; Fracking 97 pH 13+				
Potentiostat:	OCP (VMP3)	CPP (Gamry)			
Potentiostat ID:	1568	1408			
Comments:	- OCP 18hrs - CPP - 50 °C; N2 Purging Solution - full immersion				
Test Performed by:	Amnoyporn Kelley		Home Phone:	614-889-7980	
Project Manager:	Sean Brossia				
Date end:	5/28/08		Time end:	18:00 PM	

* Set a value such that the reversal current density is 1mA/cm²;

No corrosion product

QA APPROVED

NAME: Cdum

DATE: 8-7-08

Potentiodynamic/Potentiostatic Polarization Test Information Form					
Project Name:	ARES		Project#:	81170135	
Test Type:	CPP		Date Start:	5/28/08	
Specimen ID:	EL1196-109		Time Start:	12:00 PM	
Data Files:	OCP: EL1196-109 OCP.mpR				
	CPP: EL1196-109 CPP.DTA				
Solution:	SY101	Atmosphere:		N_2	
Temperature:	50 °C	Reference Electrode:		SCE	
Initial pH:	13.30	Final pH:		13.150 AF 5/28/08	
Starting Potential:	-0.1 V vs. OCP	Reversal Potential:		0.1 V vs. SCE	
Scan Rate:	0.17 mV/s	Final Potential:		AF 1.0.1 V vs. OCP	
Reverse Current	4.76 mA*	Applied potential for potentiostatic test:		V vs. SCE	
Sample Length:	3.14 cm	Sample Diameter:		0.18 cm	
Sample Area:	4.76 cm^2	Sample initial weight:		3.509 g	
Solution Batch ID:	SY 101; pH 13+; Batching # 98				
Potentiostat:	OCP (PMP3)	CPP (Gamry)			
Potentiostat ID:	1568	1408			
Comments:	- OCP 18 hrs - CPP - at 50 C N_2 purging - Full immersion				
Test Performed by:	Amnoyporn Kelley		Home Phone:	614-889-7980	
Project Manager:	Sean Brossia				
Date end:	5/29/08		Time end:	15:00 PM	

* Set a value such that the reversal current density is 1mA/cm^2;

Not corroded

QA APPROVED
NAME: Cldunn
DATE: 8-7-08

Potentiodynamic/Potentiostatic Polarization Test Information Form					
Project Name:	ARES		Project#:	81170135	
Test Type:	CPP		Date Start:	5/29/08	
Specimen ID:	EL 1196-110		Time Start:	11:00 AM	
Data Files:	OCP:	EL1196-110 OCP.mpr			
	CPP:	EL1196-110 CPP.DTA			
Solution:	AY 101 - CSL		Atmosphere:		N_2 Purging
Temperature:	50 °C		Reference Electrode:		SCE
Initial pH:	11.85		Final pH:		12.10
Starting Potential:	-0.1 V vs. OCP		Reversal Potential:		1.0 V vs. SCE
Scan Rate:	0.167 mV/s		Final Potential:		-0.1 V vs. OCP
Reverse Current	1.076 mA*		Applied potential for potentiostatic test:		NA V vs. SCE
Sample Length:	3.17 cm		Sample Diameter:		0.48 cm
Sample Area:	1.076 cm^2		Sample Initial weight:		3.475 g
Solution Batch ID:	AY 101 - CSL ; Tracking # 99 pH 11.85				
Potentiostat:	OCP (VMP3)		CPP (Gamry)		
Potentiostat ID:	1568		1408		
Comments:	- OCP 18 hrs. - CPP - Full immersion - 50°C - N_2 Purging Solution				
Test Performed by:	Amnoyporn Kelley		Home Phone:	614-889-7980	
Project Manager:	Sean Brossia				
Date end:	5/30/08		Time end:	12:00 PM	

* Set a value such that the reversal current density is 1mA/cm^2;

QA APPROVED
NAME: CEdun
DATE: 8-7-08

Potentiodynamic/Potentiostatic Polarization Test Information Form					
Project Name:	ARES		**Project#:**	81170135	
Test Type:	CPP		**Date Start:**	6/16/08	
Specimen ID:	EL 1196-111		**Time Start:**	9:00 AM	
Data Files:	OCP: EL 1196-111 OCP. mpr				
	CPP: EL 1196-111 CPP. DTA				
Solution:	AY 101 - CSL	**Atmosphere:**		N_2 Purging	
Temperature:	50 °C	**Reference Electrode:**		SCE	
Initial pH:	11.82	**Final pH:**		11.90	
Starting Potential:	−0.1 V vs. OCP	**Reversal Potential:**		1.0 V vs. SCE	
Scan Rate:	0.17 mV/s	**Final Potential:**		-0.1 V vs. OCP	
Reverse Current	4.76 mA*	**Applied potential for potentiostatic test:**		NA V vs. SCE	
Sample Length:	3.17 cm	**Sample Diameter:**		0.48 cm	
Sample Area:	4.76 cm^2	**Sample initial weight:**		3.518 g	
Solution Batch ID:	AY 101- CSL pH 11.82 Tracking # 100				
Potentiostat:	OCP VMP3	CPP Gamry			
Potentiostat ID:	1568	1408			
Comments:	- OCP for 18 hrs. - CPP - 50°C - N_2 Purging - full immersion * Cassosion on coupon 5				
Test Performed by:	Amnoyporn Kelley		**Home Phone:**	614-889-7980	
Project Manager:	Sean Brossia				
Date end:	6/17/08		**Time end:**	12:00 PM.	

* Set a value such that the reversal current density is 1mA/cm^2;

QA APPROVED
NAME: Cadun
DATE: 8-7-08

Potentiodynamic/Potentiostatic Polarization Test Information Form					
Project Name:	ARES		**Project#:**	81170135	
Test Type:	CPP		**Date Start:**	7/10/08	
Specimen ID:	EL 1196 - 11d		**Time Start:**	7/11/08	
Data Files:	OCP: EL 1196-11d OCP. DTA				
	CPP: EL 1196-11d CPP. DTA				
Solution:	AY 101- CSL	**Atmosphere:**		N_2 Purging	
Temperature:	50 °C	**Reference Electrode:**		SCE	
Initial pH:	13.82	**Final pH:**		13.90	
Starting Potential:	-0.1 V vs. OCP	**Reversal Potential:**		1 V vs. SCE	
Scan Rate:	0.17 mV/s	**Final Potential:**		-0.1 V vs. OCP	
Reverse Current	4.76 mA*	**Applied potential for potentiostatic test:**		N/A V vs. SCE	
Sample Length:	3.17 cm	**Sample Diameter:**		0.48 cm	
Sample Area:	4.76 cm^2	**Sample Initial weight:**		3.538 g	
Solution Batch ID:	AY 101 - CSL Tracking # 103; pH 13.82				
Potentiostat:	OCP Gamry	CPP Gamry			
Potentiostat ID:	1408	1408			
Comments:	- 18 hrs. OCP then CPP - N_2 Purging - Full immersion				
Test Performed by:	Amnoyporn Kelley		**Home Phone:**	614-889-7980	
Project Manager:	Sean Brossia				
Date end:	7/11/08		**Time end:**	11:00	

* Set a value such that the reversal current density is 1mA/cm^2;

Coupon not corroded

QA APPROVED
NAME: Adam
DATE: 8-7-08

Potentiodynamic/Potentiostatic Polarization Test Information Form			
Project Name:	ARES	Project#:	81170135
Test Type:	CPP	Date Start:	7/23/08
Specimen ID:	EL 1196-113	Time Start:	10:00 AM
Data Files:	OCP: EL 1196-113 OCP. mpr		
	CPP: EL 196-113 CPP. DTA		

AK 7/29/08

Solution:	AY101-CSL	Atmosphere:	~~Open to a~~ N_2
Temperature:	Room Temp°	Reference Electrode:	SCE
Initial pH:	11.82	Final pH:	11.97
Starting Potential:	-0.1 V vs. OCP	Reversal Potential:	1.0 V vs. SCE
Scan Rate:	0.17 mV/s	Final Potential:	-0.1 V vs. OCP
Reverse Current	A.76 mA*	Applied potential for potentiostatic test:	V vs. SCE
Sample Length:	3.18 cm	Sample Diameter:	0.48 cm
Sample Area:	4.76 cm^2	Sample initial/final weight:	3.5328g g

Solution Batch ID:	AY 101 - CSL # 100 PH 11.82

Potentiostat:	VMP3 (OCP)	CPP Gamry
Potentiostat ID:	1568	1408

Comments:
- OCP for 18 hrs.
- Room Temperature
- CPP
- N_2 Purge
- Full immersion

Test Performed by:		Home Phone:	
Project Manager:	Sean Brossia		
Date end:	7/31/08	Time end:	12:00 PM

* Set a value such that the reversal current density is 1mA/cm^2;

Coupon not cathode

QA APPROVED
NAME: Adam
DATE: 8-7-08

Potentiodynamic/Potentiostatic Polarization Test Information Form			
Project Name:	ARES	Project#:	81170135
Test Type:	CPP	Date Start:	7/31/08
Specimen ID:	EL 1196 - 114	Time Start:	9:00 AM
Data Files:	OCP: EL 1196-114. mpr. OCP		
	CPP: EL 1196-114 CPP. DAT		

Solution:	AY 101 - CSL +100	Atmosphere:	N_2
Temperature:	50 °C	Reference Electrode:	SCE
Initial pH:	12.34	Final pH:	12.33
Starting Potential:	-0.1 V vs. OCP	Reversal Potential:	1.0 V vs. SCE
Scan Rate:	0.17 mV/s	Final Potential:	-0.1 V vs. OCP
Reverse Current	4.76 mA*	Applied potential for potentiostatic test:	V vs. SCE
Sample Length:	3.17 cm	Sample Diameter:	0.18 cm
Sample Area:	4.76 cm^2	Sample initial/final weight:	g/ g

Solution Batch ID:	AY 101 - CSL # 100 adjusting pH from 11.82 to 12.30 pes (Jeong)
Potentiostat:	OCP (VMP3) CPP (Gamry)
Potentiostat ID:	1568 1408

Comments: Area solution AY 101 - CSL pH 12.34
- T 50 °C
- OCP for 18 hs
- CPP
- Full immersion
- N_2 Purging

Test Performed by:	Noy Kelley	Home Phone:	889-7980
Project Manager:	Sean Brossia		
Date end:	8/1/08	Time end:	14.00 PM

* Set a value such that the reversal current density is 1mA/cm^2;

QA APPROVED
NAME: Cleum
DATE: 8-7-08

Potentiodynamic/Potentiostatic Polarization Test Information Form					
Project Name:	ARES		**Project#:**	81170135	
Test Type:	CPP		**Date Start:**	8/1/08	
Specimen ID:	EL 1196-115 OCP		**Time Start:**	15:00 PM	
Data Files:	OCP: EL 1196-115 xD ~~PIT~~ AL 8/5/08				
	CPP: EL 1196-115 CPP. DAT				
Solution:	AY 101 - CSL	**Atmosphere:**		N_2	
Temperature:	50 °C	**Reference Electrode:**		SCE	
Initial pH:	12.30	**Final pH:**		12.10	
Starting Potential:	-0.1 V vs. OCP	**Reversal Potential:**		1.0 V vs. SCE	
Scan Rate:	0.17 mV/s	**Final Potential:**		-0.1 V vs. OCP	
Reverse Current	4.76 mA*	**Applied potential for potentiostatic test:**		V vs. SCE	
Sample Length:	3.17 cm	**Sample Diameter:**		0.48 cm	
Sample Area:	4.76 cm^2	**Sample initial/final weight:**		3.529 g/ g	
Solution Batch ID:	AY 101 - CSL pH 12.30 # 105				
Potentiostat:	OCP (Gamry 1408) CCP (Gamry 1408)				
Potentiostat ID:	1408				
Comments:	- Ares solution AY 101 - CSL pH 12.30 Tracking #105 - N_2 purging - 50°C - Full immersion - OCP for 18 hrs. - CCP after OCP				
Test Performed by:	Noy Kelley		**Home Phone:**	889-7980	
Project Manager:	Sean Brossia				
Date end:	8/5/08		**Time end:**	12:00 PM	

* Set a value such that the reversal current density is 1mA/cm^2;

sample anode after CPP

QA APPROVED
NAME: Cedun
DATE: 8-7-08

Slow Strain Rate
Work Request/Test Information Form

Person Performing Test: JOE GERST | Home Phone: 740 548 7747
Special Hazards: Caustic | Project Name: ARES 1007
Filled cell
Start (Date/Time): 11-2-07 8:15 | Finish (Date/Time): TAKE DOWN 11-5-07 7:15 | Project Number: 811 7013 4

TEST PARAMETERS

Material: AART 1286 Grade B | Test #: 1196-47 | SSR System #: 1
Material ID#: 1196 | Extension Rate: 1E-6 in/sec | RPM: 694
Sample #: SSR 1196-47 | Strain Rate: 1E-6 sec^{-1}

DATA ACQUISITION

Data File Name: 1196-47.DAT | Strip Chart Scale: — | Data Acquisition Computer #: 3
Data Channels: 1+2 | Strip Chart Speed: — | LVDT or Dial Gage ID#: 181

SAMPLE ENVIRONMENT

Test Solution: AN 107 | Gas: None | Reference Electrode: SCE
Initial pH: 11 | Temperature: 500 C | Free Corrosion Potential: -315 mV
Final pH: 10.90 | Pressure: room | Applied Potential: -740 mV

SPECIMEN DIMENSIONS

Initial		*Final*
Overall Length: 8.0 in.	Measurement Device: CALIPERS	Overall Length: ____ in.
Gage Mark Length: 1.819 in.	Device ID #: 1497	Gage Mark Distance: 2.038 in.
Gage Diameter: 0.1255 in.		Gage Diameter: .081 in.
Cross Sectional Area: .012371 $in.^2$	Machined Gage Length: 1.000 in.	Cross Sectional Area: .005153 $in.^2$

RESULTS & CALCULATIONS

Pre-Load: 75 lbs. | Max. Load 978 lbs. | Time to Failure: 62.89 hrs.
Elongation = 2.038 - 1.819 in. | Reduction in Area: .012371-.005153 $in.^2$ | Time to Failure: 226405 sec.

$$\%\,\text{Elongation} = \frac{\text{Elongation}}{\text{Machined Gage Length}} = \frac{(.219)}{(1.000)} \times 100 = 21.9\,\%$$

$$\%\,\text{Reduction} = \frac{\text{Reduction in Area}}{\text{Initial Cross Section Area}} \quad \frac{(.007218)}{(.012371)} \times 100 = 58.3\%$$

$$\text{UTS} = \frac{\text{Max. Load}}{\text{Initial Cross Section Area}} = \frac{(978)}{(.012371)} = 79056\ \text{psi}$$

$79056\ \text{psi} \times 6.895 \times 10^{-3} = 545.09\ \text{MPa}$

CRACKING

Visual: ____ | Crack Mode: ____
Low Power (30X): ____ | Max. Crack Depth: ____ mm
Metallographic: ____ | Crack Velocity: ____ mm/sec

Comments: 100 Ω Resistor
PSTAT #2090 Controller #1260 TC #1532

Project Leader's Signature: [signature] | QA APPROVED Date: 1/7/8
NAME: C Durr
DATE: 1-7-08

Test Sheet Addendum

Test #	1196-47
Sample #	SSR 1196-47
Filar Eye Piece	CCT # 0224
Magnification	30 K
inches/graduation	.001

Readings
86
85

Avg. Reading, graduations	*	inches/ graduation	= Final Diameter, in.
81		.001	.081

8.

Comments

Slow Strain Rate
Work Request/Test Information Form

Person Performing Test: JOE GERST — Home Phone: 7405487747
Special Hazards: CAUSTIC — Project Name: ARES 2007
Start (Date/Time): 11-2-07 8:15 Filled cell — Finish (Date/Time): 11-5-07 7:15 TAKEDOW — Project Number: 81170134

TEST PARAMETERS

Material: AART128 Grade B — Test #: 1196-48 — SSR System #: 2
Material ID#: 1196 — Extension Rate: 1E-6 in/sec — RPM: 174
Sample #: SSR 1196-48 — Strain Rate: 1E-6 sec^{-1}

DATA ACQUISITION

Data File Name: 1196-48.DAT — Strip Chart Scale: — — Data Acquisition Computer #: 3
Data Channels: 15+16 — Strip Chart Speed: — — LVDT or Dial Gage ID#: 434

SAMPLE ENVIRONMENT

Test Solution: AN 107 — Gas: NONE — Reference Electrode: SCE
Initial pH: 11 — Temperature: 50 °C — Free Corrosion Potential: -296 mV
Final pH: 10.88 — Pressure: Room — Applied Potential: -765 mV

SPECIMEN DIMENSIONS

Initial		*Final*
Overall Length: 9.0 in.	Measurement Device: CALIPERS	Overall Length: ____ in.
Gage Mark Length: 1.772 in.	Device ID #: 1497	Gage Mark Distance: 1.997 in.
Gage Diameter: ~~0.125~~ 0.126 in.		Gage Diameter: .079 .080 in.
Cross Sectional Area: .012470 $in.^2$	Machined Gage Length: 1.000 in.	Cross Sectional Area: .004902 $in.^2$

RESULTS & CALCULATIONS

Pre-Load: 75 lbs. — Max. Load 969 lbs. — Time to Failure: 61.57 hrs.
Elongation = 1.997 − 1.772 in. — Reduction in Area: .012470 − .004902 $in.^2$ — Time to Failure: 221649 sec.

$$\%\,\text{Elongation} = \frac{\text{Elongation}}{\text{Machined Gage Length}} = \frac{(.225)}{(1.000)} \times 100 = 22.5\,\%$$

$$\%\,\text{Reduction} = \frac{\text{Reduction in Area}}{\text{Initial Cross Section Area}} \frac{(.007568)}{(.012470)} \times 100 = 60.69\,\%$$

$$\text{UTS} = \frac{\text{Max. Load}}{\text{Initial Cross Section Area}} = \frac{(969)}{(.012470)} = 77078\ \text{psi}$$

77078 psi × 6.895×10^{-3} = 535.79 MPa

CRACKING

Visual: No — Crack Mode: ____
Low Power (30X): No — Max. Crack Depth: ____ mm
Metallographic: ____ — Crack Velocity: ____ mm/sec

Comments: 100 Ω Resistor
PSTAT # 2088 Tcontroller # 1269 TC # 1538

Project Leader's Signature: [signature] — APPROVED — NAME: Cdunn — Date: 1/7/8 — DATE: 1-7-08

Test Sheet Addendum

Test #	1196-48	**Readings**	99
Sample #	SSR 1196-48		20
Filar Eye Piece	CCT # 0224		
Magnification	30		
inches/graduation	.001		

Avg. Reading, graduations	*	inches/ graduation	=	Final Diameter, in.
~~.07~~ .079		.001		.079

Q.

Comments

Slow Strain Rate
Work Request/Test Information Form

Person Performing Test: Joe Gerst — Home Phone: 740 548 7747
Special Hazards: Caustic — Project Name:
Start (Date/Time): 11-7-07 8:15 Filled cell — Finish (Date/Time): 11-5-07 7:15 Take Down — Project Number:

TEST PARAMETERS

Material: AART 128 Grade B — Test #: 1196-49 — SSR System #: 6
Material ID#: 1196 — Extension Rate: 1E-6 in/sec — RPM: 174
Sample #: SSR 1196 - 49 — Strain Rate: 1E-6 sec^{-1}

DATA ACQUISITION

Data File Name: 1196-49.DAT — Strip Chart Scale: — — Data Acquisition Computer #: 11
Data Channels: 9+15 — Strip Chart Speed: — — LVDT or Dial Gage ID#: 530

SAMPLE ENVIRONMENT

Test Solution: AN 107 — Gas: None — Reference Electrode: SCE
Initial pH: 11 — Temperature: 50°C — Free Corrosion Potential: -274 mV
Final pH: 10.88 — Pressure: Room — Applied Potential: -790 mV

SPECIMEN DIMENSIONS

Initial		*Final*
Overall Length: 8.0 in.	Measurement Device: CALIPERS	Overall Length: 8.2 in.
Gage Mark Length: 1.808 in.	Device ID #: 1497	Gage Mark Distance: 2.021 in.
Gage Diameter: 0.126 in.		Gage Diameter: .077 in.
Cross Sectional Area: .012470 $in.^2$	Machined Gage Length: 1.000 in.	Cross Sectional Area: .004657 $in.^2$

RESULTS & CALCULATIONS

Pre-Load: 75 lbs. — Max. Load 963 lbs. — Time to Failure: 61.13 hrs.
Elongation = 2.021 - 1.808 = .213 in. — Reduction in Area: .012470 - .004657 $in.^2$ — Time to Failure: 220050 sec.

$$\%\ \text{Elongation} = \frac{\text{Elongation}}{\text{Machined Gage Length}} = \frac{(.213)}{(1.000)} \times 100 = 21.3\ \%$$

$$\%\ \text{Reduction} = \frac{\text{Reduction in Area}}{\text{Initial Cross Section Area}} = \frac{(.067893)}{(.012470)} \times 100 = 62.65\ \%$$

$$\text{UTS} = \frac{\text{Max. Load}}{\text{Initial Cross Section Area}} = \frac{(963)}{(.012470)} = 77227\ \text{psi}$$

$77227\ \text{psi} \times 6.895 \times 10^{-3} = 532.48\ \text{MPa}$

CRACKING

Visual: — Crack Mode:
Low Power (30X): — Max. Crack Depth: mm
Metallographic: — Crack Velocity: mm/sec

Comments: Ω 100 Resistor
PSTAT # 2115 Tcontroller #1325 TC 1534

Project Leader's Signature: — QA APPROVED — Date: 1/7/8
NAME: C Dunn
DATE: 1-7-08

Test Sheet Addendum

Test #	1196-49	Readings	78
Sample #	SSR 119-49		1
Filar Eye Piece	CCT # 0224		
Magnification	30X		
inches/graduation	.001		

Avg. Reading, graduations	*	inches/ graduation	= Final Diameter, in.
77		.001	.077

Comments

Slow Strain Rate
Work Request/Test Information Form

Person Performing Test: Joe Geist — Home Phone: 7405487747
Special Hazards: Caustic — Project Name: ARES 2007
Start (Date/Time): 11-26-07 1:30 Filled cell — Finish (Date/Time): 11-29-07 TAKE DOWN — Project Number: 81170134

TEST PARAMETERS

Material: AART 128 Grade B — Test #: 1196-50 — SSR System #: 6
Material ID#: 1196 — Extension Rate: 1E-6 in/sec — RPM: 174
Sample #: SSR 1196-50 — Strain Rate: 1E-6 sec^{-1}

DATA ACQUISITION

Data File Name: 1196-50.DAT — Strip Chart Scale: — — Data Acquisition Computer #: 11
Data Channels: 9 + 15 — Strip Chart Speed: — — LVDT or Dial Gauge ID#: 530

Tracking 68

SAMPLE ENVIRONMENT

Test Solution: AP 105 PSC — Gas: None — Reference Electrode: SCE
Initial pH: 13.14 — Temperature: 50 °C — Free Corrosion Potential: -242 mV
Final pH: 13.77 — Pressure: Room — Applied Potential: 0 mV

SPECIMEN DIMENSIONS

Initial		*Final*
Overall Length: 8.0 in.	Measurement Device: Calipers	Overall Length: 8.2 in.
Gauge Mark Length: 1.681 in.	Device ID #: 1497	Gauge Mark Distance: To corroded in.
Gauge Diameter: .1255 in.		Gauge Diameter: To measure in.
Cross Sectional Area: .012371 $in.^2$	Machined Gauge Length: 1.000 in.	Cross Sectional Area: ——— $in.^2$

RESULTS & CALCULATIONS

Pre-Load: 75 lbs. — Max. Load 955 lbs. — Time to Failure: 41.58 hrs.
D/A Elongation = .158 in. — Reduction in Area: ——— $in.^2$ — Time to Failure: 149670 sec.

$$\%\,\text{Elongation} = \frac{\text{Elongation}}{\text{Machined Gage Length}} = \frac{(.158)}{(1.000)} \times 100 = 15.8\ \%$$

$$\%\,\text{Reduction} = \frac{\text{Reduction in Area}}{\text{Initial Cross Section Area}} \quad \frac{(\text{———})}{(\text{———})} \times 100 = \text{——}\ \%$$

$$\text{UTS} = \frac{\text{Max. Load}}{\text{Initial Cross Section Area}} = \frac{(955)}{(.012371)} = 77196\ \text{psi} \qquad 77196\ \text{psi} \times 6.895 \times 10^{-3} = 532.27\ \text{MPa}$$

CRACKING

Visual: NO — Crack Mode: ———
Low Power (30X): YES — Max. Crack Depth: ——— mm
Metallographic: ——— — Crack Velocity: ——— mm/sec

Comments: 100 Ω Resistor PSTAT 2115 Tcontroller 1325 TC 1528

Project Leader's Signature: [signature] — QA APPROVED — Date: 1/7/8

NAME: Odum
DATE: 1-7-08

Test Sheet Addendum

Test #	1196-50
Sample #	SSR 1196-50
Filar Eye Piece	CCT # 0224
Magnification	30X
inches/graduation	.001

Readings: Too corroded to measure

Avg. Reading, graduations	*	inches/ graduation	= Final Diameter, in.

Oj

Comments

Slow Strain Rate
Work Request/Test Information Form

Person Performing Test: Joe Gerst
Home Phone: 7405487747
Special Hazards: CAUSTIC
Project Name: ARES 2007
Start (Date/Time): 12-3 740
Finish (Date/Time): TAKE DOWN 12-7-07 8:00
Project Number: 81170134

TEST PARAMETERS

Material: MART 128 GRADE B
Test #: 1196-51
SSR System #: 2
Material ID#: 1196
Extension Rate: 1E-6 in/sec
RPM: 694
Sample #: SSR 1196-51
Strain Rate: 1E-6 sec^{-1}

DATA ACQUISITION

Data File Name: 1196-51.DAT
Strip Chart Scale: —
Data Acquisition Computer #: 3
Data Channels: 15 + 16
Strip Chart Speed: —
LVDT or Dial Gage ID#: 434

SAMPLE ENVIRONMENT

Test Solution: TRACKING #68 AP105 PSC
Gas: None
Reference Electrode: SCE
Initial pH: 13.22
Temperature: 50
Free Corrosion Potential: -249 mV
Final pH: 13.77
Pressure: Room
Applied Potential: — mV

SPECIMEN DIMENSIONS

Initial		*Final*
Overall Length: 8.0 in.	Measurement Device: Calipers	Overall Length: 8.2 in.
Gage Mark Length: 1.638 in.	Device ID #: 1497	Gage Mark Distance: 1.847 in.
Gage Diameter: .125 in.		Gage Diameter: .078 in.
Cross Sectional Area: .012273 $in.^2$	Machined Gage Length: 1.000 in.	Cross Sectional Area: .004779 $in.^2$

RESULTS & CALCULATIONS

Pre-Load: 75 lbs.
Max. Load 982 lbs.
Time to Failure: 62.06 hrs.
Elongation = 1.847 - 1.638 in.
Reduction in Area: .012273 - .004779 $in.^2$
Time to Failure: 223419 sec.

$$\%\ \text{Elongation} = \frac{\text{Elongation}}{\text{Machined Gage Length}} = \frac{(.209)}{(1.000)} \times 100 = 20.9\ \%$$

$$\%\ \text{Reduction} = \frac{\text{Reduction in Area}}{\text{Initial Cross Section Area}} \frac{(.007494)}{(.012273)} \times 100 = 61.06\ \%$$

$$\text{UTS} = \frac{\text{Max. Load}}{\text{Initial Cross Section Area}} = \frac{(982)}{(.012273)} = 80015\ \text{psi}$$

$80015\ \text{psi} \times 6.895 \times 10^{-3} = 551.71\ \text{MPa}$

CRACKING

Visual:
Crack Mode:
Low Power (30X): YES
Max. Crack Depth: mm
Metallographic:
Crack Velocity: mm/sec

Comments: Y Tcontroller #1325 TC 1528

Project Leader's Signature:

QA APPROVED
NAME: Cedum Date: 1/7/8
DATE: 1-7-08

Test Sheet Addendum

Test #	1196-51
Sample #	SSR 1196-51
Filar Eye Piece	CCT # 0224
Magnification	30X
Inches/graduation	.001

Readings
78
0

Avg. Reading, graduations	*	Inches/ graduation	=	Final Diameter, in.
78		.001		.078

Comments

Slow Strain Rate
Work Request/Test Information Form

Person Performing Test: Joe Gerst | Home Phone: 740 548 7747
Special Hazards: Caustic filled cell | Project Name: 8H ARES 2007
Start (Date/Time): 12-10-07 11:15 | Finish (Date/Time): 12-13 8:10 | Project Number: 81170134

TEST PARAMETERS

Material: AART 128 Grade B | Test #: 1196-52 | SSR System #: 2
Material ID#: 1196 | Extension Rate: 1E-6 in/sec | RPM: 174
Sample #: SSR 1196- | Strain Rate: 1E-6 sec^{-1}

DATA ACQUISITION

Data File Name: 1196 .DAT | Strip Chart Scale: — | Data Acquisition Computer #: 3
Data Channels: 15 + 16 | Strip Chart Speed: — | LVDT or Dial Gage ID#: 434

SAMPLE ENVIRONMENT

Tracking 68
Test Solution: AP105 PSC | Gas: None | Reference Electrode: SCE
Initial pH: 13.02 | Temperature: 50°C | Free Corrosion Potential: -289 mV
Final pH: 13.75 | Pressure: Room | Applied Potential: — mV

SPECIMEN DIMENSIONS

Initial		*Final*
Overall Length: 8.0 in.	Measurement Device: Calipers	Overall Length: 8.2 in.
Gage Mark Length: 1.628 in.	Device ID #: 1497	Gage Mark Distance: 1.844 in.
Gage Diameter: .125 in.		Gage Diameter: .076 in.
Cross Sectional Area: .012273 $in.^2$	Machined Gage Length: 1.000 in.	Cross Sectional Area: .004573 $in.^2$

RESULTS & CALCULATIONS

Pre-Load: 75 lbs. | Max. Load 977 lbs. | Time to Failure: 61.24 hrs.
Elongation = 1.844 - 1.628 in. | Reduction in Area: .012273 - .004573 $in.^2$ | Time to Failure: 220465 sec.

$$\%\,\text{Elongation} = \frac{\text{Elongation}}{\text{Machined Gage Length}} = \frac{(.216)}{(1.000)} \times 100 = 21.6\,\%$$

$$\%\,\text{Reduction} = \frac{\text{Reduction in Area}}{\text{Initial Cross Section Area}} \frac{(.007736)}{(.012273)} \times 100 = 63.03\,\%$$

$$\text{UTS} = \frac{\text{Max. Load}}{\text{Initial Cross Section Area}} = \frac{(977)}{(.012273)} = 79608\ \text{psi}$$

79608 psi x 6.895×10^{-3} = 548.90 MPa

CRACKING

Visual: NO | Crack Mode: —
Low Power (30X): — | Max. Crack Depth: — mm
Metallographic: — | Crack Velocity: — mm/sec

Comments: TController 1203 TC 1528

Project Leader's Signature: [signature] **QA APPROVED** Date: 1/7/8
NAME: Cldurr
DATE: 1-7-08

Test Sheet Addendum

Test #	1196-52	**Readings**	80			
Sample #	SSR 1196-52		4			
Filar Eye Piece	CCT # 0224					
Magnification	30 X					
inches/graduation	.001	**Avg. Reading, graduations**	76	*	.001	= Final Diameter, in. .076

Oj.

Comments

Slow Strain Rate
Work Request/Test Information Form

Person Performing Test: Joe Gerst — Home Phone: 740 548 7747
Special Hazards: Caustic — Project Name: 84 ARES 2007
Filled cell
Start (Date/Time): 12-10-07 11:15 — Finish (Date/Time): 12-13 8:00 — Project Number: 811701134

TEST PARAMETERS

Material: AART 128 Grade B — Test #: 1196-53 — SSR System #: 6
Material ID#: 1196 — Extension Rate: 1E-6 in/sec — RPM: 1.74
Sample #: SSR 1196- — Strain Rate: 1E-6 sec^{-1}

DATA ACQUISITION

Data File Name: 1196-53.DAT — Strip Chart Scale: — Data Acquisition Computer #: 11
Data Channels: 9+15 — Strip Chart Speed: — LVDT or Dial Gage ID#:

SAMPLE ENVIRONMENT

Tracking 68
Test Solution: AP105 PSC — Gas: None — Reference Electrode: SCE
Initial pH: 13.02 — Temperature: 50°C — Free Corrosion Potential: -259 mV
Final pH: 13.75 — Pressure: Room — Applied Potential: 0 mV

SPECIMEN DIMENSIONS

Initial		*Final*
Overall Length: 8.0 in.	Measurement Device: Calipers	Overall Length: 8.2 in.
Gage Mark Length: 1.720 in.	Device ID #: 1497	Gage Mark Distance: 1.900 in.
Gage Diameter: .125 in.		Gage Diameter: .095 in.
Cross Sectional Area: .012273 $in.^2$	Machined Gage Length: 1.000 in.	Cross Sectional Area: .007089 $in.^2$

RESULTS & CALCULATIONS

Pre-Load: 75 lbs. — Max. Load 973 lbs. — Time to Failure: 49.24 hrs.
Elongation = 1.900 - 1.720 in. — Reduction in Area: .012273-.007089 $in.^2$ — Time to Failure: 177274 sec.

$$\%\ \text{Elongation} = \frac{\text{Elongation}}{\text{Machined Gage Length}} = \frac{(180)}{(1.000)} \times 100 = 18.0\ \%$$

$$\%\ \text{Reduction} = \frac{\text{Reduction in Area}}{\text{Initial Cross Section Area}} \frac{(.005184)}{(.012273)} \times 100 = 42.24\%$$

$$\text{UTS} = \frac{\text{Max. Load}}{\text{Initial Cross Section Area}} = \frac{(973)}{(.012273)} = 79282\ \text{psi}$$

79282 psi x 6.895×10^{-3} = 546.65 MPa

CRACKING

Visual: Yes — Crack Mode:
Low Power (30X): Yes — Max. Crack Depth: mm
Metallographic: — Crack Velocity: mm/sec

Comments: 100 Ω Resistor PSTAT 2115 Tcontroller 1325 TC 1534

Project Leader's Signature: — **QA APPROVED** — Date:
NAME: Cleun
DATE: 1-7-08

Test Sheet Addendum

Test #	1196-53	Readings				
Sample #	SSR 1196-53	100				
Filar Eye Piece	CCT # 0224	5				
Magnification	30X					
inches/graduation	.001	Avg. Reading, graduations	*	inches/ graduation	=	Final Diameter, in.
		95		.001		.095

Comments

Slow Strain Rate
Work Request/Test Information Form

Person Performing Test: Joe Gerst — Home Phone: 740548 7747
Special Hazards: CAUSTIC HOT — Project Name: 81170135
Filled cell
Start (Date/Time): 2-1-08 1230 — Finish (Date/Time): TAKEDOWN 2-4-08 715 — Project Number:

TEST PARAMETERS

Material: AART 128 Grade B — Test #: 1196-54 — SSR System #: 1
Material ID#: 1196 — Extension Rate: 1E-6 in/sec — RPM: 694
Sample #: SSR 1196-54 — Strain Rate: 1E-6 sec^{-1}

DATA ACQUISITION

Data File Name: 1196-54.DAT — Strip Chart Scale: — — Data Acquisition Computer #: 3
Data Channels: 1 & 2 — Strip Chart Speed: — — LVDT or Diaf Gauge ID#:

SAMPLE ENVIRONMENT

Test Solution: AP 105 — Gas: None — Reference Electrode: SCE
Initial pH: 12.98 — Temperature: 50°C — Free Corrosion Potential: -287 mV
Final pH: 13.10 — Pressure: Room — Applied Potential: 0 mV mV

SPECIMEN DIMENSIONS

Initial		Final
Overall Length: 8.0 in.	Measurement Device: Calipers 1497	Overall Length: 8.2 in.
Gauge Mark Length: 1.708 in.	Device ID #: 1497	Gauge Mark Distance: To corroded in.
Gauge Diameter: 0.1245 in.		Gauge Diameter: To corroded in.
Cross Sectional Area: .012175 $in.^2$	Machined Gauge Length: 1.000 in.	Cross Sectional Area: To corroded $in.^2$

RESULTS & CALCULATIONS

D/A

Pre-Load: 75 lbs. — Max. Load 951 lbs. — Time to Failure: 53.78 hrs.
Elongation = .187 in. — Reduction in Area: ? $in.^2$ — Time to Failure: 193606 sec.

$$\%\ \text{Elongation} = \frac{\text{Elongation}}{\text{Machined Gage Length}} = \frac{(.187)}{(1.000)} \times 100 = 18.7\ \%$$

$$\%\ \text{Reduction} = \frac{\text{Reduction in Area}}{\text{Initial Cross Section Area}} \quad \frac{(\ ?\ )}{(.012175)} \times 100 = ?\ \%$$

$$\text{UTS} = \frac{\text{Max. Load}}{\text{Initial Cross Section Area}} = \frac{(951)}{(.012175)} = 78118\ \text{psi}$$

78118 psi × 6.895 10^{-3} = 538.62 MPa

CRACKING

Visual: corroded — Crack Mode:
Low Power (30X): — Max. Crack Depth: mm
Metallographic: — Crack Velocity: mm/sec

Comments: 100Ω Resistor PSTAT#2090 Tcontroller#1260 TC #1528
Scribed x on end of specimen that will be Top

Project Leader's Signature: [signature] — QA APPROVED — Date: 2/5/08.
NAME: Cldunn
DATE: 2-5-08

Slow Strain Rate
Work Request/Test Information Form

Person Performing Test: Joe Gerst — Home Phone: 740 548 7747
Special Hazards: Caustic / Filled Cell — Project Name: ARES
Start (Date/Time): 3-25-08 910 — Finish (Date/Time): 3-28-08 TAKEDOWN 7:20 — Project Number: 81170135

TEST PARAMETERS

Material: AART 128 Grade B — Test #: 1196-55 — SSR System #: JR 6
Material ID#: 1196 — Extension Rate: 1E-6 in/sec — RPM: JR 173
Sample #: SSR 119655.1 — Strain Rate: 1E-6 sec^{-1}

DATA ACQUISITION

Data File Name: 1196-55.DAT — Strip Chart Scale: — — Data Acquisition Computer #: JR 311
Data Channels: 9 + 15 — Strip Chart Speed: — — LVDT or Dial Gauge ID#: 530

SAMPLE ENVIRONMENT

Test Solution: SY103 PIL — Gas: None — Reference Electrode: SCE
Initial pH: 14.06 — Temperature: 50 °C — Free Corrosion Potential: -424 mV
Final pH: 13 + [redacted] — Pressure: Room — Applied Potential: — mV

SPECIMEN DIMENSIONS

Initial		*Final*
Overall Length: 8.0 in.	Measurement Device: Calipers	Overall Length: 8.2 in.
Gauge Mark Length: 1.667 in.	Device ID #: 1497	Gauge Mark Distance: 1.888 in.
Gauge Diameter: .1255 in.		Gauge Diameter: .075 in.
Cross Sectional Area: .012370 in.^{2}	Machined Gauge Length: 1.000 in.	Cross Sectional Area: .004418 in.^{2}

RESULTS & CALCULATIONS

Pre-Load: 75 lbs. — Max. Load 979 lbs. — Time to Failure: 61.18 hrs.
Elongation = 1.888 - 1.667 in. — Reduction in Area: .012370 - .004418 in.^{2} — Time to Failure: 220237 sec.

$$\%\,\text{Elongation} = \frac{\text{Elongation}}{\text{Machined Gage Length}} = \frac{(.221)}{(1.000)} \times 100 = 22.1\,\%$$

$$\%\,\text{Reduction} = \frac{\text{Reduction in Area}}{\text{Initial Cross Section Area}} = \frac{(.007952)}{(.012370)} \times 100 = 64.28\,\%$$

$$\text{UTS} = \frac{\text{Max. Load}}{\text{Initial Cross Section Area}} = \frac{(979)}{(.012370)} = 79142\ \text{psi}$$

79142 psi × 6.895 10^{-3} = 545.68 MPa

CRACKING

Visual: None — Crack Mode: —
Low Power (30X): — — Max. Crack Depth: — mm
Metallographic: — — Crack Velocity: — mm/sec

Comments: Temp Controller #1203 TC #1670

Project Leader's Signature: — Date: —

QA APPROVED
NAME: Coleman
DATE: 3-28-08

Test Sheet Addendum

Test #	1196-55
Sample #	SSR 1196-55
Filar Eye Piece	CCT # 0224
Magnification	30X
inches/graduation	.001

Readings
87
12
75

Avg. Reading, graduations	*	inches/ graduation	= Final Diameter, in.
75		.001	.075

Comments

Slow Strain Rate
Work Request/Test Information Form

Person Performing Test: Joe Geist
Home Phone: 7405487747
Special Hazards: Caustic
Project Name: ARES
Start (Date/Time): 3-25-08 955 Finish (Date/Time): 3-28-07 720 TAKE DOWN
Project Number: 81170135

TEST PARAMETERS

Material: AART 128 Grade B
Test #: 119656.
SSR System #: J&J 2
Material ID#: 1196
Extension Rate: 1E-6 in/sec
RPM: 173
Sample #: SSR 1196-56
Strain Rate: 1E-6 sec^{-1}

DATA ACQUISITION

Data File Name: 1196-56.DAT
Strip Chart Scale: —
Data Acquisition Computer #: 3
Data Channels: 15 + 16
Strip Chart Speed: —
LVDT or Dial Gauge ID#: 434

SAMPLE ENVIRONMENT

Test Solution: AW 105 PIL
Gas: NONE
Reference Electrode: SCE
Initial pH: 13.6
Temperature: 50
Free Corrosion Potential: -290 mV
Final pH: pH 13+
Pressure: Room
Applied Potential: — mV

SPECIMEN DIMENSIONS

	Initial		*Final*
Overall Length:	8.0 in.	Measurement Device: Calipers	Overall Length: 8.2 in.
Gauge Mark Length:	1.653 in.	Device ID #: 1497	Gauge Mark Distance: 1.870 in.
Gauge Diameter:	.1255 in.		Gauge Diameter: .0776 in.
Cross Sectional Area:	.012370 $in.^2$	Machined Gauge Length: 1.000 in.	Cross Sectional Area: .004537 $in.^2$

RESULTS & CALCULATIONS

Pre-Load: 75 lbs.
Max. Load 977 lbs.
Time to Failure: 62.04 hrs.
Elongation = 1.870 − 1.653 in.
Reduction in Area: .012370 − .004537 $in.^2$
Time to Failure: 223341 sec.

$$\%\,\text{Elongation} = \frac{\text{Elongation}}{\text{Machined Gage Length}} = \frac{(.217)}{(1.000)} \times 100 = 21.7\,\%$$

$$\%\,\text{Reduction} = \frac{\text{Reduction in Area}}{\text{Initial Cross Section Area}} \quad \frac{(.007833)}{(.012370)} \times 100 = 63.33\,\%$$

$$\text{UTS} = \frac{\text{Max. Load}}{\text{Initial Cross Section Area}} = \frac{(977)}{(.012370)} = 78980\ \text{psi} \qquad 78980\ \text{psi} \times 6.895\ 10^{-3} = 544.57\ \text{MPa}$$

CRACKING

Visual: NO
Crack Mode:
Low Power (30X): 2
Max. Crack Depth: mm
Metallographic:
Crack Velocity: mm/sec

Comments: Temp Controller #1236 TC# 1668
~~pitting~~ IN corrosion ~~AROUND~~ IN crack like AREAS
And corrosion product in solution removed From cell

Project Leader's Signature: QA APPROVED Date:

NAME: Odum
DATE: 3-28-08

Test Sheet Addendum

Test #	1196-56	Readings	
Sample #	SSR 1196-56	81	
Filar Eye Piece	CCT # 0224	5	
Magnification	30X		
inches/graduation	.001		

Avg. Reading, graduations	*	inches/ graduation	= Final Diameter, in.
76		.001	.076

Comments

Slow Strain Rate
Work Request/Test Information Form

Person Performing Test: Joe Geist — Home Phone: 7405487747
Special Hazards: Caustic — Project Name: ARES 2008
Start (Date/Time): Filled cell 9 20 4.2.08 — Finish (Date/Time): Took Down 4-5 6:30 — Project Number: 81170135

TEST PARAMETERS

Material: AART 128 Grade B — Test #: 1196-57 — SSR System #: 2
Material ID#: 1196 — Extension Rate: 1E-6 in/sec — RPM: 173
Sample #: SSR 1196-57 — Strain Rate: 1E-6 sec^{-1}

DATA ACQUISITION

Data File Name: 1196-57.DAT — Strip Chart Scale: — — Data Acquisition Computer #: 3
Data Channels: 15 + 16 — Strip Chart Speed: — — LVDT or Dial Gauge ID#: 434

SAMPLE ENVIRONMENT

Tracking 85
Test Solution: S4103 PIC — Gas: None — Reference Electrode: SCE
Initial pH: 13 + — Temperature: ~~Room~~ 50C — Free Corrosion Potential: -477 mV
Final pH: 13 + — Pressure: Room — Applied Potential: 0.0 mV

SPECIMEN DIMENSIONS

Initial		*Final*
Overall Length: 8.0 in.	Measurement Device: Calipers	Overall Length: 8.2 in.
Gauge Mark Length: 1.728 in.	Device ID #: 1497	Gauge Mark Distance: 1.945 in.
Gauge Diameter: .125 in.		Gauge Diameter: .078 in.
Cross Sectional Area: .012272 $in.^2$	Machined Gauge Length: 1.000 in.	Cross Sectional Area: .004779 $in.^2$

RESULTS & CALCULATIONS

Pre-Load: 75 lbs. — Max. Load 964 lbs. — Time to Failure: 62.21 hrs.
Elongation = 1.945 - 1.728 in. — Reduction in Area: .007493 $in.^2$ — Time to Failure: 223954 sec.

$$\%\,\text{Elongation} = \frac{\text{Elongation}}{\text{Machined Gage Length}} = \frac{(.217)}{(1.000)} \times 100 = 21.7\,\%$$

$$\%\,\text{Reduction} = \frac{\text{Reduction in Area}}{\text{Initial Cross Section Area}} \quad \frac{(.007493)}{(.012272)} \times 100 = 61.06\%$$

$$\text{UTS} = \frac{\text{Max. Load}}{\text{Initial Cross Section Area}} = \frac{(964)}{(.012272)} = 78554\ \text{psi}$$

78554 psi x 6.895 10^{-3} = 541.63 MPa

CRACKING

Visual: No — Crack Mode:
Low Power (30X): — Max. Crack Depth: mm
Metallographic: — Crack Velocity: mm/sec

Comments:

Project Leader's Signature: [signature] 4/14/08 — **QA APPROVED** Date:
NAME: [illegible]
DATE: 4-14-08

Test Sheet Addendum

Test #	1196-57
Sample #	SSR 1196-57
Filar Eye Piece	CCT # 0224
Magnification	30X
inches/graduation	.001

Readings
98
20
78

Avg. Reading, graduations	*	inches/ graduation	= Final Diameter, in.
78		.001	.078

Comments

Slow Strain Rate
Work Request/Test Information Form

Person Performing Test: Joe Gerst — Home Phone: 7405487747
Special Hazards: Caustic — Project Name: ARES 2008
Start (Date/Time): Filled Cell 4-2-08 940 — Finish (Date/Time): Took Down 4-7-08 7:20 — Project Number: 81170135

TEST PARAMETERS

Material: AART 128 Grade B — Test #: 1196-58 — SSR System #: 6
Material ID#: 1196 — Extension Rate: 1E-6 in/sec — RPM: 173
Sample #: SSR 1196-58 — Strain Rate: 1E-6 sec^{-1}

DATA ACQUISITION

Data File Name: 1196-58.DAT — Strip Chart Scale: — — Data Acquisition Computer #: 11
Data Channels: 9 + 15 — Strip Chart Speed: — — LVDT or Dial Gauge ID#: 530

SAMPLE ENVIRONMENT

Tracking 86
Test Solution: AW 105 PIL — Gas: None — Reference Electrode: SCE
Initial pH: 13+ — Temperature: ~~Room~~ 50C — Free Corrosion Potential: -193 mV
Final pH: 13+ — Pressure: Room — Applied Potential: 0.0 mV

SPECIMEN DIMENSIONS

Initial		*Final*
Overall Length: 8.0 in.	Measurement Device: Calipers	Overall Length: 8.2 in.
Gauge Mark Length: 1.636 in.	Device ID #: 1497	Gauge Mark Distance: 1.838 in.
Gauge Diameter: .125 in.		Gauge Diameter: .079 in.
Cross Sectional Area: .012272 $in.^2$	Machined Gauge Length: 1.000 in.	Cross Sectional Area: .004902 $in.^2$

RESULTS & CALCULATIONS

Pre-Load: 75 lbs. — Max. Load 988 lbs. — Time to Failure: 60.28 hrs.
Elongation = 1.838 - 1.636 in. — Reduction in Area: .012272 - .004902 $in.^2$ — Time to Failure: 217022 sec.

$$\%\ \text{Elongation} = \frac{\text{Elongation}}{\text{Machined Gage Length}} = \frac{(.202)}{(1.000)} \times 100 = 20.2\ \%$$

$$\%\ \text{Reduction} = \frac{\text{Reduction in Area}}{\text{Initial Cross Section Area}} \frac{(.007370)}{(\quad)} \times 100 = 60.06\ \%$$

$$\text{UTS} = \frac{\text{Max. Load}}{\text{Initial Cross Section Area}} = \frac{(988)}{(.012272)} = 80509\ \text{psi}$$

80509 psi × 6.895 10^{-3} = 555.11 MPa

CRACKING

Visual: No — Crack Mode:
Low Power (30X): — Max. Crack Depth: mm
Metallographic: — Crack Velocity: mm/sec

Comments:

Project Leader's Signature: 4/14/08 — **QA APPROVED** Date:

NAME:
DATE: 4-11-08

Test Sheet Addendum

Test #	1196-58	**Readings**				
Sample #	SSR 1196-58	89				
Filar Eye Piece	CCT # 0224	10				
Magnification	30X					
inches/graduation	.001	**Avg. Reading, graduations**	*	**Inches/ graduation**	=	**Final Diameter, in.**
		79		.001		.079

Comments

Slow Strain Rate
Work Request/Test Information Form

Person Performing Test: Joe Gerst — Home Phone: 7405487797
Special Hazards: Caustic — Project Name: 81170135
Start (Date/Time): 4-15-08 1155 — Finish (Date/Time): TAKEDOWN 7:50 4-18-08 — Project Number:

TEST PARAMETERS

Material: AART 128 Grade B — Test #: 1196-59 — SSR System #: 2
Material ID#: 1196 — Extension Rate: 1E-6 in/sec — RPM: 174
Sample #: SSR 1196-59 — Strain Rate: 1E-6 sec^{-1}

DATA ACQUISITION

Data File Name: 1196-59 — Strip Chart Scale: — — Data Acquisition Computer #: 3
Data Channels: 15 + 16 — Strip Chart Speed: — — LVDT or Dial Gauge ID#: 434

SAMPLE ENVIRONMENT

Test Solution: Evaporated Supernate Trachis 91 — Gas: NONE — Reference Electrode: SCE
Initial pH: 14+ — Temperature: 50 C — Free Corrosion Potential: -510 mV
Final pH: 14+ — Pressure: Room — Applied Potential: — mV

SPECIMEN DIMENSIONS

Initial		*Final*
Overall Length: 8.0 in.	Measurement Device: Calipers	Overall Length: 8.2 in.
Gauge Mark Length: 1.667 in.	Device ID #: 1497	Gauge Mark Distance: 1.876 in.
Gauge Diameter: .125 in.		Gauge Diameter: .079 in.
Cross Sectional Area: .012272 $in.^2$	Machined Gauge Length: 1.000 in.	Cross Sectional Area: .004779 $in.^2$

RESULTS & CALCULATIONS

Pre-Load: 75 lbs. — Max. Load 967 lbs. — Time to Failure: 58.96 hrs.
Elongation = 1.876 - 1.667 in. — Reduction in Area: .012272 - .004779 $in.^2$ — Time to Failure: 212265 sec.

$$\%\,\text{Elongation} = \frac{\text{Elongation}}{\text{Machined Gage Length}} = \frac{(.209)}{(1.000)} \times 100 = 20.9\,\%$$

$$\%\,\text{Reduction} = \frac{\text{Reduction in Area}}{\text{Initial Cross Section Area}} \quad \frac{(.007493)}{(.012272)} \times 100 = 61.06\,\%$$

$$\text{UTS} = \frac{\text{Max. Load}}{\text{Initial Cross Section Area}} = \frac{(967)}{(.012272)} = 78798\ \text{psi} \qquad 78798\ \text{psi} \times 6.895 \times 10^{-3} = 543.31\ \text{MPa}$$

CRACKING

QA APPROVED

Visual: NO
Low Power (30X): NO
Metallographic:

NAME: Odum
DATE: 4-18-08

Crack Mode:
Max. Crack Depth: mm
Crack Velocity: mm/sec

Comments: Tcontroller #1236 TC #1670
one side of Fracture was damaged when I dropped it in the sink

Project Leader's Signature: [signature] — Date: 4/18/08

Slow Strain Rate
Work Request/Test Information Form

Person Performing Test: Joe Gerst — Home Phone: 7405487747
Special Hazards: Caustic — Project Name: ARES
Start (Date/Time): Filled cell 11:30 5-5-08 — Finish (Date/Time): TAKE DOWN 5-7-08 7:00 A.M. — Project Number: K1170135

TEST PARAMETERS

Material: AART (28) Grade B — Test #: 1196-60 — SSR System #: 2
Material ID#: 1196 — Extension Rate: 1E-6 in/sec — RPM: 174
Sample #: SSR 1196-60 — Strain Rate: 1E-6 sec^{-1}

DATA ACQUISITION

Data File Name: 1196-60.DAT — Strip Chart Scale: — — Data Acquisition Computer #: 3
Data Channels: 15 + 16 — Strip Chart Speed: — — LVDT or Dial Gauge ID#: 434

SAMPLE ENVIRONMENT

Tracking 90
Test Solution: AP105-PSC — Gas: None — Reference Electrode: SCE
Initial pH: 13+ — Temperature: 50 °C — Free Corrosion Potential: -277 mV
Final pH: 13+ — Pressure: Room — Applied Potential: FCP mV

SPECIMEN DIMENSIONS

	Initial		Final (measured with calipers)
Overall Length:	8.0 in.	Measurement Device: Calipers	Overall Length: 8.1 in.
Gauge Mark Length:	1.702 in.	Device ID #: 1497	Gauge Mark Distance: 1.816 in.
Gauge Diameter:	.126 in.		Gauge Diameter: .118 in.
Cross Sectional Area:	.012469 $in.^2$	Machined Gauge Length: 1.000 in.	Cross Sectional Area: .00937 $in.^2$

RESULTS & CALCULATIONS

Pre-Load: 75 lbs. — Max. Load 977 lbs. — Runaway Time to ~~Failure~~: 38.85 hrs.
Elongation = 1.816 − 1.702 in. — Reduction in Area: .012469 − .010937 $in.^2$ — Runaway Time to ~~Failure~~: 139862 sec.

$$\%\,\text{Elongation} = \frac{\text{Elongation}}{\text{Machined Gage Length}} = \frac{(.114)}{(1.000)} \times 100 = 11.4\,\%$$

$$\%\,\text{Reduction} = \frac{\text{Reduction in Area}}{\text{Initial Cross Section Area}} = \frac{(.001532)}{(.012469)} \times 100 = 12.29\,\%$$

$$\text{UTS} = \frac{\text{Max. Load}}{\text{Initial Cross Section Area}} = \frac{(977)}{(.012469)} = 78354\ \text{psi}$$

78354 psi × 6.895 10^{-3} = 540.25 MPa

CRACKING

Visual: None — Crack Mode:
Low Power (30X): None — Max. Crack Depth: mm
Metallographic: — Crack Velocity: mm/sec

Comments: stopped AT 38.85 hrs and Took down
some corrosion AT interface
TC 1670 Tcontroller 1236

IA APPROVED
NAME: Clow
DATE: 6-18-08

Project Leader's Signature: [signature] 6/5/08 — Date:

Slow Strain Rate
Work Request/Test Information Form

Person Performing Test: Joe Gerst — Home Phone: 7405487747
Special Hazards: CAUSTIC — Project Name: AKES 2008
Start (Date/Time): 5-4-08 7:15 — Finish (Date/Time): 5-12-08 7:15 (Take Down) — Project Number: 81170135
Filled cell

TEST PARAMETERS

Material: DART 128 Grade B — Test #: 1196-60 61 — SSR System #: 2
Material ID#: 1196 — Extension Rate: 1E-6 in/sec — RPM: 175
Sample #: SSR 1196-60 61 — Strain Rate: 1E-6 sec^{-1}

DATA ACQUISITION

Data File Name: 1196-60.DAT — Strip Chart Scale: — — Data Acquisition Computer #: 3
Data Channels: 15+16 — Strip Chart Speed: — — LVDT or Dial Gauge ID#: 434

SAMPLE ENVIRONMENT

Tracking 93
Test Solution: A2102 — Gas: none — Reference Electrode: SCE
Initial pH: 12.25 — Temperature: 77°C — Free Corrosion Potential: -239 mV
Final pH: — Pressure: Room — Applied Potential: FCP mV

SPECIMEN DIMENSIONS

Initial		*Final*
Overall Length: 8.0 in.	Measurement Device: Calipers	Overall Length: 8.2 in.
Gauge Mark Length: 1.593 in.	Device ID #: 1407	Gauge Mark Distance: 1.802 in.
Gauge Diameter: .125 in.		Gauge Diameter: .078 in.
Cross Sectional Area: .012272 in.^{2}	Machined Gauge Length: 1.000 in.	Cross Sectional Area: .004779 in.^{2}

RESULTS & CALCULATIONS

Pre-Load: 75 lbs. — Max. Load 1000 lbs. — Time to Failure: 58.25 hrs.
Elongation = 1.802 - 1.593 in. — Reduction in Area: .012272 - .004779 in.^{2} — Time to Failure: 209715 sec.

$$\%\,\text{Elongation} = \frac{\text{Elongation}}{\text{Machined Gage Length}} = \frac{(.209)}{(1.000)} \times 100 = 20.9\,\%$$

$$\%\,\text{Reduction} = \frac{\text{Reduction in Area}}{\text{Initial Cross Section Area}} \quad \frac{(.007493)}{(.012272)} \times 100 = 61.06\%$$

$$\text{UTS} = \frac{\text{Max. Load}}{\text{Initial Cross Section Area}} = \frac{(1000)}{(.012272)} = 81487 \text{ psi}$$

81487 psi × 6.895 10^{-3} = 561.85 MPa

CRACKING

Visual: NO — Crack Mode:
Low Power (30X): NO — Max. Crack Depth: mm
Metallographic: — Crack Velocity: mm/sec

Comments: Controller #1236 TC #1670

QA APPROVED
NAME: Cedum
DATE: 6-18-08

Project Leader's Signature: 6/5/08 — Date:

Test Sheet Addendum

Test #	1196-61
Sample #	SSR 1196-61
Filar Eye Piece	CCT # 0224
Magnification	30X
inches/graduation	.001

Readings

90
12
78

Avg. Reading, graduations	*	inches/ graduation	=	Final Diameter, in.
78		.001		.078

Comments

Slow Strain Rate
Work Request/Test Information Form

Person Performing Test: Joe Gerst
Home Phone: 740 548 7747
Special Hazards: Caustic
Project Name: ARES 2008
Filled cell
Start (Date/Time): 1510 5-12-08
Finish (Date/Time):
Project Number: 81170135

TEST PARAMETERS

Material: AART128 Grade B
Test #: 1196-62
SSR System #: 2
Material ID#: 1196
Extension Rate: 1E-6 in/sec
RPM: 174
Sample #: SSR 1196-62
Strain Rate: 1E-6 sec^{-1}

DATA ACQUISITION

Data File Name: 1196-62.DAT
Strip Chart Scale:
Data Acquisition Computer #: 3
Data Channels: 15+16
Strip Chart Speed:
LVDT or Dial Gauge ID#: 434

SAMPLE ENVIRONMENT

Evaporated Supernate Tracking #95
Test Solution: A2 10
Gas: None
Reference Electrode: SCE
Initial pH: 14.0
Temperature: 50 °C
Free Corrosion Potential: -333 mV
Final pH: 14+
Pressure: Room
Applied Potential: FCP mV

SPECIMEN DIMENSIONS

Initial		*Final*
Overall Length: 8.0 in.	Measurement Device: Calipers	Overall Length: 8.2 in.
Gauge Mark Length: 1.689 in.	Device ID #: 1497	Gauge Mark Distance: 1.933 in.
Gauge Diameter: .124 in.		Gauge Diameter: .077 in.
Cross Sectional Area: .012076 $in.^2$	Machined Gauge Length: 1.000 in.	Cross Sectional Area: .004657 $in.^2$

RESULTS & CALCULATIONS

Pre-Load: 75 lbs.
Max. Load 993 lbs.
Time to Failure: 64.67 hrs.
Elongation = 1.933 - 1.689 in.
Reduction in Area: .012076 - .004657 $in.^2$
Time to Failure: 232813 sec.

$$\%\ \text{Elongation} = \frac{\text{Elongation}}{\text{Machined Gage Length}} = \frac{(.244)}{(1.000)} \times 100 = 24.4\ \%$$

$$\%\ \text{Reduction} = \frac{\text{Reduction in Area}}{\text{Initial Cross Section Area}} \frac{(.007419)}{(.012076)} \times 100 = 61.44\%$$

$$\text{UTS} = \frac{\text{Max. Load}}{\text{Initial Cross Section Area}} = \frac{(993)}{(.012076)} = 82227\ \text{psi}$$

82227 psi x 6.895 10^{-4} = 566.96 MPa

CRACKING

Visual: NO
Crack Mode:
Low Power (30X): NO
Max. Crack Depth: mm
Metallographic:
Crack Velocity: mm/sec

Comments: Controller #1236 TC #1670

QA APPROVED
NAME:
DATE: 6-9-08

Project Leader's Signature: (6/5/08)
Date:

Test Sheet Addendum

Test #	1196-62
Sample #	SSR 1196-62
Filar Eye Piece	CCT # 0224
Magnification	30X
Inches/graduation	.001

Readings

87
10
77

Avg. Reading, graduations	*	inches/ graduation	=	Final Diameter, in.
77		.001		.077

Comments

Slow Strain Rate
Work Request/Test Information Form

Person Performing Test: Joe Gerst — Home Phone: 7405487747
Special Hazards: Caustic — Project Name: ARES
Start (Date/Time): 5-14-08 1:45 — Finish (Date/Time): Take Down 5-19-08 710 — Project Number: 61170135

TEST PARAMETERS

Material: AART 128 Grade B — Test #: 1196-63 — SSR System #: 5
Material ID#: 1196 — Extension Rate: 1E-6 in/sec — RPM: 694
Sample #: SSR 1196-63 — Strain Rate: 1E-6 sec^{-1}

DATA ACQUISITION

Data File Name: 1196-63.DAT — Strip Chart Scale: — — Data Acquisition Computer #: 10
Data Channels: 9 + 16 — Strip Chart Speed: — — LVDT or Dial Gauge ID#: 1209

SAMPLE ENVIRONMENT

Tracking 96
Test Solution: AP105 — Gas: None — Reference Electrode: SCE
Initial pH: 13.5 — Temperature: 50°C — Free Corrosion Potential: -300 mV
Final pH: 13+ — Pressure: Room — Applied Potential: FCP mV

SPECIMEN DIMENSIONS

Initial		*Final*
Overall Length: 8.0 in.	Measurement Device: Calipers	Overall Length: 8.2 in.
Gauge Mark Length: 1.656 in.	Device ID #: 1497	Gauge Mark Distance: 1.897 in.
Gauge Diameter: .124 in.		Gauge Diameter: .077 in.
Cross Sectional Area: .012076 $in.^2$	Machined Gauge Length: 1.000 in.	Cross Sectional Area: .004657 $in.^2$

RESULTS & CALCULATIONS

Pre-Load: 75 lbs. — Max. Load 996 lbs. — Time to Failure: 64.33 hrs.
Elongation = 1.897 − 1.656 in. — Reduction in Area: .012076 − .004657 $in.^2$ — Time to Failure: 23159.5 sec.

$$\% \text{ Elongation} = \frac{\text{Elongation}}{\text{Machined Gage Length}} = \frac{(.241)}{(1.000)} \times 100 = 24.1\ \%$$

$$\%\text{Reduction} = \frac{\text{Reduction in Area}}{\text{Initial Cross Section Area}} = \frac{(.007419)}{(.012076)} \times 100 = 61.44\%$$

$$\text{UTS} = \frac{\text{Max. Load}}{\text{Initial Cross Section Area}} = \frac{(996)}{(.012076)} = 82476\ \text{psi}$$

82476 psi × 6.895 10^{-3} = 568.67 MPa

CRACKING

Visual: NO — Crack Mode:
Low Power (30X): NO — Max. Crack Depth: mm
Metallographic: — Crack Velocity: mm/sec

Comments: TController #1264 TC#1301

QA APPROVED
NAME: Adam
DATE: 6-18-08

Project Leader's Signature: 6/5/08 — Date:

Test Sheet Addendum

		Readings
Test #	1196-63	84
Sample #	SSR 1196-63	7
Filar Eye Piece	CCT # 0224	77
Magnification	30X	
inches/graduation	.001	

Avg. Reading, graduations	*	inches/ graduation	=	Final Diameter, in.
77		.001		.077

Comments

Slow Strain Rate
Work Request/Test Information Form

Person Performing Test: Joe Gerst
Home Phone: 7405487747
Special Hazards: Caustic
Project Name: ARES
Start (Date/Time): 5-16-08 11:25 Filled cell
Finish (Date/Time): 5-19-08 7:20 TAKE DOWN
Project Number: 81170135

TEST PARAMETERS

Material: AART 128 Grade B
Test #: 1196-64
SSR System #: 2
Material ID#: 1196
Extension Rate: 1E-6 in/sec
RPM: 174
Sample #: SSR 1196-64
Strain Rate: 1E-6 sec^{-1}

DATA ACQUISITION

Data File Name: 1196-64
Strip Chart Scale: —
Data Acquisition Computer #: 3
Data Channels: 15+16
Strip Chart Speed: —
LVDT or Dial Gauge ID#: 434

SAMPLE ENVIRONMENT

Test Solution: Tracking 89 AP105 mixed
Gas: NONE
Reference Electrode: SCE
Initial pH: 13+
Temperature: 50°C
Free Corrosion Potential: -324 mV
Final pH: 13+
Pressure: Room
Applied Potential: FCP mV

SPECIMEN DIMENSIONS

Initial		*Final*
Overall Length: 8.0 in.	Measurement Device: Calipers	Overall Length: 8.2 in.
Gauge Mark Length: 1.660 in.	Device ID #: 1497	Gauge Mark Distance: 1.876 in.
Gauge Diameter: .124 in.		Gauge Diameter: .076 in.
Cross Sectional Area: .012076 $in.^2$	Machined Gauge Length: 1.000 in.	Cross Sectional Area: .004537 $in.^2$

RESULTS & CALCULATIONS

Pre-Load: 75 lbs.
Max. Load 989 lbs.
Time to Failure: 60.27 hrs.
Elongation = 1.876 - 1.660 in.
Reduction in Area: .012076 - .004537 $in.^2$
Time to Failure: 216966 sec.

$$\%\,\text{Elongation} = \frac{\text{Elongation}}{\text{Machined Gage Length}} = \frac{(.216)}{(1.000)} \times 100 = 21.6\,\%$$

$$\%\,\text{Reduction} = \frac{\text{Reduction in Area}}{\text{Initial Cross Section Area}} = \frac{(.007540)}{(.012076)} \times 100 = 62.43\,\%$$

$$\text{UTS} = \frac{\text{Max. Load}}{\text{Initial Cross Section Area}} = \frac{(989)}{(.012076)} = 81896\ \text{psi}$$

81896 psi × 6.895 10^{-3} = 564.67 MPa

CRACKING

Visual: NO
Crack Mode:
Low Power (30X): NO
Max. Crack Depth: mm
Metallographic:
Crack Velocity: mm/sec

Comments: T Controller #1236 TC #1670

QA APPROVED
NAME: cdunn
DATE: 6-18-08

Project Leader's Signature:

Test Sheet Addendum

Test #	1196-64	Readings				
Sample #	SSR 1196-64	91				
Filar Eye Piece	CCT # 0224	15				
		76				
Magnification	30X					
inches/graduation	.001	Avg. Reading, graduations	*	inches/ graduation	=	Final Diameter, in.
		JH .00 76		.001		.076

Comments

Slow Strain Rate
Work Request/Test Information Form

Person Performing Test: Joe Gest | Home Phone: 7405487747
Special Hazards: Caustic | Project Name: ARES
Start (Date/Time): Filled cell 5-28-07 11:00 | Finish (Date/Time): | Project Number: 8170135

TEST PARAMETERS

Material: AART 128 Grade B | Test #: 1196-65 | SSR System #: 2
Material ID#: 1196 | Extension Rate: 1E-6 in/sec | RPM: 174
Sample #: SSR 1196-65 | Strain Rate: 1E-6 sec^{-1}

DATA ACQUISITION

Data File Name: 1196-65.DAT | Strip Chart Scale: — | Data Acquisition Computer #: 3
Data Channels: 15 + 16 | Strip Chart Speed: — | LVDT or Dial Gauge ID#: 434

SAMPLE ENVIRONMENT

Tracking 90
Test Solution: AP105 PSC | Gas: None | Reference Electrode: SCE
Initial pH: 13.01 | Temperature: 50 °C | Free Corrosion Potential: -281 mV
Final pH: 13 + | Pressure: Room | Applied Potential: -250 mV

SPECIMEN DIMENSIONS

	Initial		Final (measured with calipers)
Overall Length:	8.0 in.	Measurement Device: Calipers	Overall Length: 8.2 in.
Gauge Mark Length:	1.760 in.	Device ID #: 1497	Gauge Mark Distance: 1.888 in.
Gauge Diameter:	.1245 in.		Gauge Diameter: .1175 in.
Cross Sectional Area:	.012174 $in.^2$	Machined Gauge Length: 1.000 in.	Cross Sectional Area: .010844 $in.^2$

RESULTS & CALCULATIONS

Pre-Load: 75 lbs. | Max. Load 985 lbs. | Time to Failure: RAN 41.69 hrs.
Elongation = 1.888 - 1.760 in. | Reduction in Area: .012174 - .010844 $in.^2$ | Time to Failure: RA~ 150072 sec.

$$\%\,\text{Elongation} = \frac{\text{Elongation}}{\text{Machined Gage Length}} = \frac{(.128)}{(1.000)} \times 100 = 12.8\,\%$$

$$\%\,\text{Reduction} = \frac{\text{Reduction in Area}}{\text{Initial Cross Section Area}} = \frac{(.001310)}{(.012174)} \times 100 = 10.92\,\%$$

$$\text{UTS} = \frac{\text{Max. Load}}{\text{Initial Cross Section Area}} = \frac{(985)}{(.012174)} = 80911\ \text{psi}$$

80911 psi × 6.895 10^{-3} = 557.88 MPa

CRACKING

Visual: NO | Crack Mode:
Low Power (30X): NO | Max. Crack Depth: mm
Metallographic: | Crack Velocity: mm/sec

Comments: Tcontroller 1325 TC 1301 PSTAT 2115
2000 Ω Resistor
Stopped AT 7:30 A.M. 985 lbs -250

QA APPROVED
NAME: Cesar
DATE: 6-18-07

Project Leader's Signature: 6/5/08 | Date:

Slow Strain Rate
Work Request/Test Information Form

Person Performing Test: Joe Gest — Home Phone: 740 548 7747
Special Hazards: Caustic — Project Name: ARES
Filled cell — TAKE DOWN
Start (Date/Time): 6-3-08 230 — Finish (Date/Time): 6-6-08 — Project Number: 81170135

TEST PARAMETERS

Material: AART 128 Grade B — Test #: 1196-66 — SSR System #: 2
Material ID#: 1196 — Extension Rate: 1E-6 in/sec — RPM: 174
Sample #: SSR 1196-66 — Strain Rate: 1E-6 sec^{-1}

DATA ACQUISITION

Data File Name: 1196-66.DAT — Strip Chart Scale: — — Data Acquisition Computer #: 3
Data Channels: 15+16 — Strip Chart Speed: — — LVDT or Dial Gauge ID#: 434
Tracking 97

SAMPLE ENVIRONMENT

Test Solution: AW105 Supernate — Gas: None — Reference Electrode: SCE
Initial pH: 13 + — Temperature: 50°C — Free Corrosion Potential: -235 mV
Final pH: 13 + — Pressure: Room — Applied Potential: — mV

	Initial		Final
Overall Length:	8.0 in.	Measurement Device: Calipers	Overall Length: 8.2 in.
Gauge Mark Length:	1.672 in.	Device ID #: 1497	Gauge Mark Distance: 1.885 in.
Gauge Diameter:	.1245 in.		Gauge Diameter: .377 in.
Cross Sectional Area:	.012174 $in.^2$	Machined Gauge Length: 1.000 in.	Cross Sectional Area: .004657 $in.^2$

RESULTS & CALCULATIONS

Pre-Load: 75 lbs. — Max. Load 987 lbs. — Time to Failure: 61.87 hrs.
Elongation = 1.885 - 1.672 in. — Reduction in Area: .012174 - .004657 $in.^2$ — Time to Failure: 222716 sec.

$$\%\ \text{Elongation} = \frac{\text{Elongation}}{\text{Machined Gage Length}} = \frac{(.213)}{(1.000)} \times 100 = 21.3\ \%$$

$$\%\ \text{Reduction} = \frac{\text{Reduction in Area}}{\text{Initial Cross Section Area}} \frac{(.007517)}{(.012174)} \times 100 = 61.75\ \%$$

$$\text{UTS} = \frac{\text{Max. Load}}{\text{Initial Cross Section Area}} = \frac{(987)}{(.012174)} = 81075\ \text{psi} \qquad 81075\ \text{psi} \times 6.895\ 10^{-3} = 559.01\ \text{MPa}$$

QA APPROVED
CRACKING
NAME: Odum
DATE: 8-20-08

Visual: NO — Crack Mode:
Low Power (30X): 2 — Max. Crack Depth: mm
Metallographic: — Crack Velocity: mm/sec

Comments: Tcontroller 1325 TC 1670

Project Leader's Signature: — Date: 8/4/08

Test Sheet Addendum

		Readings
Test #	1196-66	88
Sample #	SSR 1196-66	11
Filar Eye Piece	CCT # 0224	77
Magnification	30 X	
inches/graduation	.001	

Avg. Reading, graduations	*	inches/ graduation	= Final Diameter, in.
77		.001	.077

Comments

Slow Strain Rate
Work Request/Test Information Form

Person Performing Test: Joe Geist — Home Phone: 740 548 7747
Special Hazards: Caustic — Project Name: ARES
Start (Date/Time): 6-4-08 810 (Filled cell) — Finish (Date/Time): 6-7-08 6:30 AM (TAKEDOWN) — Project Number: 81170135

TEST PARAMETERS

Material: AART128 Grade B — Test #: 1196-67 — SSR System #: 4
Material ID#: 1196 — Extension Rate: 1E-6 in/sec — RPM: 694
Sample #: SSR 1196-67 — Strain Rate: 1E-6 sec^{-1}

DATA ACQUISITION

Data File Name: 1196-67.DAT — Strip Chart Scale: — — Data Acquisition Computer #: 11
Data Channels: 11 + 12 — Strip Chart Speed: — — LVDT or Dial Gauge ID#: 1219

SAMPLE ENVIRONMENT

Tracking 98
Test Solution: SY 101 — Gas: None — Reference Electrode: SCE
Initial pH: 13+ — Temperature: 50 °C — Free Corrosion Potential: -206 mV
Final pH: 13+ — Pressure: Room — Applied Potential: — mV

SPECIMEN DIMENSIONS

Initial		Final
Overall Length: 8.0 in.	Measurement Device: Calipers	Overall Length: 8.2 in.
Gauge Mark Length: 1.676 in.	Device ID #: 1497	Gauge Mark Distance: 1.900 in.
Gauge Diameter: .1245 in.		Gauge Diameter: .075 in.
Cross Sectional Area: .012174 in.^{2}	Machined Gauge Length: 1.000 in.	Cross Sectional Area: .004418 in.^{2}

RESULTS & CALCULATIONS

Pre-Load: 75 lbs. — Max. Load 1000 lbs. — Time to Failure: 63.70 hrs.
Elongation = 1.900 − 1.676 in. — Reduction in Area: .012174 − .004418 in.^{2} — Time to Failure: 229328 sec.

$$\%\,\text{Elongation} = \frac{\text{Elongation}}{\text{Machined Gage Length}} = \frac{(.224)}{(1.000)} \times 100 = 22.4\,\%$$

$$\%\,\text{Reduction} = \frac{\text{Reduction in Area}}{\text{Initial Cross Section Area}} \frac{(.007756)}{(.012174)} \times 100 = 63.71\,\%$$

$$\text{UTS} = \frac{\text{Max. Load}}{\text{Initial Cross Section Area}} = \frac{(1000)}{(.012174)} = 82143\ \text{psi} \qquad 82143\ \text{psi} \times 6.895 \times 10^{-3} = 566.38\ \text{MPa}$$

QA APPROVED for Reporting
NAME: Coburn
DATE: 8-20-08

Visual: NO — Crack Mode:
Low Power (30X): ? — Max. Crack Depth: mm
Metallographic: — Crack Velocity: mm/sec

Comments: Temp Controller 1260 TC 1538

Project Leader's Signature: — Date: 8/4/08

Test Sheet Addendum

Test #	1196-67	Readings			
Sample #	SSR 1196-67	77			
~~Filar Eye Piece~~	~~CCT # 0224~~	2			
		75			
Magnification	30X				
inches/graduation	.001	Avg. Reading, graduations	*	inches/ graduation	= Final Diameter, in.
		75		.001	.075

Comments

Slow Strain Rate
Work Request/Test Information Form

Person Performing Test: MIKE LANDERS / Joe Gerst — Home Phone: 616-443-8620
Special Hazards: ~~Elevated~~ — Project Name: ARES 2008
Start (Date/Time): 6-10-08 — Finish (Date/Time): 6-13-08 — Project Number: 81170135
Failed early 10:30

TEST PARAMETERS

Material: AART 128 Grade B — Test #: 1196-68 — SSR System #: 4
Material ID#: 1196 — Extension Rate: 1E-6 in/sec — RPM: 1.94
Sample #: SSR 1196-68 — Strain Rate: 1E-6 sec^{-1}

DATA ACQUISITION

Data File Name: 1196-68 — Strip Chart Scale: — Data Acquisition Computer #: 11
Data Channels: 11 + R — Strip Chart Speed: — LVDT or Dial Gauge ID#: 1014
Tracking 94

SAMPLE ENVIRONMENT

Test Solution: A4101 CSL — Gas: None — Reference Electrode: SCE
Initial pH: 11.89 — Temperature: 50°C = 122°F — Free Corrosion Potential: -180 mV
Final pH: 12.09 — Pressure: Room — Applied Potential: — mV

SPECIMEN DIMENSIONS

	Initial		Final
Overall Length:	8.0 in.	Measurement Device: Calipers	Overall Length: 8.2 in.
Gauge Mark Length:	1.6340 in.	Device ID #: 1497	Gauge Mark Distance: 1.860 in.
Gauge Diameter:	.124 in.		Gauge Diameter: .077 in.
Cross Sectional Area:	.012076 $in.^2$	Machined Gauge Length: 1.000 in.	Cross Sectional Area: .004657 $in.^2$

RESULTS & CALCULATIONS

Pre-Load: 75 lbs. — Max. Load 1004 lbs. — Time to Failure: *64.00 hrs.
Elongation = 1.860 − 1.634 in. — Reduction in Area: .012076 − .004657 $in.^2$ — Time to Failure: 230402 sec.

$$\%\,\text{Elongation} = \frac{\text{Elongation}}{\text{Machined Gage Length}} = \frac{(.226)}{(1.000)} \times 100 = 22.6\,\%$$

$$\%\,\text{Reduction} = \frac{\text{Reduction in Area}}{\text{Initial Cross Section Area}} \quad \frac{(.007419)}{(.012076)} \times 100 = \frac{61.44}{\cancel{83138}\,\%}$$

$$\text{UTS} = \frac{\text{Max. Load}}{\text{Initial Cross Section Area}} = \frac{(1004)}{(.012076)} = 83138\ \text{psi}$$

83138 psi × 6.895 10^{-3} = 573.24 MPa

Visual: No — **QA APPROVED** — Crack Mode:
Low Power (30X): 2 — NAME: Cadm — Max. Crack Depth: mm
Metallographic: — DATE: 8-20-08 — Crack Velocity: mm/sec

Comments: TController 1260 TC 1670
*Machine stopped For 1.335 hrs At 44.636 hr

Project Leader's Signature: — Date: 8/9/08

Test Sheet Addendum

Test #	1196-68	Readings				
Sample #	SSR 1196-68	94				
~~Filar Eye Piece~~	~~CCT # 0224~~	17				
		77				
Magnification	30X					
inches/graduation	.001	Avg. Reading, graduations	*	inches/ graduation	=	Final Diameter, in.
		77		.001		.077

Comments

Slow Strain Rate
Work Request/Test Information Form

Person Performing Test: Joe Gerst — Home Phone: 740 548 7747
Special Hazards: CAUSTIC — Project Name: ARES
Start (Date/Time): 7:45 6-17-08 — Finish (Date/Time): TAKE DOWN 7-20-08 — Project Number: 811 70135

Filled cell

TEST PARAMETERS

Material: AART 128 Grade B — Test #: 1196-69 — SSR System #: 4
Material ID#: 1196 — Extension Rate: 1E-6 in/sec — RPM: 694
Sample #: SSR 1196-69 — Strain Rate: 1E-6 sec^{-1}

DATA ACQUISITION

Data File Name: 1196-69.DAT — Strip Chart Scale: — — Data Acquisition Computer #: 11
Data Channels: 11 + 12 — Strip Chart Speed: — — LVDT or Dial Gauge ID#: 1219

Tracking 100

SAMPLE ENVIRONMENT

Test Solution: AY101 CSL — Gas: None — Reference Electrode: SCE
Initial pH: 11.82 — Temperature: 50°C — Free Corrosion Potential: -782 mV
Final pH: 12.16 — Pressure: Room — Applied Potential: FCP mV

SPECIMEN DIMENSIONS

	Initial	Measurement Device: Calipers	*Final*
Overall Length:	8.0 in.		8.2 in.
Gauge Mark Length:	1.656 in.	Device ID #: 1497	Gauge Mark Distance: 1.960 in.
Gauge Diameter:	.1245 in.		Gauge Diameter: .075 in.
Cross Sectional Area:	.012174 $in.^2$	Machined Gauge Length: 1.000 in.	Cross Sectional Area: .004418 $in.^2$

RESULTS & CALCULATIONS

Pre-Load: 75 lbs. — Max. Load 988 lbs. — Time to Failure: 59.95 hrs.
Elongation = 1.860 - 1.656 in. — Reduction in Area: .012174 - .004418 $in.^2$ — Time to Failure: 215807 sec.

$$\%\,\text{Elongation} = \frac{\text{Elongation}}{\text{Machined Gage Length}} = \frac{(.204)}{(1.000)} \times 100 = 20.4\%$$

$$\%\,\text{Reduction} = \frac{\text{Reduction in Area}}{\text{Initial Cross Section Area}} = \frac{(.007756)}{(.012174)} \times 100 = 63.7\%$$

$$\text{UTS} = \frac{\text{Max. Load}}{\text{Initial Cross Section Area}} = \frac{(988)}{(.012174)} = 81157 \text{ psi}$$

81157 psi x 6.895 10^{-3} = 559.58 MPa

QA APPROVED
NAME: Clawn
DATE: 8-20-08

Visual: None — Crack Mode:
Low Power (30X): ? — Max. Crack Depth: mm
Metallographic: — Crack Velocity: mm/sec

Comments: T Controller 1264 TC 1538

Project Leader's Signature: — Date: 8/4/08

Test Sheet Addendum

Test #	1196-69	Readings				
Sample #	SSR 1196-69	78				
Filar Eye Piece	CCT # 0224	3				
		75				
Magnification	30X					
inches/graduation	.001	Avg. Reading, graduations	*	inches/ graduation	=	Final Diameter, in.
		75		.001		.075

Comments

Slow Strain Rate
Work Request/Test Information Form

Person Performing Test: Joe Gerst — Home Phone: 740 548 7747
Special Hazards: Caust. C — Project Name: ARES
Start (Date/Time): Filled cell 9:50 7-9 — Finish (Date/Time): TAKEDOWN 7-13-08 9:00 — Project Number: 81170135

TEST PARAMETERS

Material: AART 128 Grade B — Test #: 1196-70 — SSR System #: 2
Material ID#: 1196 — Extension Rate: 1E-6 in/sec — RPM: 173
Sample #: SSR 1196-70 — Strain Rate: 1E-6 sec^{-1}

DATA ACQUISITION

Data File Name: 1196-70.DAT — Strip Chart Scale: — — Data Acquisition Computer #: 3
Data Channels: 15 + 16 — Strip Chart Speed: — — LVDT or Dial Gauge ID#: 434

SAMPLE ENVIRONMENT

Test Solution: Tracking 102 AW105 Supernate — Gas: None — Reference Electrode: SCE
Initial pH: 13.17 — Temperature: 50 °C — Free Corrosion Potential: -269 mV
Final pH: 13+ — Pressure: Room — Applied Potential: -100 mV

SPECIMEN DIMENSIONS

Initial		*Final*
Overall Length: 8.0 in.	Measurement Device: Calipers	Overall Length: 8.2 in.
Gauge Mark Length: 1.733 in.	Device ID #: 1497	Gauge Mark Distance: 1.953 in.
Gauge Diameter: .124 in.		Gauge Diameter: .077 in.
Cross Sectional Area: .012076 $in.^2$	Machined Gauge Length: 1.000 in.	Cross Sectional Area: .004657 $in.^2$

RESULTS & CALCULATIONS

Pre-Load: 75 lbs. — Max. Load: 1074 lbs. — Time to Failure: 67.78 hrs.
Elongation = 1.953 − 1.733 in. — Reduction in Area: .012076 − .004657 $in.^2$ — Time to Failure: 244019 sec.

$$\%\,\text{Elongation} = \frac{\text{Elongation}}{\text{Machined Gage Length}} = \frac{(.220)}{(1.000)} \times 100 = 22.0\ \%$$

$$\%\,\text{Reduction} = \frac{\text{Reduction in Area}}{\text{Initial Cross Section Area}} \frac{(.007419)}{(.012076)} \times 100 = 61.44\%$$

$$\text{UTS} = \frac{\text{Max. Load}}{\text{Initial Cross Section Area}} = \frac{(1074)}{(.012076)} = 89348\ \text{psi}$$

89348 psi × 6.895 10^{-3} = 616.06 MPa

GRADING

QA APPROVED
NAME: Odum
DATE: 8-20-08

Visual: No — Crack Mode:
Low Power (30X): No — Max. Crack Depth: mm
Metallographic: — Crack Velocity: mm/sec

Comments: 1000 Ω T Controller 1325 PSTAT 2115 TC 1670
Bad Test did not Analyze
Temperature control failure CS.

Project Leader's Signature: Cliff. — Date: 8/4/08

Test Sheet Addendum

Test #	1196-70
Sample #	SSR 1196-70
Filar Eye Piece	CCT # 0224
Magnification	30X
inches/graduation	.001

Readings
79
2
77

Avg. Reading, graduations	*	inches/ graduation	=	Final Diameter, in.
77		.001		.077

Comments

Slow Strain Rate
Work Request/Test Information Form

Person Performing Test: Joe Gerst — Home Phone: 740 548 7747
Special Hazards: Caustic — Project Name: ARES
Filled cell — Start (Date/Time): 7-14 11:10 — Finish (Date/Time): TAKE DOWN 7-17 — Project Number: 51170135

TEST PARAMETERS

Material: AART 128 Grade B / ja1196 — Test #: 1196-71 — SSR System #: 2
Material ID#: 1196 — Extension Rate: 1E-6 in/sec — RPM: 174
Sample #: SSR 1196-71 — Strain Rate: 1E-6 sec^{-1}

DATA ACQUISITION

Data File Name: 1196-71.DAT — Strip Chart Scale: — Data Acquisition Computer #: 3
Data Channels: 15 & 16 — Strip Chart Speed: — LVDT or Dial Gauge ID#: 434

SAMPLE ENVIRONMENT

Test Solution: Tracking 102 AW105 Supernat — Gas: None — Reference Electrode: SCE
Initial pH: 13.17 — Temperature: 50 °C — Free Corrosion Potential: -362 mV
Final pH: 13.41 — Pressure: Room — Applied Potential: -100 mV

SPECIMEN DIMENSIONS

Initial		*Final*
Overall Length: 8.0 in.	Measurement Device: Calipers	Overall Length: 8.2 in.
Gauge Mark Length: 1.665 in.	Device ID #: 1497	Gauge Mark Distance: 1.895 in.
Gauge Diameter: .1245 in.		Gauge Diameter: .078 in.
Cross Sectional Area: .012174 $in.^2$	Machined Gauge Length: 1.000 in.	Cross Sectional Area: .004779 $in.^2$

RESULTS & CALCULATIONS

Pre-Load: 75 lbs. — Max. Load: 1006 lbs. — Time to Failure: 65.08 hrs.
Elongation = 1.895 - 1.665 in. — Reduction in Area: .007395 $in.^2$ — Time to Failure: 234298 sec.

$$\%\ \text{Elongation} = \frac{\text{Elongation}}{\text{Machined Gage Length}} = \frac{(.230)}{(1.000)} \times 100 = 23.0\%$$

$$\%\ \text{Reduction} = \frac{\text{Reduction in Area}}{\text{Initial Cross Section Area}} \quad \frac{(.007395)}{(.012174)} \times 100 = 60.75\%$$

$$\text{UTS} = \frac{\text{Max. Load}}{\text{Initial Cross Section Area}} = \frac{(1650\,8)}{(1006)} = 82636\ \text{psi}$$

82636 psi × 6.895 10^{-3} = 569.77 MPa

Visual: No — **QA APPROVED** — Crack Mode:
Low Power (30X): No — NAME: Cladius — Max. Crack Depth: mm
Metallographic: — DATE: 8-20-08 — Crack Velocity: mm/sec

Comments: 1000 Ω PSTAT 2115 TeoTroller 1325 TC 1670

Project Leader's Signature: — Date: 8/4/08

Test Sheet Addendum

Test #	1196-71
Sample #	SSR 1196-71
Filar Eye Piece	CCT # 0224
Magnification	30X
inches/graduation	.001

Readings
81
3
78

Avg. Reading, graduations	*	inches/ graduation	= Final Diameter, in.
78		.001	.078

Comments

Slow Strain Rate
Work Request/Test Information Form

Person Performing Test: Joe Gerst — Home Phone: 740 548 7747
Special Hazards: CAUSTIC — Project Name: ARES
Filled cell Start (Date/Time): 7-22-08 9:00 — Take Down Finish (Date/Time): 7-25-08 2:10 — Project Number: 81170135

TEST PARAMETERS

Material: AART 128 Grade B — Test #: 1196-72 — SSR System #: 2
Material ID#: 1196 — Extension Rate: 1E-6 in/sec — RPM: 174
Sample #: SSR 1196-72 — Strain Rate: 1E-6 sec^{-1}

DATA ACQUISITION

Data File Name: 1196-72.DAT — Strip Chart Scale: — — Data Acquisition Computer #: 3
Data Channels: 15 + 16 — Strip Chart Speed: — — LVDT or Dial Gauge ID#: 434

SAMPLE ENVIRONMENT

Test Solution: Tracking #102 AW105 Supernate — Gas: None — Reference Electrode: SCE
Initial pH: 13.7 — Temperature: HTR 50°C — Free Corrosion Potential: -210 mV
Final pH: 13.37 — Pressure: Room — Applied Potential: -50 mV

SPECIMEN DIMENSIONS

Initial		*Final*
Overall Length: 8.0 in.	Measurement Device: Calipers	Overall Length: 9.2 in.
Gauge Mark Length: 1.637 in.	Device ID #: 1497	Gauge Mark Distance: 1.862 in.
Gauge Diameter: 0.125 in.		Gauge Diameter: .077 in.
Cross Sectional Area: .012272 $in.^2$	Machined Gauge Length: 1.000 in.	Cross Sectional Area: .004657 $in.^2$

RESULTS & CALCULATIONS

Pre-Load: 75 lbs. — Max. Load 977 lbs. — Time to Failure: 60.79 hrs.
Elongation = 1.862 - 1.637 in. — Reduction in Area: .007518 (615) $in.^2$ — Time to Failure: 218846 sec.

$$\%\ \text{Elongation} = \frac{\text{Elongation}}{\text{Machined Gage Length}} = \frac{(.225)}{(1.000)} \times 100 = 22.5\ \%$$

$$\%\ \text{Reduction} = \frac{\text{Reduction in Area}}{\text{Initial Cross Section Area}} \quad \frac{(.007518)\ (615)}{(.012272)} \times 100 = 62.05\ \%$$

$$\text{UTS} = \frac{\text{Max. Load}}{\text{Initial Cross Section Area}} = \frac{(977)}{(.012272)} = 79613\ \text{psi} \qquad 79613\ \text{psi} \times 6.895 \times 10^{-3} = 548.93\ \text{MPa}$$

Visual: NO — Discoloration: **QA APPROVED** — Crack Mode:
Low Power (30X): 2 — NAME: Odum — Max. Crack Depth: mm
Metallographic: — DATE: 8-20-08 — Crack Velocity: mm/sec

Comments: 1000 Ω Resistor ISTAT #2115 Controller #1325 TC

Project Leader's Signature: Cliff — Date: 8/4/08

Test Sheet Addendum

Test #	1196-72	**Readings**	
Sample #	SSR 1196-72	82	
Filar Eye Piece	CCT # 0224	5	
		77	
Magnification	30X		
Inches/graduation	.001		

Avg. Reading, graduations	*	inches/ graduation	=	Final Diameter, in.
77		.001		.077

Comments

Slow Strain Rate
Work Request/Test Information Form

Person Performing Test: Joe Gerst — Home Phone: 740 548 7747
Special Hazards: CAUSTIC — Project Name: ARES 2008
Filled cell
Start (Date/Time): 7-25-08 830 — Finish (Date/Time): TAKE DOWN 7-28 7:00 — Project Number: 81170135

TEST PARAMETERS

Material: AART 128 Grade B — Test #: 1196-73, — SSR System #: 2
Material ID#: 1196 — Extension Rate: 1E-6 in/sec — RPM: 174
Sample #: SSR 1196-73 — Strain Rate: 1E-6 sec^{-1}

DATA ACQUISITION

Data File Name: 1196-73.DAT — Strip Chart Scale: — Data Acquisition Computer #: 3
Data Channels: 15+16 — Strip Chart Speed: — LVDT or Dial Gauge ID#: 434

SAMPLE ENVIRONMENT

TRACKING 103 .032M NITRITE
Test Solution: J13-3 AW105 SUPERNATE — Gas: NONE — Reference Electrode: SCE
Initial pH: 13.32 — Temperature: 50°C — Free Corrosion Potential: -717 mV
Final pH: 13+ — Pressure: Room — Applied Potential: -100 mV

SPECIMEN DIMENSIONS

	Initial	Measurement Device: Calipers	*Final*
Overall Length:	8.0 in.		8.2 in.
Gauge Mark Length:	1.634 in.	Device ID #: 1497	Gauge Mark Distance: 1.835 in.
Gauge Diameter:	.127 in.		Gauge Diameter: .077 in.
Cross Sectional Area:	.012668 in.^{2}	Machined Gauge Length: 1.000 in.	Cross Sectional Area: .004657 in.^{2}

RESULTS & CALCULATIONS

Pre-Load: 75 lbs. — Max. Load 1010 lbs. — Time to Failure: 62.43 hrs.
Elongation = 1.835 - 1.634 in. — Reduction in Area: .012668 - .004657 in.^{2} — Time to Failure: 224741 sec.

$$\%\,\text{Elongation} = \frac{\text{Elongation}}{\text{Machined Gage Length}} = \frac{(.201)}{(1.000)} \times 100 = 20.1\,\%$$

$$\%\,\text{Reduction} = \frac{\text{Reduction in Area}}{\text{Initial Cross Section Area}} \quad \frac{(.008011)}{(.012668)} \times 100 = 63.24\%$$

$$\text{UTS} = \frac{\text{Max. Load}}{\text{Initial Cross Section Area}} = \frac{(1010)}{(.012668)} = 79730 \text{ psi} \qquad 79730 \text{ psi} \times 6.895\ 10^{-3} = 549.74 \text{ MPa}$$

CRACKING

Visual: — **QA APPROVED** — Crack Mode:
Low Power (30X): — NAME: C Scott — Max. Crack Depth: mm
Metallographic: — DATE: 8-20-08 — Crack Velocity: mm/sec

Comments: 1000 Ω Resistor PSTAT #2115 Controller #1325 TC 1670

Project Leader's Signature: — Date: 8/20/8

Test Sheet Addendum

Test #	1196-73
Sample #	SSR 1196-73
Filar Eye Piece	CCT # 0224
Magnification	30
inches/graduation	.001

Readings

85
8
77

Avg. Reading, graduations	*	inches/ graduation	=	Final Diameter, in.
77		.001		.077

Comments

Slow Strain Rate
Work Request/Test Information Form

Person Performing Test: Joe Gerst — Home Phone: 740 548 7747
Special Hazards: CAUSTIC — Project Name: ARES
Filled cell Start (Date/Time): 8-7-08 10:15 — Finish (Date/Time): TAKE DOWN 8-11-08 730 — Project Number: 81170135

TEST PARAMETERS

Material: AART 128 GRADE B — Test #: 1196-74 — SSR System #: 2
Material ID#: 1196 — Extension Rate: 1E-6 in/sec — RPM: 174
Sample #: SSR 1196-74 — Strain Rate: 1E-6 sec^{-1}

DATA ACQUISITION

Data File Name: 1196-74.DAT — Strip Chart Scale: — Data Acquisition Computer #: 3
Data Channels: 15+16 — Strip Chart Speed: — LVDT or Dial Gauge ID#: 434

SAMPLE ENVIRONMENT

Test Solution: AW 105 Supernate ~~500~~ gallon batch FOR TRACKING ~~105~~ 106 — Gas: None — Reference Electrode: SCE
Initial pH: 13.32 — Temperature: 50°C — Free Corrosion Potential: −257 mV
Final pH: 13+ — Pressure: Room — Applied Potential: −100 mV

SPECIMEN DIMENSIONS

Initial		*Final*
Overall Length: 8.0 in.	Measurement Device: Calipers	Overall Length: 8.2 in.
Gauge Mark Length: 1.625 in.	Device ID #: 1497	Gauge Mark Distance: 1.834 in.
Gauge Diameter: .126 in.		Gauge Diameter: .075 in.
Cross Sectional Area: .012469 $in.^2$	Machined Gauge Length: 1.000 in.	Cross Sectional Area: .004418 $in.^2$

RESULTS & CALCULATIONS

Pre-Load: 75 lbs. — Max. Load 1012 lbs. — Time to Failure: 61.28 hrs.
Elongation = 1.834 − 1.625 in. — Reduction in Area: .012469 − .004418 $in.^2$ — Time to Failure: 220620 sec.

$$\%\,\text{Elongation} = \frac{\text{Elongation}}{\text{Machined Gage Length}} = \frac{(.209)}{(1.000)} \times 100 = 20.9\,\%$$

$$\%\,\text{Reduction} = \frac{\text{Reduction in Area}}{\text{Initial Cross Section Area}} \frac{(.007971)}{(.012469)} \times 100 = 64.57\,\%$$

$$\text{UTS} = \frac{\text{Max. Load}}{\text{Initial Cross Section Area}} = \frac{(1012)}{(.012469)} = 81161\ \text{psi}$$

81161 psi × 6.895 10^{-3} = 559.61 MPa

QA APPROVED
NAME: Olsen
DATE: 8-20-08

Visual: ND — Crack Mode:
Low Power (30X): — Max. Crack Depth: mm
Metallographic: — Crack Velocity: mm/sec

Comments: 1000 Ω Resistor Tcontroller 1325 PSTAT 2115 TC 1670

Large amount of corr. material at interface and crevice corr. at fittings

Project Leader's Signature: — Date: 8/20/8

Test Sheet Addendum

Test #	1196-74
Sample #	SSR1196-74
Filar Eye Piece	CCT # 0224
Magnification	30X
inches/graduation	.001

Readings

77
2
75

Avg. Reading, graduations	*	inches/ graduation	=	Final Diameter, in.
75		.001		.075

Comments

Slow Strain Rate
Work Request/Test Information Form

Person Performing Test: MARK / JOE — Home Phone: 614-403-8620
Special Hazards: Caustic — Project Name: ARES 2008
Start (Date/Time): 1:00 8-14-08 — Finish (Date/Time): 8-15-08 4:45 — Project Number: 81170135

TEST PARAMETERS

Material: AART 128 Grade B — Test #: 1196-75 — SSR System #: 4
Material ID#: 1196 — Extension Rate: 1E-6 in/sec — RPM: 174
Sample #: SSR 1196-75 — Strain Rate: 1E-6 sec^{-1}

DATA ACQUISITION

Data File Name: 1196-75.DAT — Strip Chart Scale: — — Data Acquisition Computer #: 3
Data Channels: 15 + 16 — Strip Chart Speed: — — LVDT or Dial Gauge ID#: 434

SAMPLE ENVIRONMENT

Tracking S0703106GX
Test Solution: AW 105 Supernate — Gas: Non-P — Reference Electrode: SCE
Initial pH: 13+ — Temperature: 50 °C — Free Corrosion Potential: -770 mV
Final pH: 13+ — Pressure: Room — Applied Potential: -50 mV

SPECIMEN DIMENSIONS

Initial		*Final*
Overall Length: 8.0 in.	Measurement Device: Calipers	Overall Length: 8.1 in.
Gauge Mark Length: 1.6445 in.	Device ID #: 1497	Gauge Mark Distance: To corroded in.
Gauge Diameter: .125 in.		Gauge Diameter: To measure in.
Cross Sectional Area: .012272 $in.^2$	Machined Gauge Length: 1.000 in.	Cross Sectional Area: — $in.^2$

RESULTS & CALCULATIONS

Pre-Load: 75 lbs. — Max. Load: 782 lbs. — Time to Failure: 23.63 hrs.
D/A
Elongation = .074 in. — Reduction in Area: — $in.^2$ — Time to Failure: 85080 sec.

$$\%\,\text{Elongation} = \frac{\text{Elongation}}{\text{Machined Gage Length}} = \frac{(.074)}{(1.000)} \times 100 = 7.4\,\%$$

$$\%\,\text{Reduction} = \frac{\text{Reduction in Area}}{\text{Initial Cross Section Area}} \quad \frac{(\text{—})}{(.012272)} \times 100 = \text{—}\,\%$$

$$\text{UTS} = \frac{\text{Max. Load}}{\text{Initial Cross Section Area}} = \frac{(782)}{(.012272)} = 63723\ \text{psi}$$

$63723\ \text{psi} \times 6.895 \times 10^{-3} = 439.37\ \text{MPa}$

QA APPROVED

Visual: — NAME: Adam — Crack Mode: —
Low Power (30X): — — Max. Crack Depth: — mm
Metallographic: — DATE: 8-20-08 — Crack Velocity: — mm/sec

Comments: 100 Ω Resistor Tcontroller 1325 PSAT 2115 TC 1670
severe corrosion at break and on Lower 1/2
NO Final Diameter or ending gauge mark

Project Leader's Signature: — Date: 8/20/8

ARES AN 107 Crack Growth Testing (JR Don't need) Test # 1196 CT-17 Project Name ARES 2008

Specimen 1196 CT-17 ~~PSTAT #2115~~ Lab Computer 11 Project Number 81170135

Frame 4 Tcontroller #1325 TC # 1538 File Name 1196 CT17.DAT Run at FCP

Setup File ARES 2008

Load Cell 2181 Test Solution 5M $NaNO_3$ Starting pH 6.5 ph Paper Material AART128 Grade B

LVDT 1219 Batch 2-12-08 Ending pH 6.5 ph Paper Material ID # 1196

Date	Time	Temp. C	Load, lbs.	Disp. In	Current Amps	Pot Drop V	Control PD V	PSTAT Pot V SCE	V Drop across ~~ohm~~ Resistor, V	Specimen Isolated and All Leads Comments
2-12-08	9:00	Room	328	—	20.01	.000317	.000298	—	FCP	Dry
2-12-08	1250	50	210	.2707	19.98	.000312	.000290	—	+ 107mv	Filled cell 9:30
2-14-08	950	50	478	.2799	19.97	.000312	.000289	—	- 48	
2-15-08	400	50	671	.2843	19.96	.000311	.000289	—	+ 22	
2-18-08	655	50	1118	.2908	19.98	.000308	.000284		- 69	
2-19-08	230	50	1367	.2948	19.99	.000311	.000285	—	- 70	
2-20-08	305	50	1560	.2979	19.99	.000315	.000287	-	- 85	
2-21-08	715	50	1690	.3001	19.98	.000315	.000286		- 72	QA APPROVED
2-22-08	730	50	1890	.3033	19.98	.000318	.000285		- 78	
2-29-08	715	50	1834	.3033	20.01	.000336	.000286		- 112	NAME: Cadum
3-3-08	825	50	1831	.3032	20.04	.000350	.000287			DATE: 8-25-08
3-5-08	740	50	1795	.3032	20.03	.000359	.000285		- 110	
3-7-08	715	50	1789	.3032	20.03	.000371	.000287		- 96	
3-10-08	1100	50	1766	.3032	20.03	.000387	.000285		- .112	added H_2O to Liner
3-13-08	200	50	1736	.3031	20.03	.000408	.000289		- 125	"
3-18-08	925	50	1685	.3030	20.02	.000446	.000288		- 128	
3-20-08	110	50	1652	.3028	20.02	.000461	.000285		- 131	
3-24-08	930	50	1565	.3027	20.03	.000506	.000289			
3-27-08	650	50	1481	.3025	20.03	.000543	.000286		- 122	D/A PD's were not reading
3-28-08	230	50	1436	.3025	20.02	.000566	.000287		- 111	
3-31-08	715	50	1322	.3021	20.03	.000611	.000287		- 073	
4-3-08	945	50	1137	.3016	20.02	.000675	.000292		- 096	

Project Manager _____ Date 8/21/18

40 Ksi = 2783 Lbs

ARES AN 107 Crack Growth Testing

Test # CT-18

Project Name ARES 2008

Specimen 1196 CT-18 PSTAT # 2090

Lab Computer #3

Project Number 81170135

Frame ~~#4~~ #1 Tcontroller #1260 TC #1201

File Name 1196CT-18.DAT

FCP -328 mv SCE Applied Potential 0 mV

Setup File ARES 2008

Load Cell 2178

Test Solution A4101

Starting pH 13.4

Material ADRT 128 Grade B

LVDT 181

Batch Tracking #78

Ending pH 13.7

Material ID # 1196

Date	Time	Temp. C	Load, lbs.	Disp. In	Current Amps	Pot Drop V	Control PD V	PSTAT Pot V SCE	V Drop across 100 ohm Resistor, V	Comments: specimen Isolated All Leads conductive
2-12-08	7:40	Room	304	.3787	20.00	.000289	.000230	-	-	Dry
2-12-08	1255	50	182	~~.5645~~	20.00	.000307	.000242	0.0	.232	Filled cell 8:05
2-14-08	835	50	177	3757	20.00	1000309	.000241	0	.0042	cell leaked had to
Remove insulation and heat Tape and Re Apply had PSTAT off Temporarily										
Solution Level was not below specimen, added more solution Restarted										
2-14-08	925	58	252	.3474	20.00	.000319	.000244	0	.0048	Tcontroller overshot
2-15-08	400	50	463	.3486	20.01	.000314	.000241	0	.0056	
2-18-08	655	50	1024	3586	20.00	.000312	.000241	0	.0060	**QA APPROVED**
2-19-08	230	50	1233	.3634	19.99	.000312	.000241	0	.0032	**NAME:** ~~C Adams~~
2-20-08	310	~~58~~ 50	1435	.3665	19.99	.000312	0.000241	.001	.0037	**DATE:** ~~8-25-08~~
2-21-08	715	50	1559	.3683	20.00	.000312	.000241	0	.0028	
2-22-08	730	50	1768	.3714	20.00	.000312	.000240	0	.0025	
2.26-08	430	50	2677	.4129	20.00	.000315	.000241	0	.0015	Added solution to Lugen
2-28-08	855	50	3068	.3874	20.00	316	241	0	.0012	stopped unloaded to 2783
2-29-08	715	50	2827	.3856	20.00	.000318	.000242	0	.0012	
3-2-08	825	50	2836	.3858	20.00	.000315	.000241	0	.0012	
3-5-08	740	50	2810	.3856	20.00	.000315	.000240	0	.0012	added 200 ml of solution
3-7-08	715	50	2819	.3856	19.99	.000316	.000240	0	.0009	on 3-4
3-10-08	11:00	50	2825	.3858	19.99	.000316	.000240	0	.0008	
3-13-08	200	50	2817	.3856	19.99	.000314	.000238	0	.0008	
3-14-08	725	50	2821	.3856	19.99	.000317	.000241	0	.0008	

Project Manager Chris H.

Date 8/2/18

ARES AN 107 Crack Growth Testing | Test # CT-18 | Project Name ARES 2008
Specimen 1196 CT 18 | Lab Computer | Project Number 81370135
Frame 1 | File Name | Setup File
Load Cell | Test Solution | Starting pH | Material
LVDT | Batch | Ending pH | Material ID #

Date	Time	Temp. C	Load, lbs.	Disp. In	Current Amps	Pot Drop V	Control PD V	PSTAT Pot V SCE	V Drop across 100 ohm Resistor, V	Comments
3-1 Re	Load	to	3068		Lbs					
3-18-08	930	50	3041	.3877	19.99	.000318	.000242	O	.0007	Added solution
3-20-08	110	50	3022	.3875	19.99	.000316	.000241	O	.0012	
3-24-08	930	50	3000	.3879	20.00	.000318	.000242	O	.0021	
3-27-08	650	50	3000	.3879	19.99	.000319	.000238	O	.0016	
3-31-08	715	50	3017	.3878	20.00	1000319	.000242	O	.0015	added solution
3-31-08	1005	50	3188	.3873	20.00	.000307	.000230	O	.0012	TController malFunction
	Replaced		Temperature		Controller			#1260 w	4th #1204 3	
4-1-08	330	29	3297	.3870	20.00	.000299	.000223	O	.0031	
Temperature		controller		Failed		Replacing	cable	+ TC	NEW TC#1669	
4-3-08	940	49	2983	.3880	20.00	.000318	.000238	O	.0014	
4-4-08	720	49	3007	.3881	19.99	.000317	.000236	O	.0019	QA APPROVED
4-7-08	730	49	3003	.3876	19.99	.000317	.000241	O	.0013	NAME: Cdave
4-9-08	755	49	3010	.3877	20.01	.000318	.000241	O	.0017	DATE: 8-25-8
4-11-08	105	49	3019	.3878	20.01	.000318	.000240	O	.0043	
4-14-08	855	49	2969	.3883	20.01	.000318	.000240	O	.0010	
4-15-08	1200	49	2978	.3884	20.02	.000318	.000241	O	.0010	Added 60 mls
4-17-08	150	49	2970	.3881	20.00	.000320	.000239	O	.0028	
4-21-08	740	49	2972	.3882	20.00	.000317	.000239	O	.0011	computer down
4-22-08	925	49	2994	.3882	20.00	.000319	.000241	O	.0013	computer down AGAIN
4-23-08	200	50	3008	.3881	20.01	.000317	.000239	O	.0014	computer down
4-25-08	730	50	2986	.3883	20.01	.000319	.000240	O	.0009	

Project Manager Cliff Date 8/21/8

ARES AN 107 Crack Growth Testing — Test # CT-18 — Project Name ARES 2008

Specimen 1196 CT 18 — Lab Computer — Project Number 81170135

Frame 1 — File Name

Setup File

Load Cell — Test Solution — Starting pH — Material

LVDT — Batch — Ending pH — Material ID #

Date	Time	Temp. C	Load, lbs.	Disp. In	Current Amps	Pot Drop V	Control PD V	PSTAT Pot V SCE	V Drop across ____ ohm Resistor, V	Comments
5-1-08	715	50	2954	.3884	20.00	.000319	.000241	0	.0008	
5-2-08	855	50	2989	.3883	20.00	.000319	.000241	0	.0011	Added 80 ml of solution
5-5-08	705	50	2956	.3883	20.00	.000319	.000241	0	.0009	
5-6-08	330	50	2997	.3882	20.00	.000319	.000236	0	.0010	
5-8-08	850	50	3003	.3882	20.00	.000318	.000239	0	.0046	QA APPROVED
5-13-08	720	50	2955	.3883	20.00	.000320	.000236	0	.0005	NAME: Crown
5-14-08	805	50	2991	.3883	20.01	.000320	.000236	0	.0014	DATE: 8-25-08
5-16-08	100	49	3003	.3882	20.01	.000319	.000239	0	.0006	
5-19-08	350	50	2977	.3885	20.01	.000320	.000240	0	.0007	
5-27-08	700	50	3018	.3883	20.01	.000321	.000241	0	.039	Adde 200ml solution
5-27-08	710	~~50~~	3066	.3880	20.01	.000310	.000235	0	37	
5-30-08	730	50	2962	.3885	20.00	.000322	.000241	0	.0007	A
6-3-08	755	50	3006	.3882	20.00	.000322	.000241	0	.0012	
6-9-08	820	50	3010	.3886	20.03	.000323	.000241	0	.0007	
6-13-08	720	50	3018	.3888	20.00	.000323	.000241	0	.0008	Added solution
6-17-08	740	50	2976	.3889	20.01	.000324	.000242	0	.0005	
6-18-08	655	50	2959	.3889	20.00	.000324	.000241	0	.0004	
6-23	705	50	2981	.3891	20.01	.000322	.000240	0	.0004	
6-24	730	50	2979	.3891	20.01	.000324	.000241	0	.0005	
6-27	705	50	3014	.3887	20.01	.000323	.000240	0	.0013	Power outs on 25 & 26th
6-30	640	50	3019	.3890	20.02	.000323	.000241	0	.0005	
7-1	1100	50	3001	.3888	20.02	323	240	0	.0005	

Project Manager [signature] Date 8/21/08

ARES AN 107 Crack Growth Testing
Specimen 1196 CT 18
Frame 1
Load Cell
LVDT
Test # CT 18
Lab Computer
File Name
Setup File
Test Solution
Batch
Starting pH
Ending pH
Project Name ARES 2008
Project Number 51170135
Material
Material ID #

Date	Time	Temp. C	Load, lbs.	Disp. In	Current Amps	Pot Drop V	Control PD V	PSTAT Pot V SCE	V Drop across ____ ohm Resistor, V	Comments
7-3-08	730	50	3010	.3889	20.02	.000324	.000241	0	.0005	Added solution
7-8-08	300	50	2997	.3890	20.02	.000324	.000241	0	.0004	
7-9-08	230	50	3005	.3889	20.03	.000323	.000241	0	.0007	
7-14-08	815	50	2999	.3888	20.02	.000322	.000240	0	.0005	
7-17	635	50	3008	.3889	20.03	.000322	.000235	0	.0006	
7-21	1250	50	3020	.3886	20.02	.000317	.000241	0	.0003	
7-25	720	50	2991	.3888	20.01	.000323	.000242	0	.0005	
8-4	800	50	3013	.3885	2.02	.000323	.000241	0	.0002	Computer Down on Sat Reset
8-7	955	50	2999	.3886	20.02	.000323	.000240	0	.0005	Added solution
8-11	1015	50	2986	.3887	20.01	.000330	.000244	0	.0005	
8-13	730	50	2986	.3886	20.01	.000329	.000242	0	.0005	
8-18	1130	50	2979	.3886	20.03	.000329	.000241	0	.0005	Take Down

TEST OVER

QA APPROVED
NAME: Odum
DATE: 8-25-08

Project Manager
Date 8/21/8

APPENDIX B

CYCLIC POTENTIODYNAMIC POLARIZATION (CPP) TESTING DATA

Table B-1. A Summary of Electrochemical Tests Performed in AP105-PSC Based Simulants.

Base Chemistry	pH	NO_2^- (M)	NO_3^- (M)	TIC (M)	OH^- (M)*	Cl^- (M)	F^- (M)	T (°C)	Aeration condition	Testing type	Visual	Sample ID (#EL1196-)
AP105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	N_2 sparging	CPP Full immersion	No pitting	54
AP105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	N_2 sparging	CPP Full immersion	No pitting	60
AP105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	N_2 sparging	Potentiostatic at 0 mV	No pitting	63
AP105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	N_2 sparging	CPP Full immersion	Crevice corrosion	64
AP105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	N_2 sparging	Potentiostatic at 0 mV	Crevice corrosion	65
AP105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	Quiescent air	Potentiostatic at 0 mV, half immersion	Severe attack at solution/vapor interface	66
AP105-PSC	>13	0.6	3.58	0.326	0.176	0.03	0.009	50	Quiescent air	Potentiostatic at 0 mV, half immersion	Corrosion**	72
AP105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	N_2 sparging	Potentiostatic at 0 mV, half immersion	Corrosion**	73
AP105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	Quiescent air	CPP Half immersion	Corrosion	75
AP105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	Room	Quiescent air	Potentiostatic at 0 mV, half immersion	Corrosion**	76
AP105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	Quiescent air	Potentiostatic at 100 mV vs. OCP, half immersion	Corrosion**	77
AP105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	Room	Quiescent air	CPP Full immersion	No pitting	81
AP105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	Quiescent air	Potentiostatic at 0 mV Half immersion	Minor corrosion	91
AP105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	Room	Quiescent air	Potentiostatic at 50 mV vs. OCP Half immersion	Corrosion	92
AP105-PSC	>13	0	3.85	0.326	0.176	0.03	0.009	50	N_2 sparging	CPP Full immersion	Pitting	93

Figure B-1. The CPP Curve in Deaerated AP105-PSC Simulant (T= 50°C and pH>13).

(a) (b)

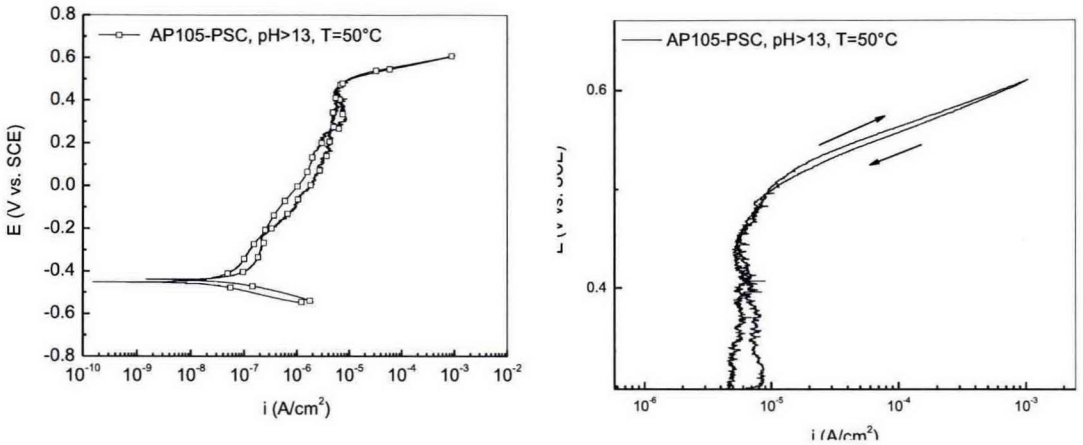


Figure B-2. A Comparison of CPP Curves in Deaerated AP105-PSC Simulant at Different Nitrite and Nitrate Concentrations (pH=13+, T=50°C)

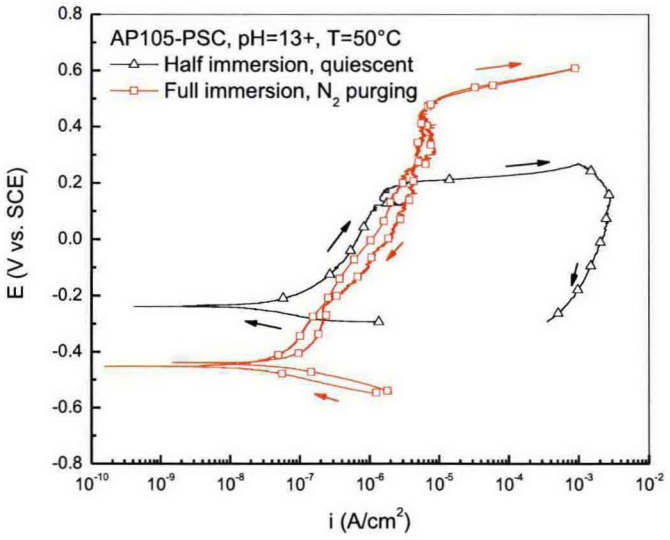


Figure B-3. Sample Appearance after CPP Testing in AP105-PSC Simulant at Quiescent Condition (pH=13+, T=50°C)

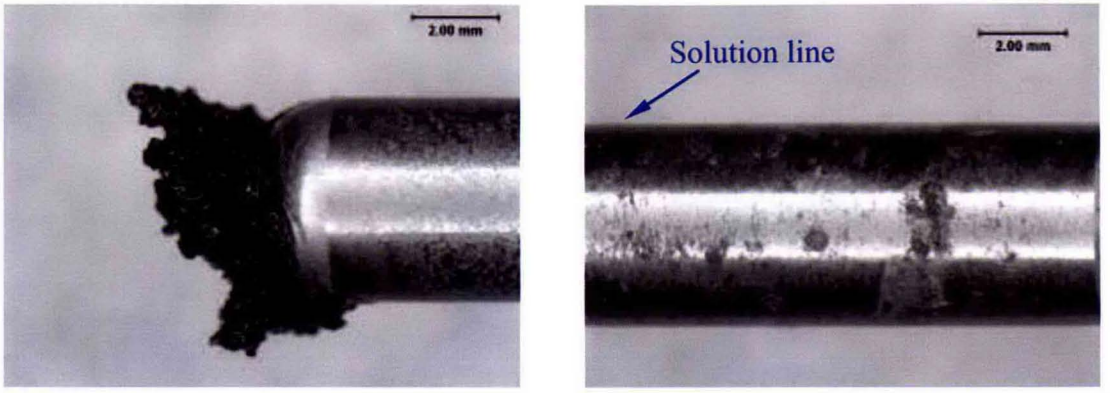


Figure B-4. The Current Density as a Function of Time when the Partially Immersed Sample Was Held at 0 mV vs. SCE (AP105-PSC, pH>13, T=50°C, Quiescent Condition).

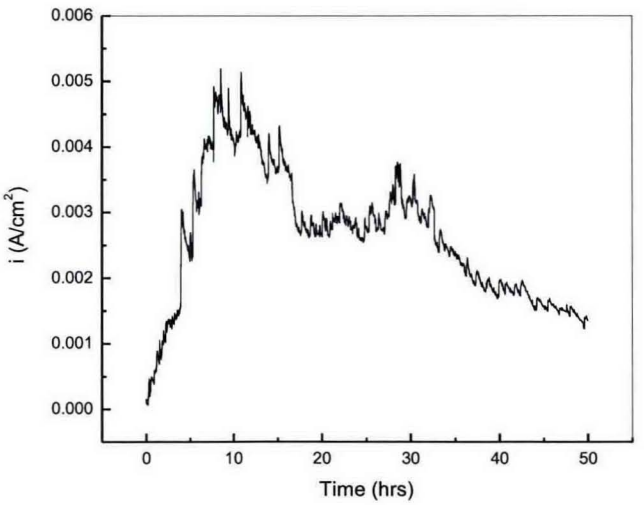
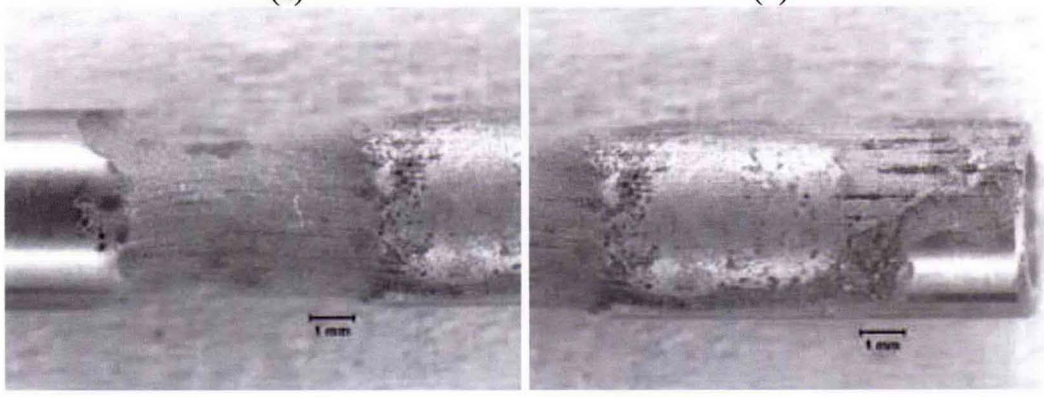


Figure B-5. The Sample Appearance after 50 Hours of Potentiostatic Testing at 0 mV vs. SCE in the AP105-PSC Simulant (pH>13, T=50°C, Quiescent Condition).
(a) Corrosion at Solution/Vapor Interface;
(b) Corrosion on the Portion above the Solution/vapor Interface.

(a) (b)



(b)

Figure B-6. The Current Density as a Function of Time When the Fully Immersed Sample Was Held at 0 mV vs. SCE in AP105-PSC Simulant (T=50°C, pH>13).

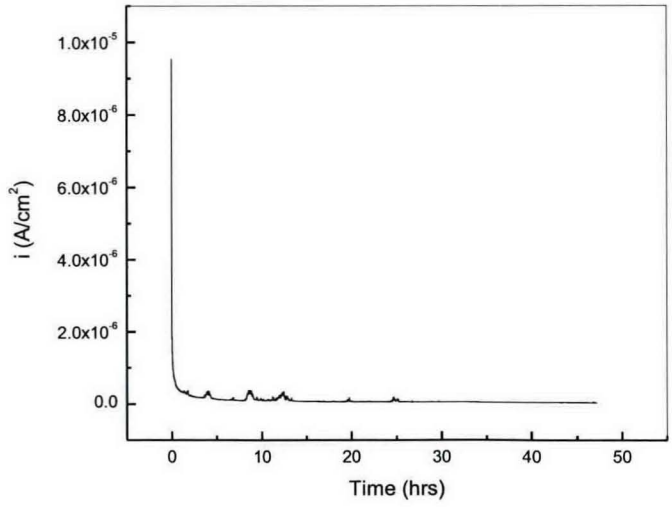


Figure B-7. A Comparison of the Current Density as a Function of Time in the Potentiostatic Tests Conducted in AP105-PSC Simulants with Different Nitrite Concentrations at 50°C and Quiescent Conditions.

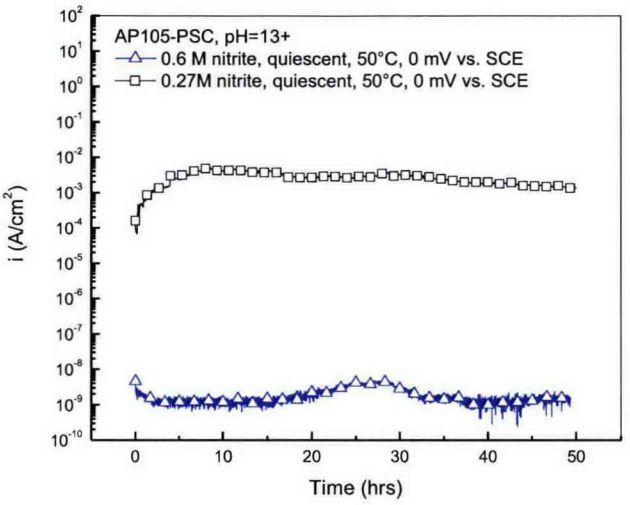


Figure B-8. The Sample Appearance After Potentiostatic Test at 0 mV (vs. SCE) in the AP105-PSC Simulant with 0.6 M Nitrite for 50 hours (Sample Partially Immersed) at 50°C.

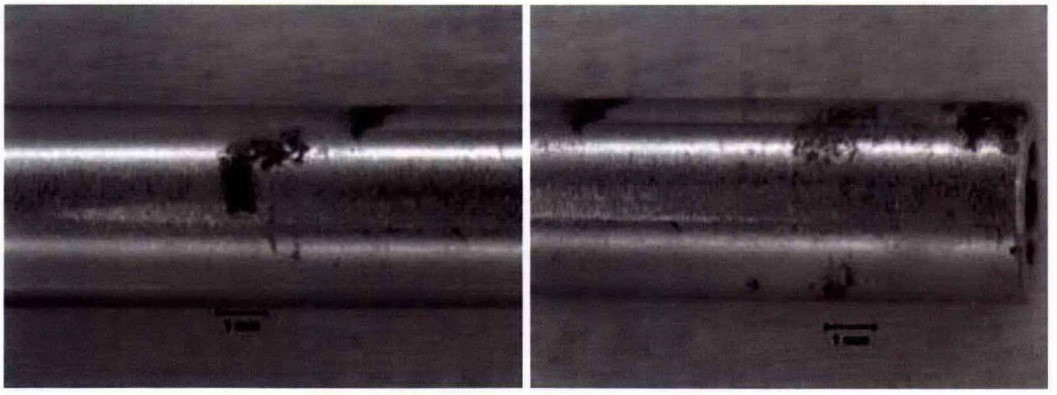


Figure B-9. A Comparison of the Current Density as a Function of Time in the Potentiostatic Tests Conducted at 0 mV (vs. SCE) in Quiescent and Nitrogen Purged AP105-PSC Simulants at 50°C.

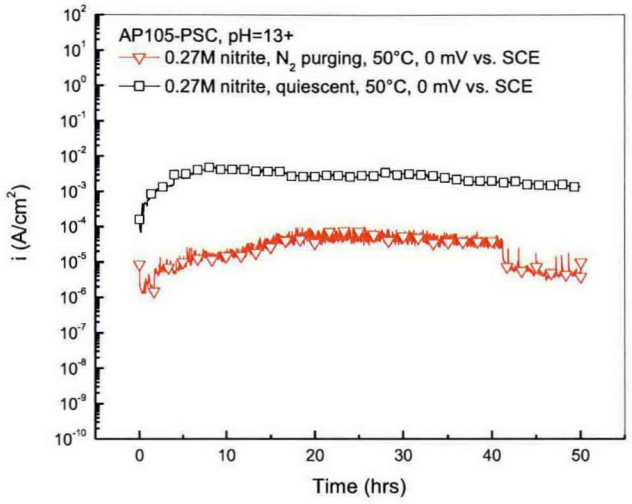


Figure B-10. The Sample Appearance after Potentiostatic Test at 0 mV (vs. SCE) in Deaerated AP105-PSC Simulant for 50 hours (Sample Partially Immersed) at 50°C.

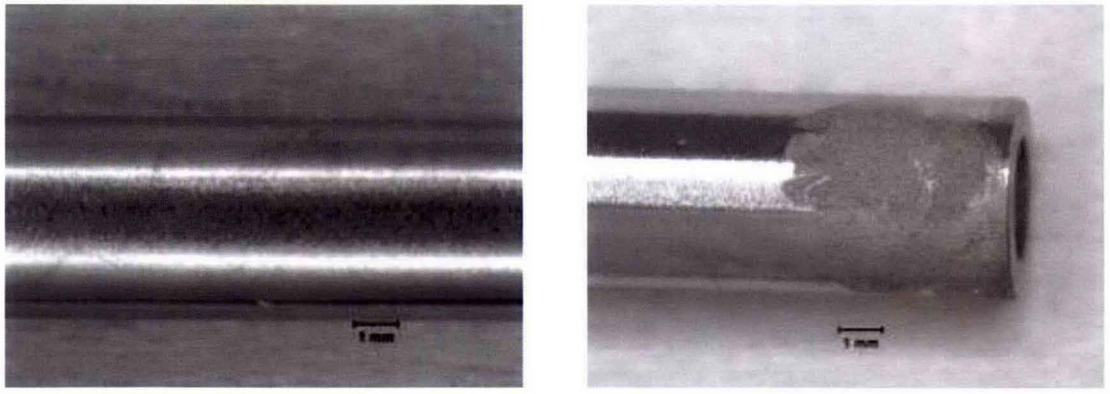


Figure B-11. A Comparison of the Current Density as a Function of Time in the Potentiostatic Tests Conducted in AP105-PSC Simulants at 0 mV (vs. SCE) and 100 mV (vs. OCP) (50°C, Quiescent Condition).

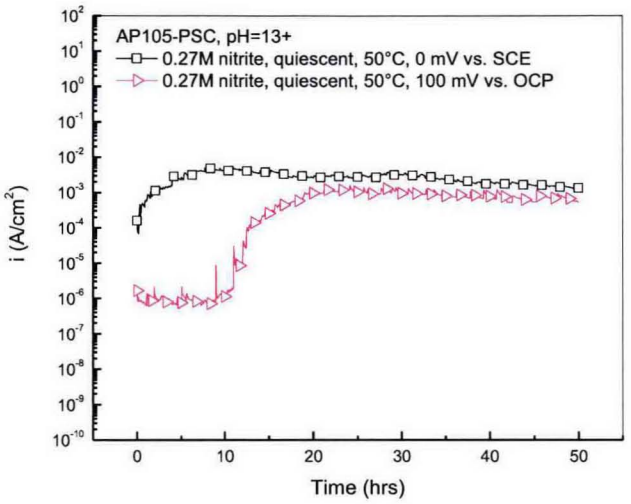


Figure B-12. The Sample Appearance after Potentiostatic Test at 100 mV (vs. OCP) in the AP105-PSC Simulant for 50 Hours (Sample Partially Immersed) at 50°C.

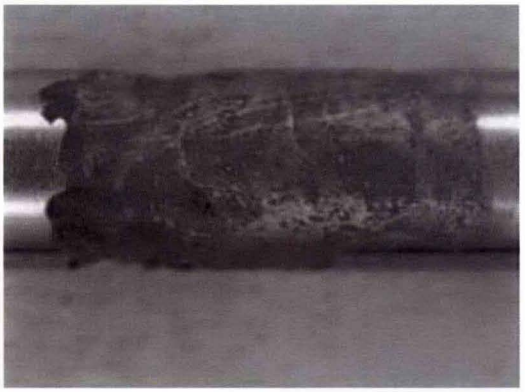


Figure B-13. A Comparison of CPP Curves in Deaerated AP105-PSC Simulant at Different Nitrite and Nitrate Concentrations (pH=13+, T=50°C).

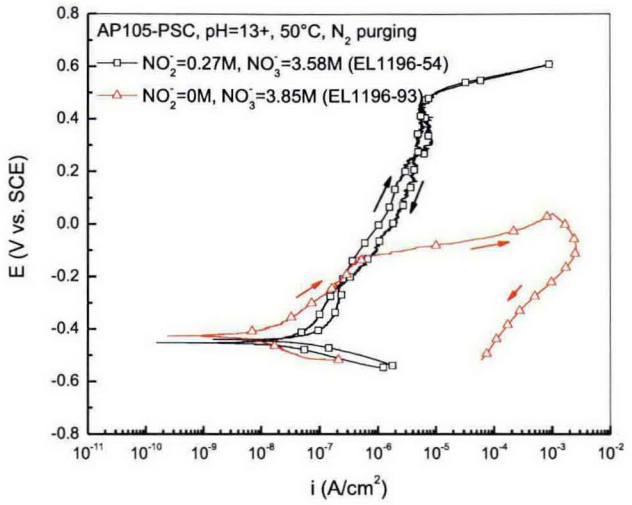


Figure B-14. The Sample Appearance after CPP Testing in Deaerated AP105-PSC with 0 M Nitrite and 3.85 M Nitrate (pH=13+, T=50°C).

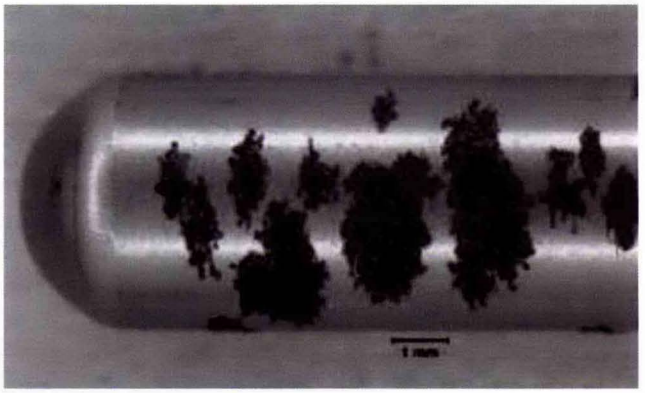
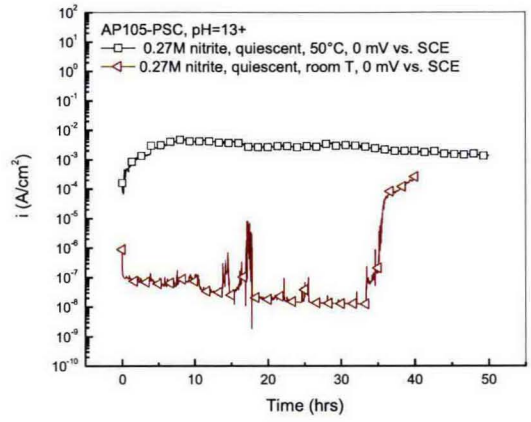
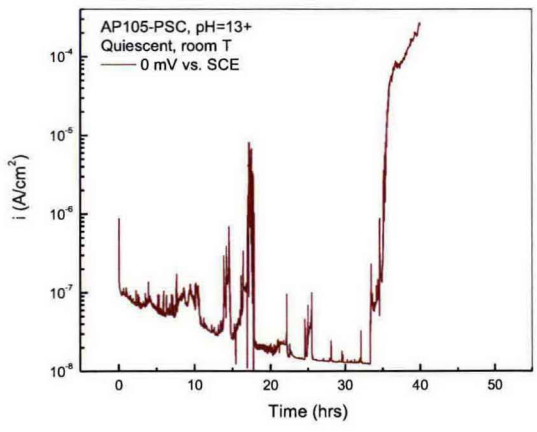


Figure B-15. A Comparison of the Current Density as a Function of Time in the Potentiostatic Tests Conducted in Different Conditions. (a) Room T vs. 50°C; (b) 0 mV (vs. SCE) vs. 50 mV (vs. OCP) at Room T.

(a) Temperature effect



(b) Potential effect



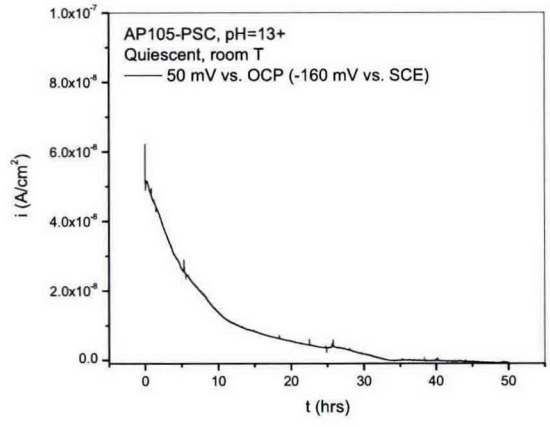


Figure B-16. A Comparison of the Sample Appearance after Potentiostatic Testing in AP105-PSC Simulant at Different Potentials (Under Quiescent Condition, Room Temperature). (a) 0 mV vs. SCE; (b) 50 mV vs. SCE (-160 mV vs. SCE).

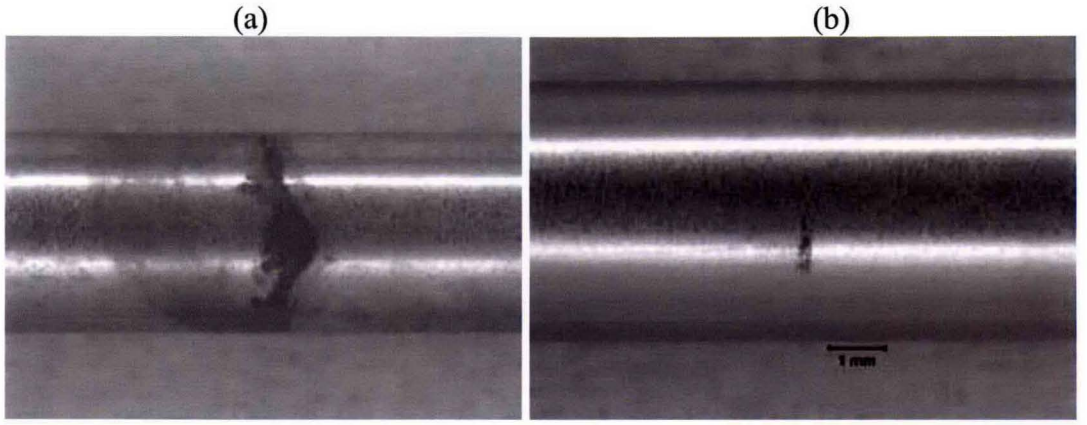


Figure B-17. A Comparison of the CPP Curves Obtained with and without Using a Crevice Former (AP105-PSC, pH>13, T=50°C)

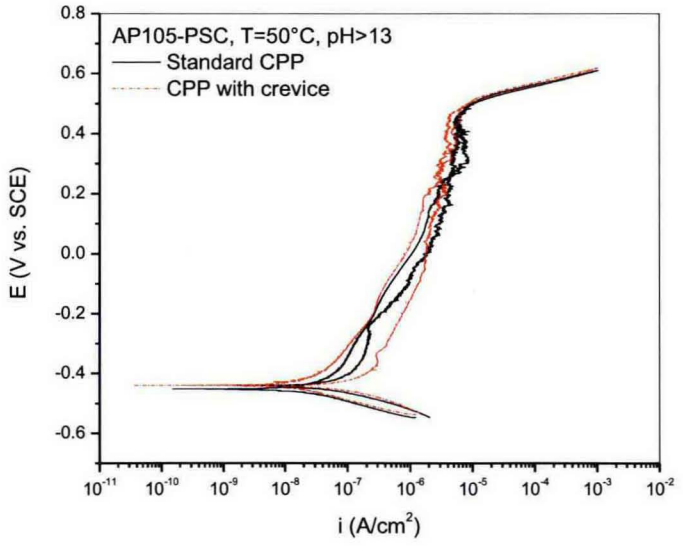
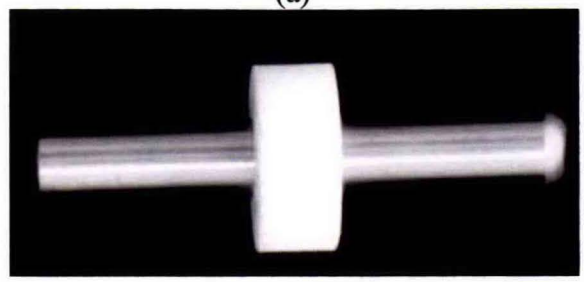


Figure B-18. The Crevice Assembly of the CPP Sample (a) and the Sample Appearance at the Crevice Section after CPP Testing in AP105-PSC Simulant (b) (pH>13, T=50°C).

(a)



(b)

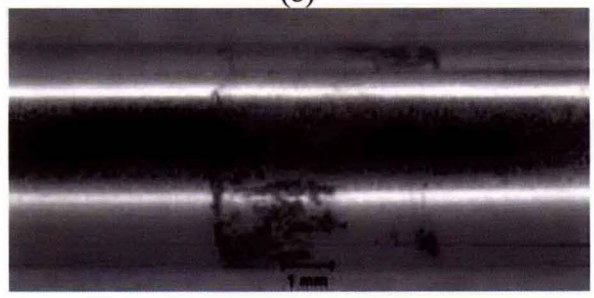


Figure B-19. The Current Density as a Function of Time When the Sample with a Crevice Former Was Polarized to 0 mV vs. SCE (AP105-PSC, pH>13, T=50°C, Deaerated Condition).

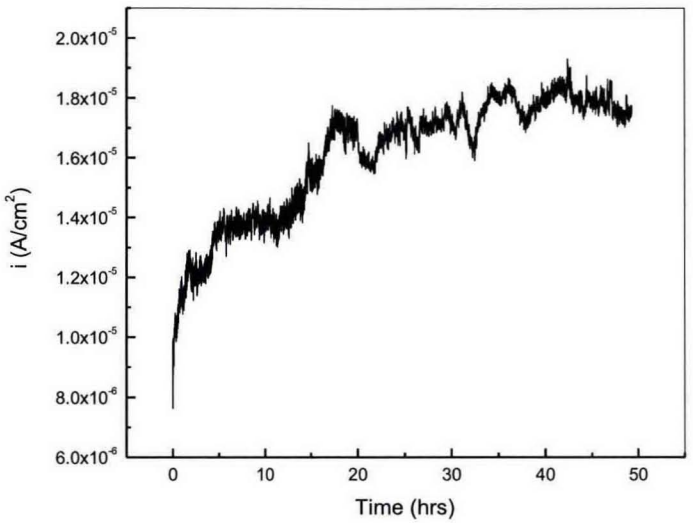


Figure B-20. The Sample Appearance at the Crevice Section after Potentiostatic Test at 0 mV vs. SCE in AP105-PSC Simulant for 50 Hours (pH>13, T=50°C, Deaerated Condition).

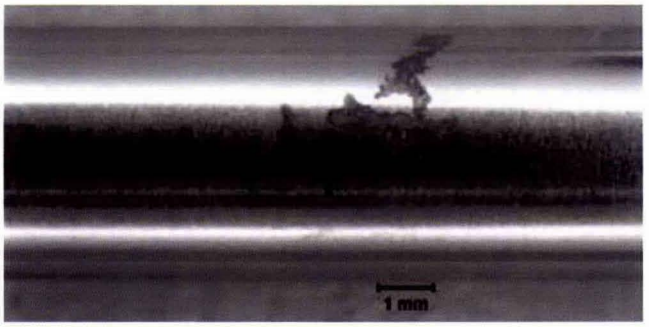


Figure B-21. A Comparison of the CPP Curves Obtained in the AP105-PSC Simulant under Different Aeration Conditions Using Fully Immersed Samples.

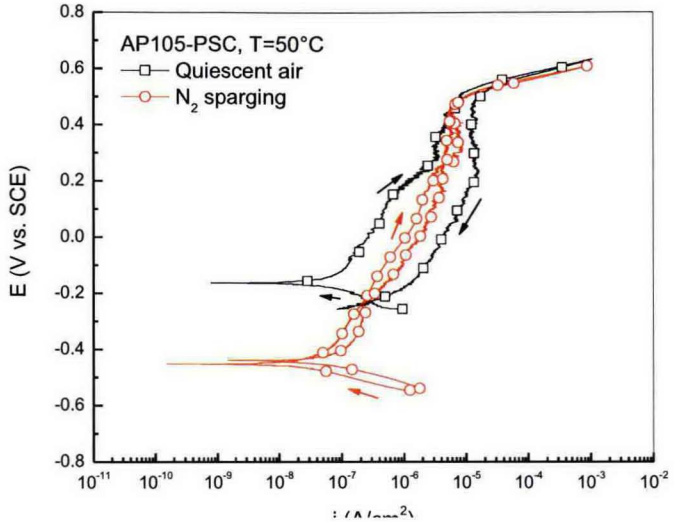


Figure B-22. The Pits on the Samples Tested in the AP105-PSC Simulant under Quiescent Conditions and at 50°C (Ph=13+).

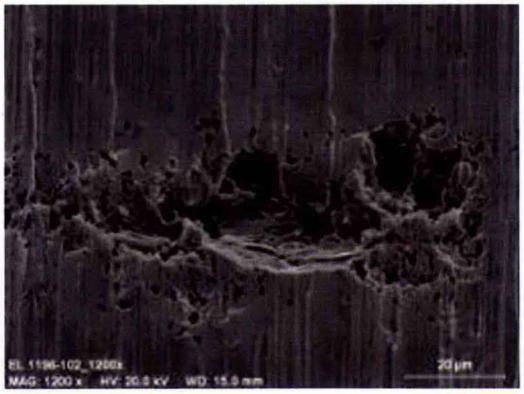


Figure B-23. The Corrosion Rate of the Samples Exposed to AP105-PSC at Different Conditions to Investigate the Interface Corrosion.

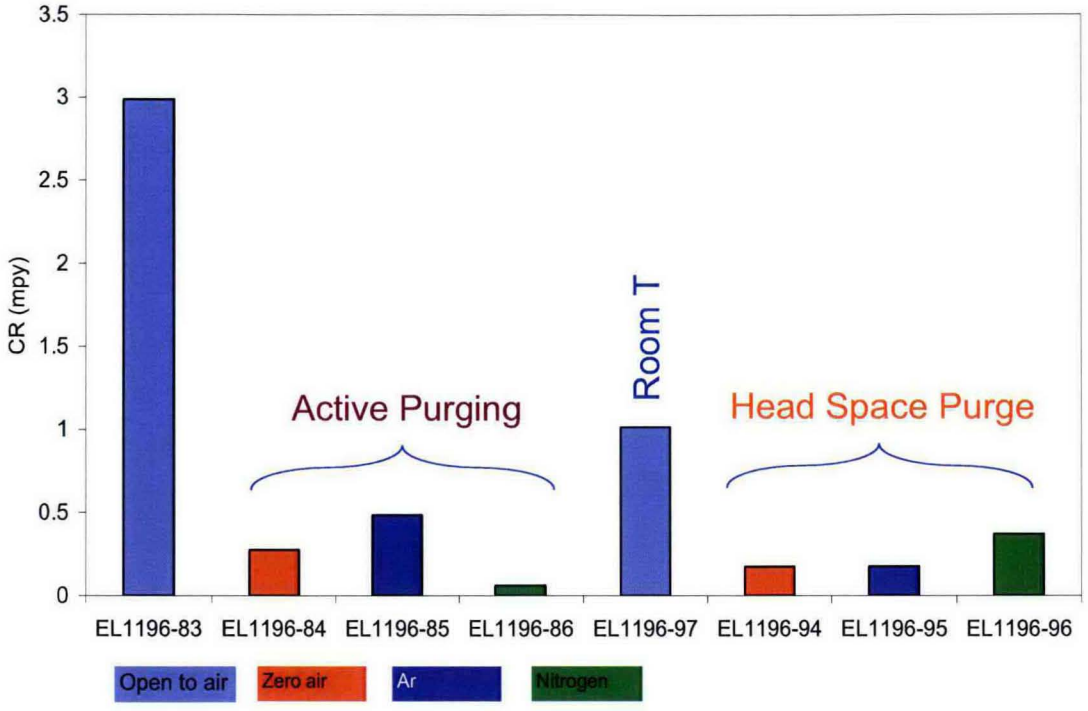
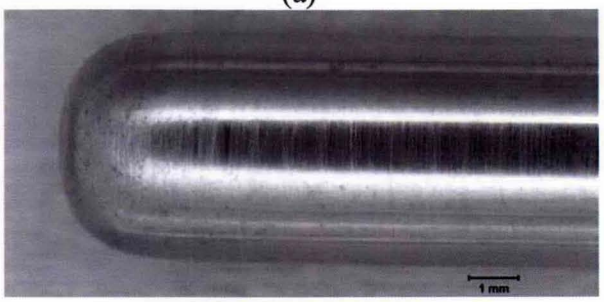
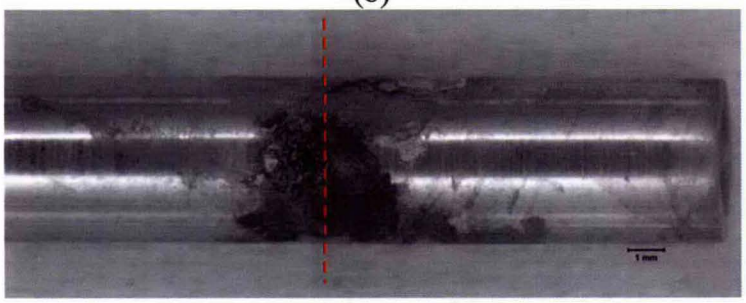


Figure B-24. The Appearance of the Sample (a, b) and the Cross Section of a Corroded Site (c) after Exposed in AP105-PSC at Quiescent Condition (Sample Partially Immersed, T=50°, EL1196-83).

(a)



(b)



(c)

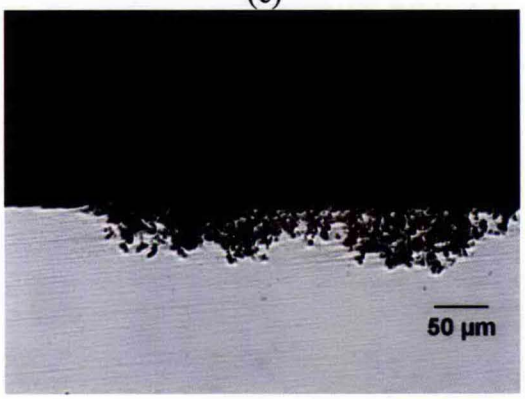
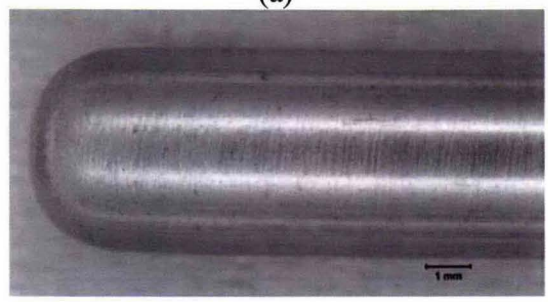


Figure B-25. The Appearance of the Sample after Exposed in AP105-PSC Purged with Zero Air (Sample Partially Immersed, No CO_2, T=50°, EL1196-84)

(a)



(b)

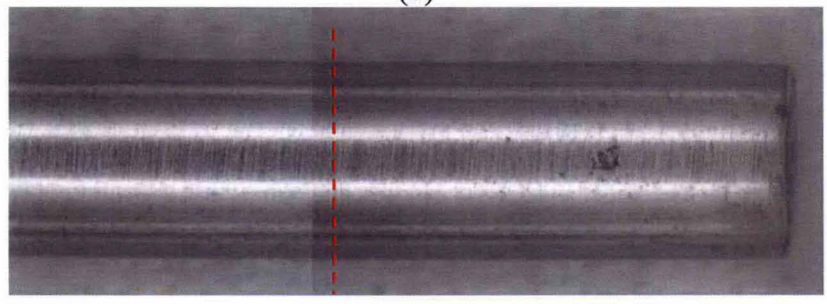
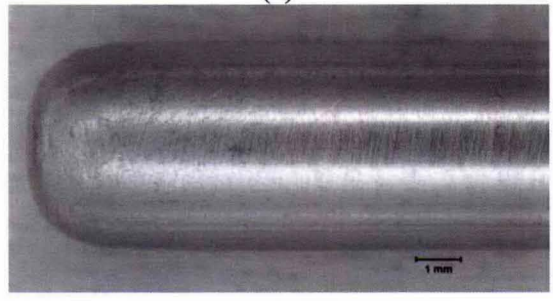


Figure B-26. The Appearance of the Sample after Exposed in AP105-PSC Purged with Ar (Sample Partially Immersed, T=50°, EL1196-85).

(a)



(b)

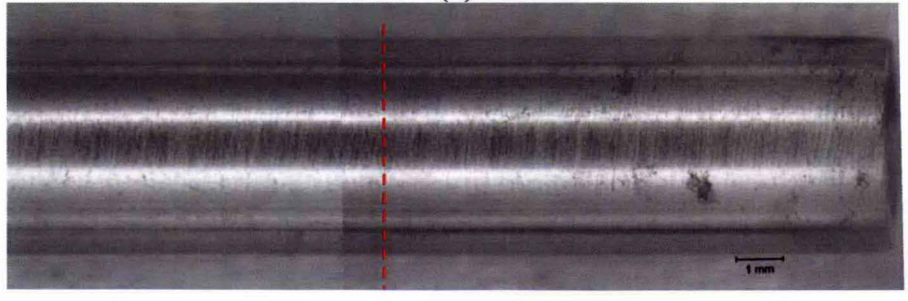
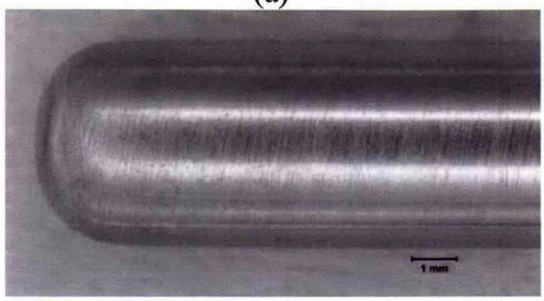


Figure B-27. The Appearance of the Sample after Exposed in AP105-PSC Purged with N_2 (Sample Partially Immersed, T=50°, EL1196-86).

(a)



(b)

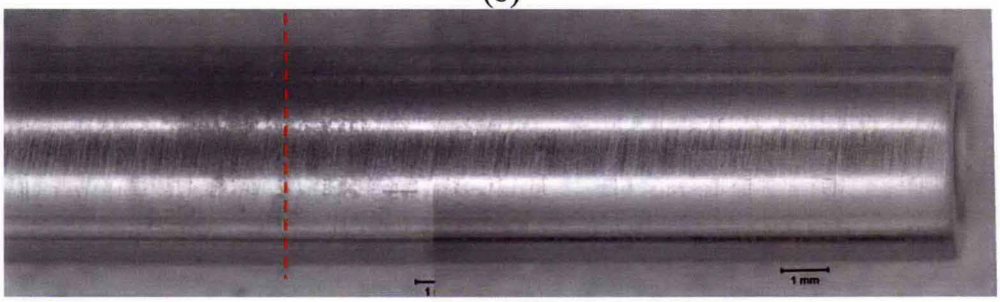
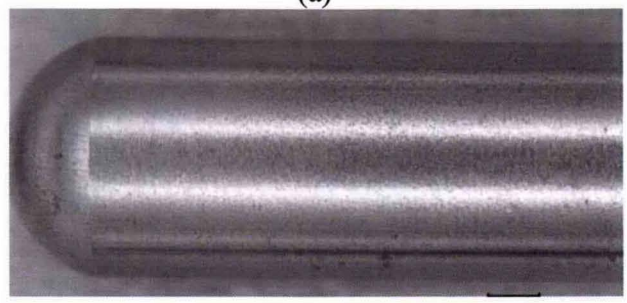
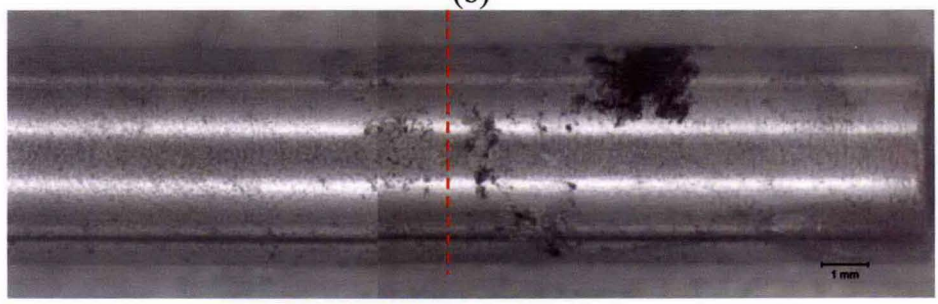


Figure B-28. The Appearance of the Sample (a, b) and the Cross Section of a Corroded Site (c) after Exposed in AP105-PSC at Quiescent Condition (Sample Partially Immersed, Room T, EL1196-97).

(a)



(b)



(c)

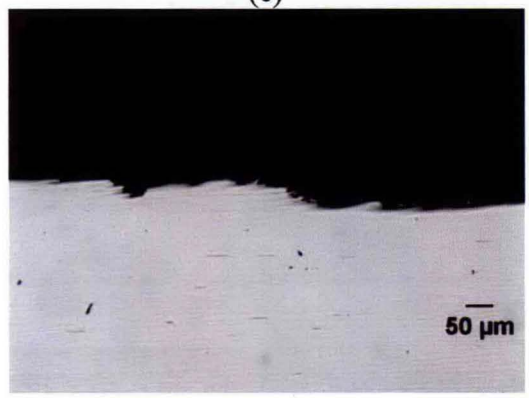
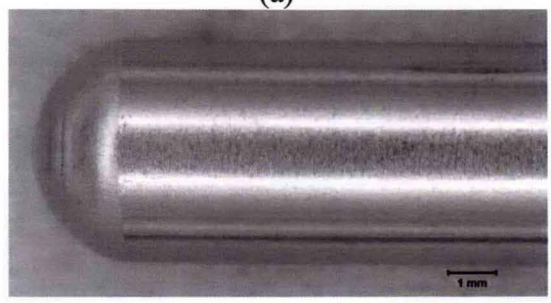


Figure B-29. The Appearance of the Sample after Exposed in AP105-PSC. The Head Space of the Cell Was Purged with Zero Air (No CO_2, Sample Partially Immersed, T=50°, EL1196-94).

(a)



(b)

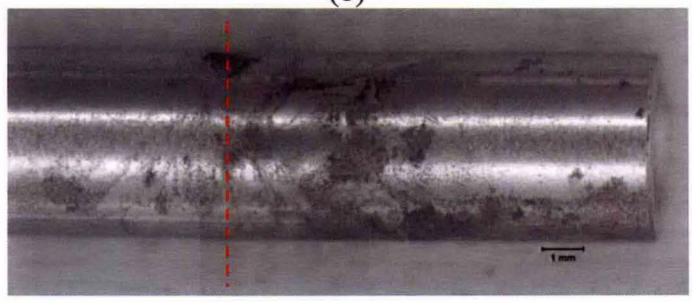
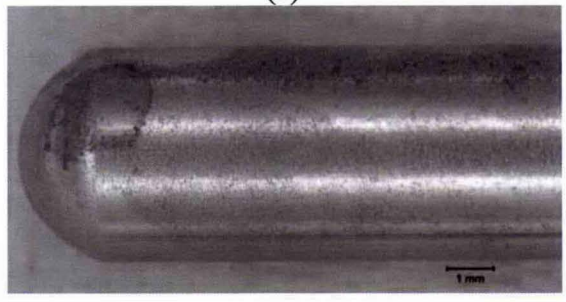


Figure B-30. The Appearance of the Sample after Exposed in AP105-PSC. The Head Space of the Cell Was Purged with Ar (Sample Partially Immersed, T=50°, EL1196-95).

(a)



(b)

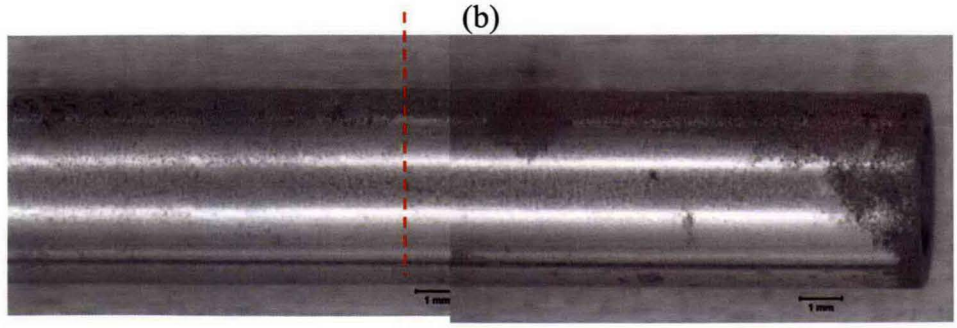


Figure B-31. The Appearance of the Sample after Exposed in AP105-PSC. The Head Space of the Cell Was Purged with N_2 (Sample Partially Immersed, T=50°, EL1196-96).

(a)

(b)

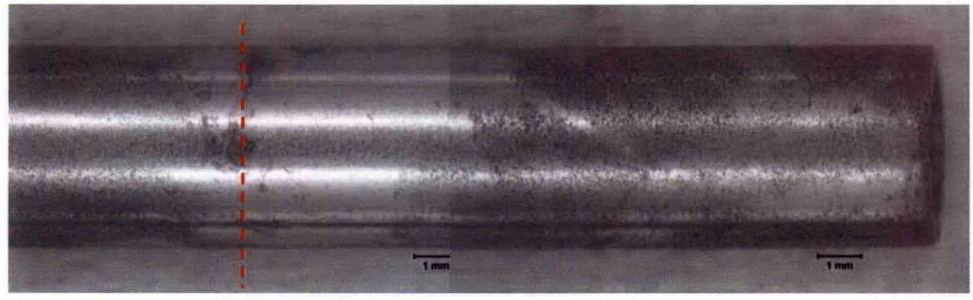


Table B-2. The pH Values of the Simulant after the Long Term Immersion Tests.

Exposed sample	Solution pH after test
EL1196-83	13.28
EL1196-84	13.23
EL1196-85	13.32
EL1196-86	13.21
EL1196-97	13.32
EL1196-94	13.4
EL1196-95	13.44
EL1196-96	13.38

Table B-3. A Summary of Electrochemical Test Performed in SY103-PIL Based Simulant.

Base Chemistry	pH	NO_2^- (M)	NO_3^- (M)	TIC (M)	OH^- (M)*	Cl^- (M)	F^- (M)	T (°C)	Aeration condition	Visual	Sample ID (#EL1196-)
SY103-PIL	>13	2.91	1.97	0.123	2.43	0.5	0	50	N_2 sparging	No pitting	89

Figure B-32. A CPP Curve in Deaerated SY103-PIL Simulant (pH>13 and T=50°C).

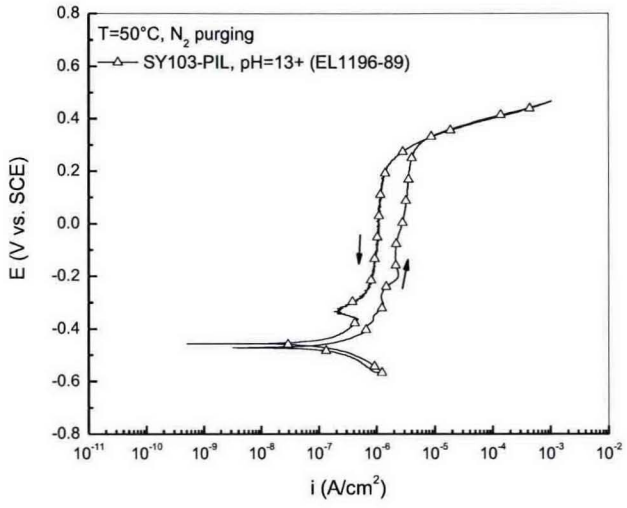


Table B-4. A Summary of Electrochemical Test Performed in AW105 Based Simulant.

Base Chemistry	pH	NO_2^- (M)	NO_3^- (M)	TIC (M)	OH^- (M)*	Cl^- (M)	F^- (M)	T (°C)	Aeration condition	Testing type	Visual	Sample ID (#EL1196-)
AW105-PIL	>13	0.124	0.419	0.097	0.4502	0.01	0.58	50	N_2 sparging	CPP Full immersion	No pitting	90
AW105-PSC	>13	0.0638	0.44	0.1076	0.2630	0.0083	0.156	50	N_2 sparging	CPP Full immersion	No pitting	108

Figure B-33. A CPP Curve in Deaerated AW105-PIL Simulant (pH>13 and T=50°C).

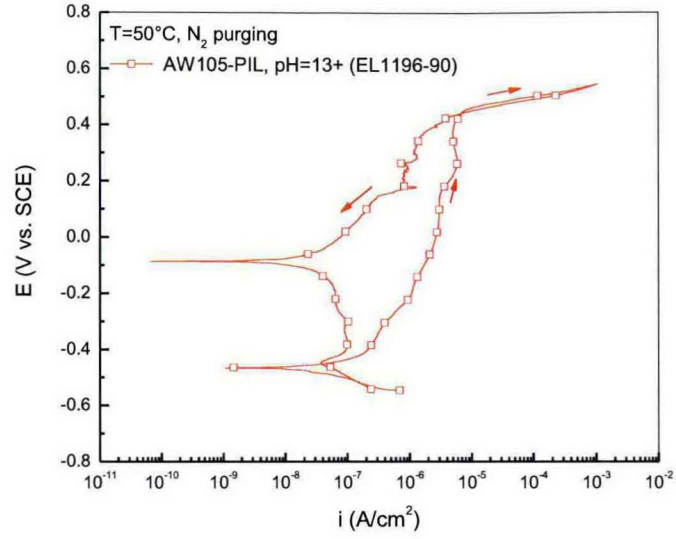


Figure B-34. A CPP Curve in Deaerated AW105-PSC Simulant (pH>13 and T=50°C).

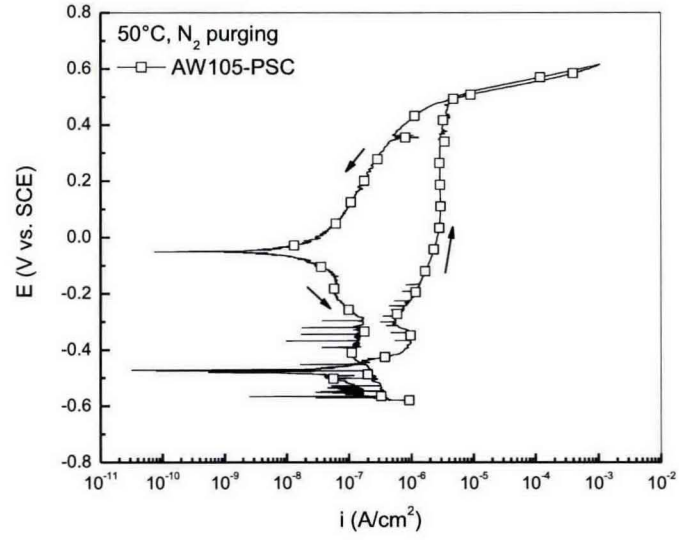


Table B-5. A Summary of Electrochemical Test Performed in AZ102 Based Simulant.

Base Chemistry	pH	NO_2^- (M)	NO_3^- (M)	TIC (M)	OH^- (M)*	Cl^- (M)	F^- (M)	T (°C)	Aeration condition	Testing type	Visual	Sample ID (#EL1196-)
AZ102	>12	0.883	0.105	0.619	-	-	0.052	77	N_2 sparging	CPP Full immersion	No pitting	103

Figure B-35. A CPP Curve in Deaerated AZ102 Simulant (pH>12 and T=77°C).

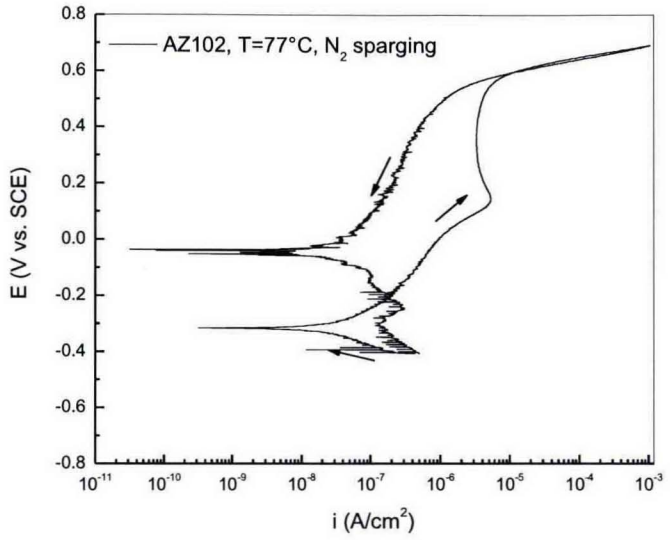


Table B-6. A Summary of Electrochemical Test Performed in SY101 Based Simulant.

Base Chemistry	pH	NO_2^- (M)	NO_3^- (M)	TIC (M)	OH^- (M)*	Cl^- (M)	F^- (M)	T (°C)	Aeration condition	Testing type	Visual	Sample ID (#EL1196-)
SY101	>13	0.2027	0.9313	0.1328	0.6555	0.0228	0.0277	50	N_2 sparging	CPP Full immersion	No pitting	109

Figure B-36. A CPP Curve in Deaerated SY101 Simulant at pH 13+ and 50°C.

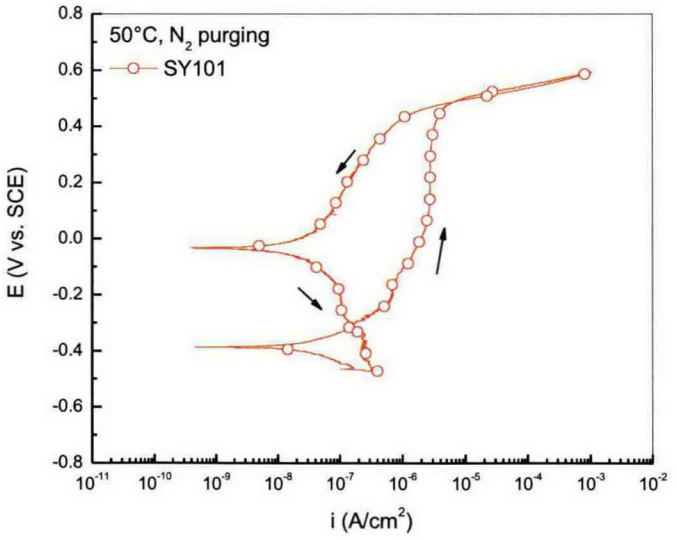


Table B-7. A Summary of Electrochemical Test Performed in AY101-CSL Based Simulant.

Base Chemistry	pH	NO_2^- (M)	NO_3^- (M)	TIC (M)	OH^- (M)*	Cl^- (M)	F^- (M)	T (°C)	Aeration condition	Testing type	Visual	Sample ID (#EL1196-)
AY101-CSL	11.82	0.0368	0.181	0.1474	0.0051	0.0064	0.0015	50	N_2 sparging	CPP Full immersion	Pitting	111
AY101-CSL	12.82	0.0368	0.181	0.1474	0.0051	0.0064	0.0015	50	N_2 sparging	CPP Full immersion	No Pitting	112
AY101-CSL	11.82	0.0368	0.181	0.1474	0.0051	0.0064	0.0015	Room	N_2 sparging	CPP Full immersion	No Pitting	113
AY101-CSL	12.3	0.0368	0.181	0.1474	0.0051	0.0064	0.0015	50	N_2 sparging	CPP Full immersion	Pitting	115

Figure B-37. A Comparison of CPP Curves in the Deaerated AY101-CSL Simulant at Different pH and Temperature Levels.

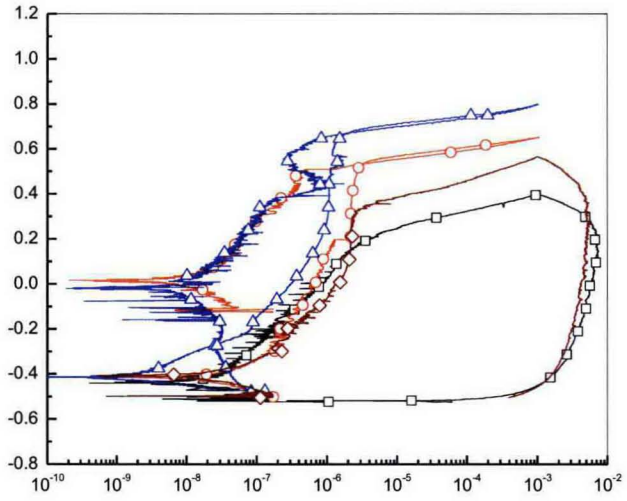
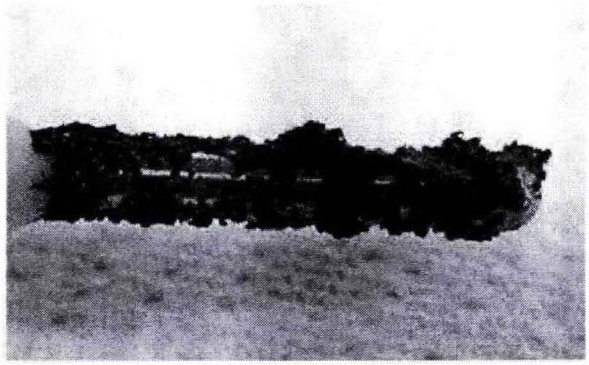


Figure B-38. The appearance of the sample after CPP test in the deaerated AY101-CSL simulant at 50°C and pH 11.82. (a) before cleaning; (b) after cleaning

(a)



(b)

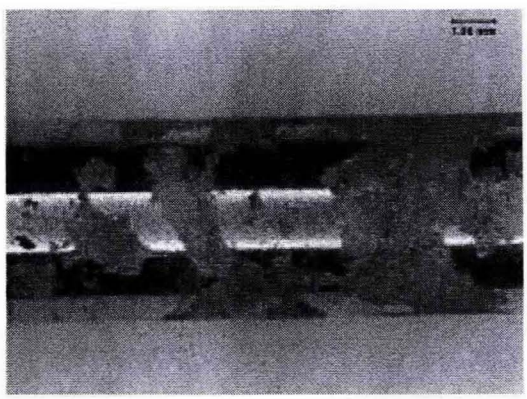
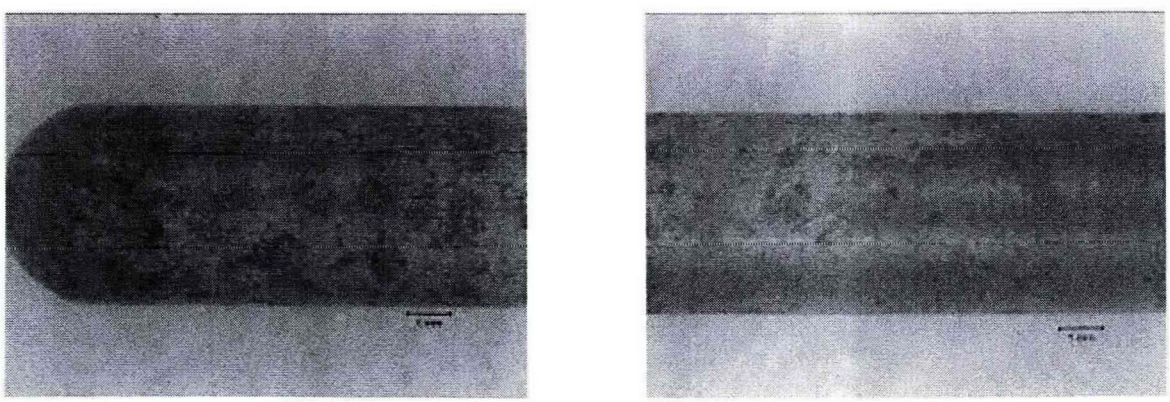


Figure B-39. The appearance of the sample after CPP test in AY101-CSL at pH 12.3 and 50°C.

(a) (b)



APPENDIX C

SLOW STRAIN RATE TEST DATA AND MICROGRAPHS

Figure C-1. The Stress-Strain Curve from SSRT 47 Performed in AN107 Standard Simulant at 50°C, pH 11 and at -740 mV vs. SCE.

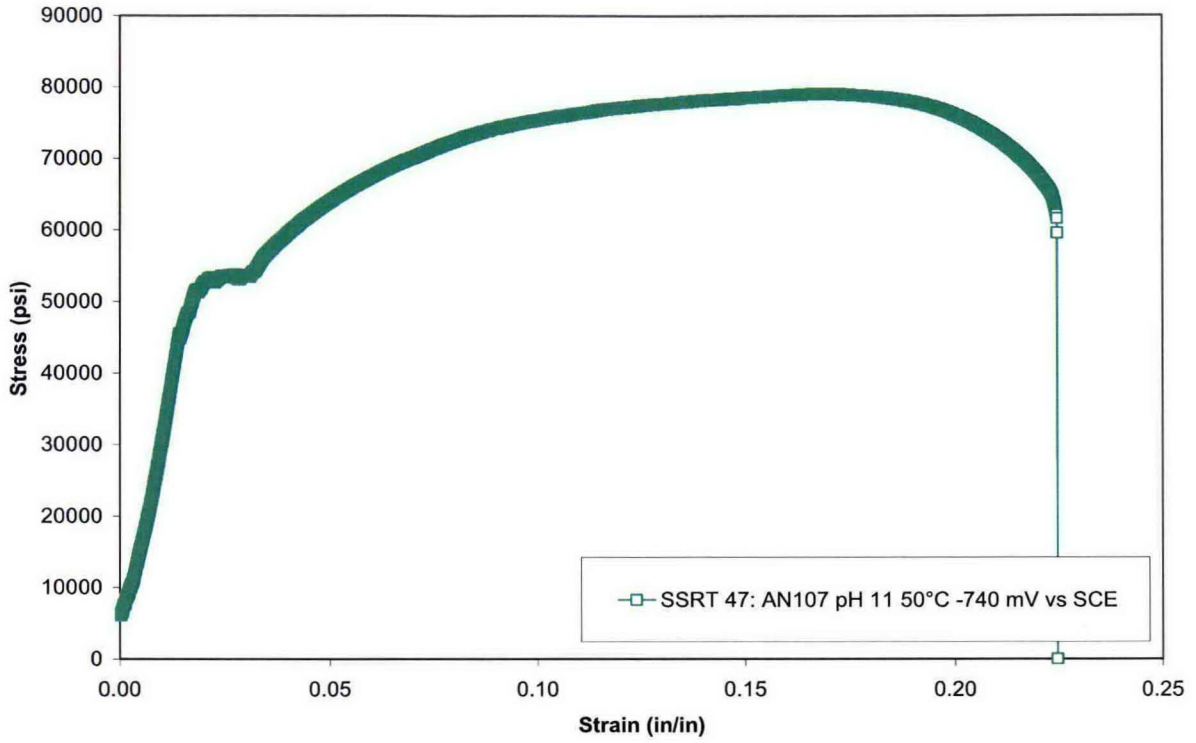


Figure C-2. A Stereo-Micrograph of the Sample from SSRT 47 Performed in AN107 Standard Simulant at 50°C, pH 11 and at -740 mV vs. SCE.

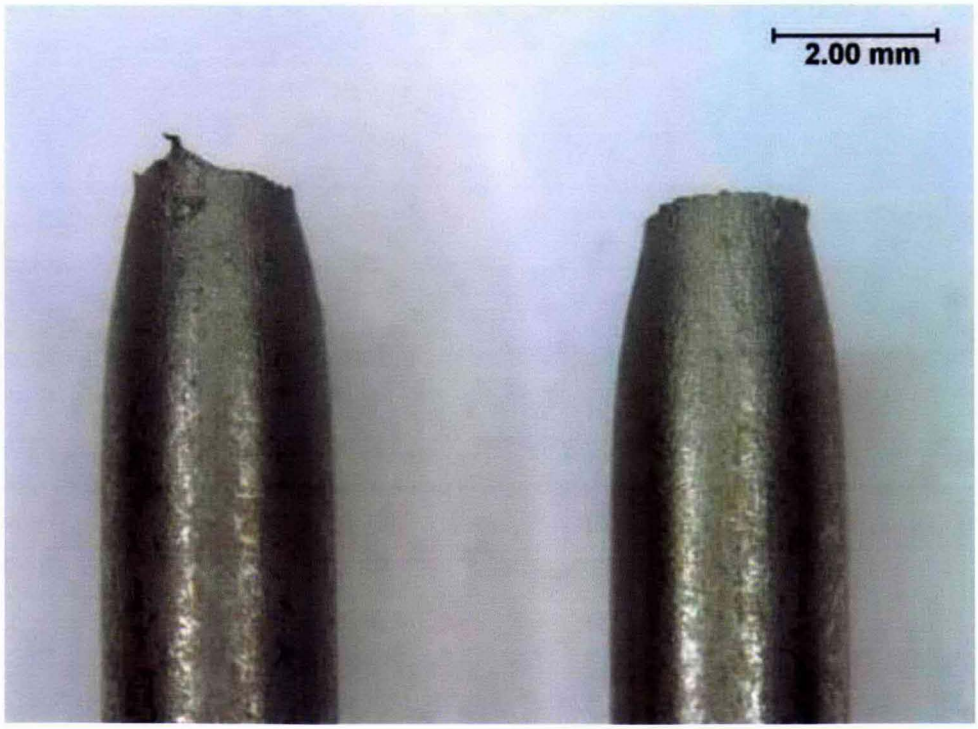


Figure C-3. An Electron-Micrograph of the Fracture Surface from SSRT 47 Performed in AN107 Standard Simulant at 50°C, pH 11 and at -740 mV vs. SCE.

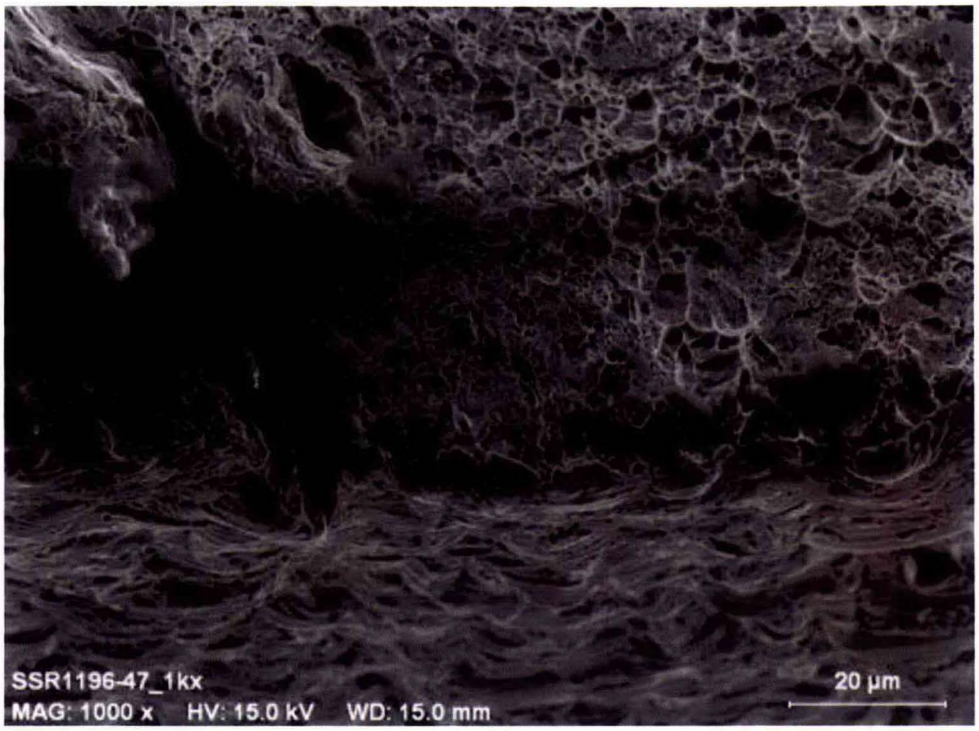


Figure C-4. The Stress-Strain Curve from SSRT 48 Performed in AN107 Standard Simulant at 77°C, pH 11 and at -765 mV vs. SCE.

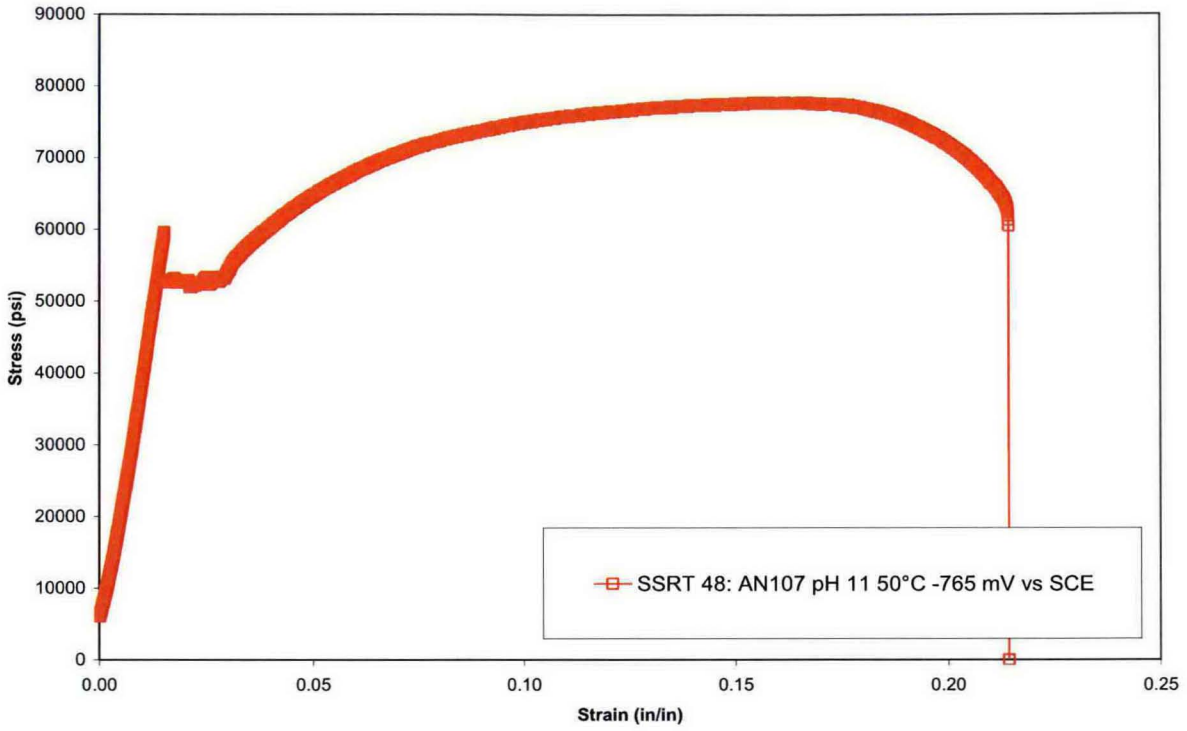


Figure C-5. A Stereo-Micrograph of the Sample from SSRT 48 Performed in AN107 Standard Simulant at 77°C, pH 11 and at -765 mV vs. SCE.

Figure C-6. An Electron-Micrograph of the Fracture Surface from SSRT 48 Performed in AN107 Standard Simulant at 77°C, pH 11 and at -765 mV vs. SCE.

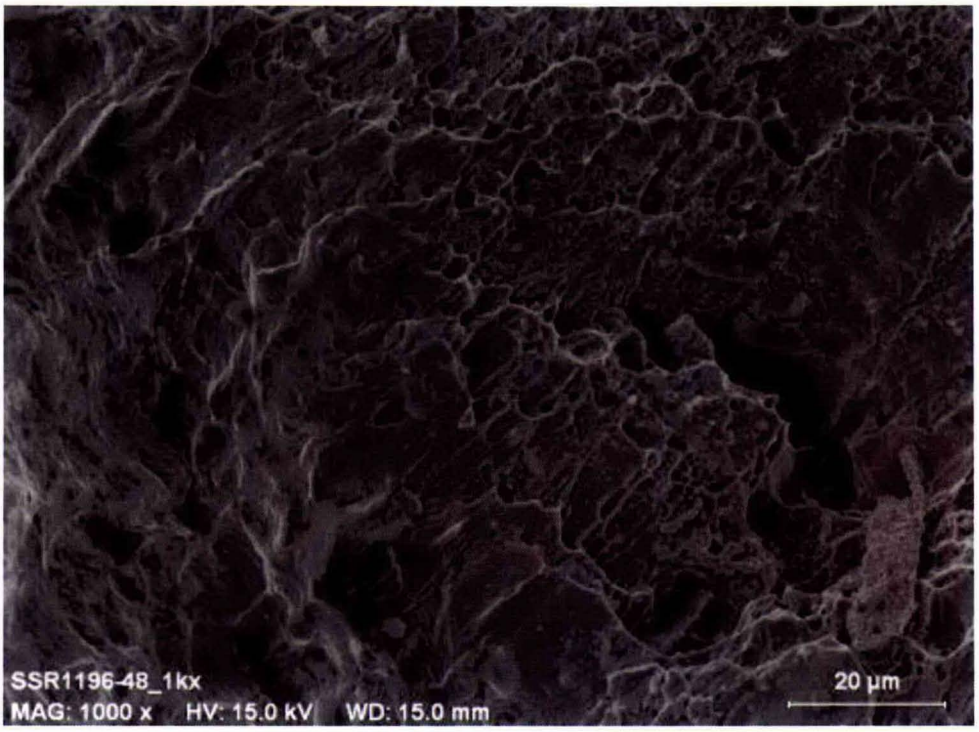


Figure C-7. The Stress-Strain Curve from SSRT 49 Performed in AN107 Standard Simulant at 77°C, pH 13+ and at -790 mV vs. SCE.

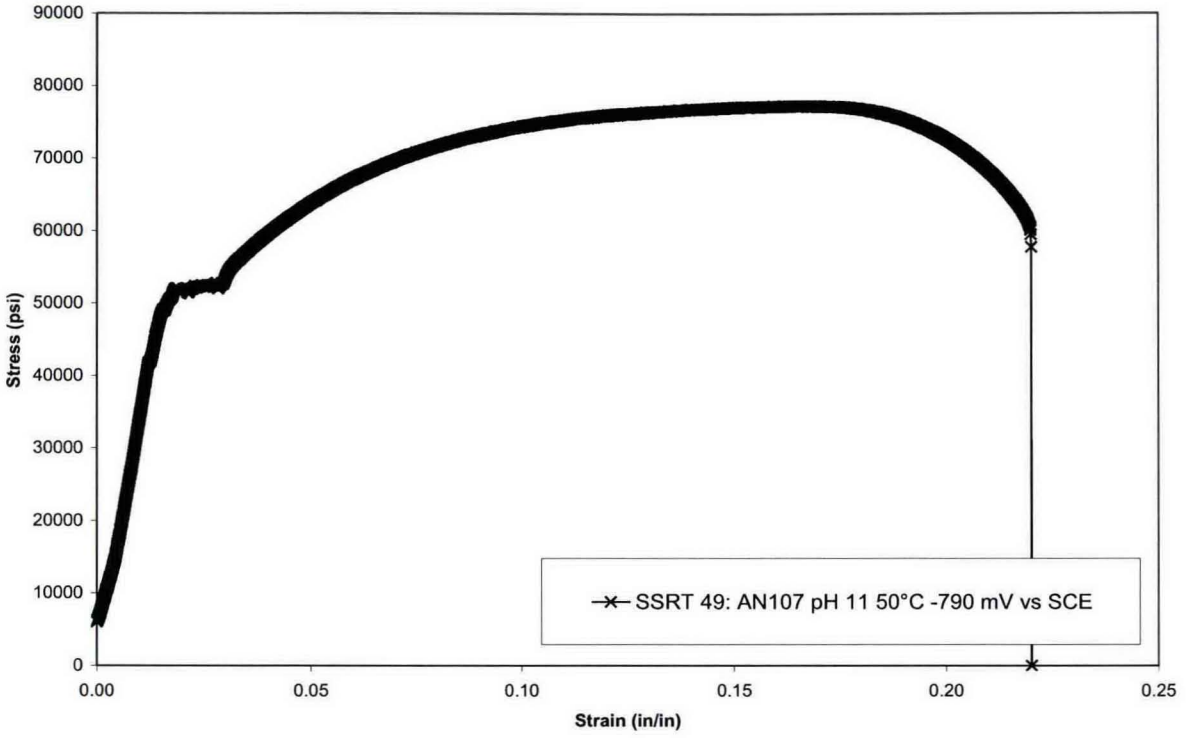


Figure C-8. A Stereo-Micrograph of the Sample from SSRT 49 Performed in AN107 Standard Simulant at 77°C, pH 13+ and at -790 mV vs. SCE.

Figure C-9. An Electron-Micrograph of the Fracture Surface from SSRT 49 Performed in AN107 Standard Simulant at 77°C, pH 13+ and at -790 mV vs. SCE.

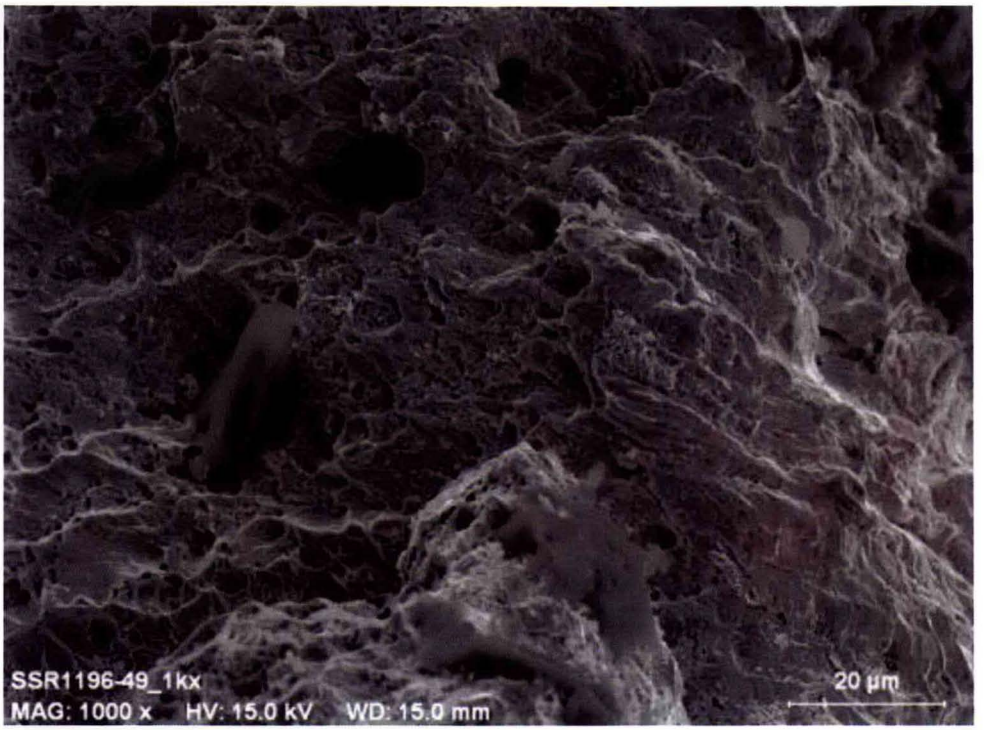


Figure C-10. The Stress-Strain Curve from SSRT 50 Performed in AP105-PSC Standard Simulant at 50°C, pH 13+ and at 0 mV vs. SCE.

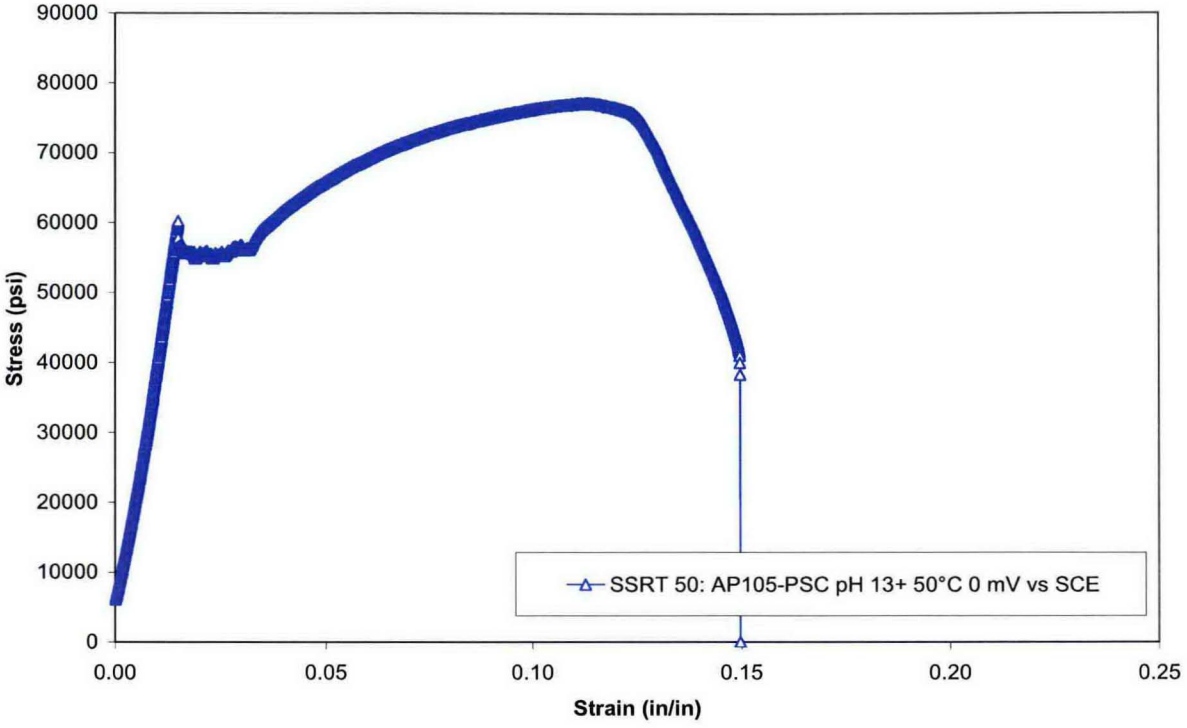


Figure C-11. A Stereo-Micrograph of the Sample from SSRT 50 Performed in AP105-PSC Standard Simulant at 50°C, pH 13+ and at 0 mV vs. SCE.

Figure C-12. An Electron-Micrograph of the Fracture Surface from SSRT 50 Performed in AP105-PSC Standard Simulant at 50°C, pH 13+ and at 0 mV vs. SCE.

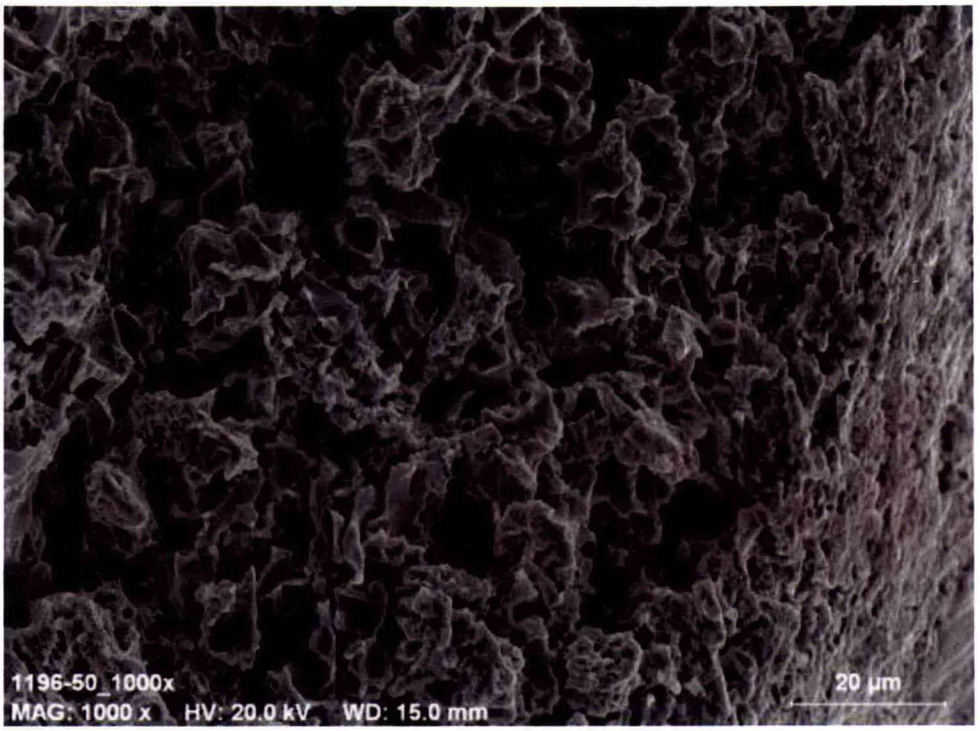


Figure C-43. The Stress-Strain Curve from SSRT 51 Performed in AP105-PSC Standard Simulant at 50°C, pH 13+ and at OCP (-249 mV vs. SCE).

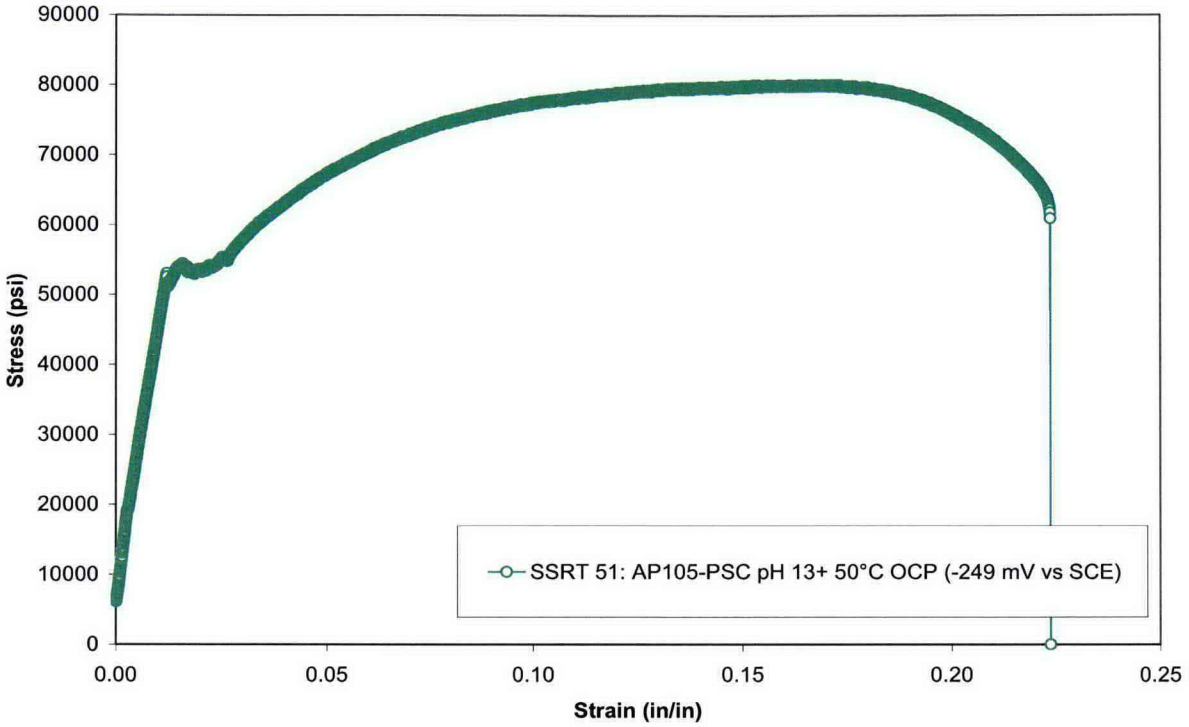


Figure C-14. A Stereo-Micrograph of the Sample from SSRT 51 Performed in AP105-PSC Standard Simulant at 50°C, pH 13+ and at OCP (-249 mV vs. SCE).

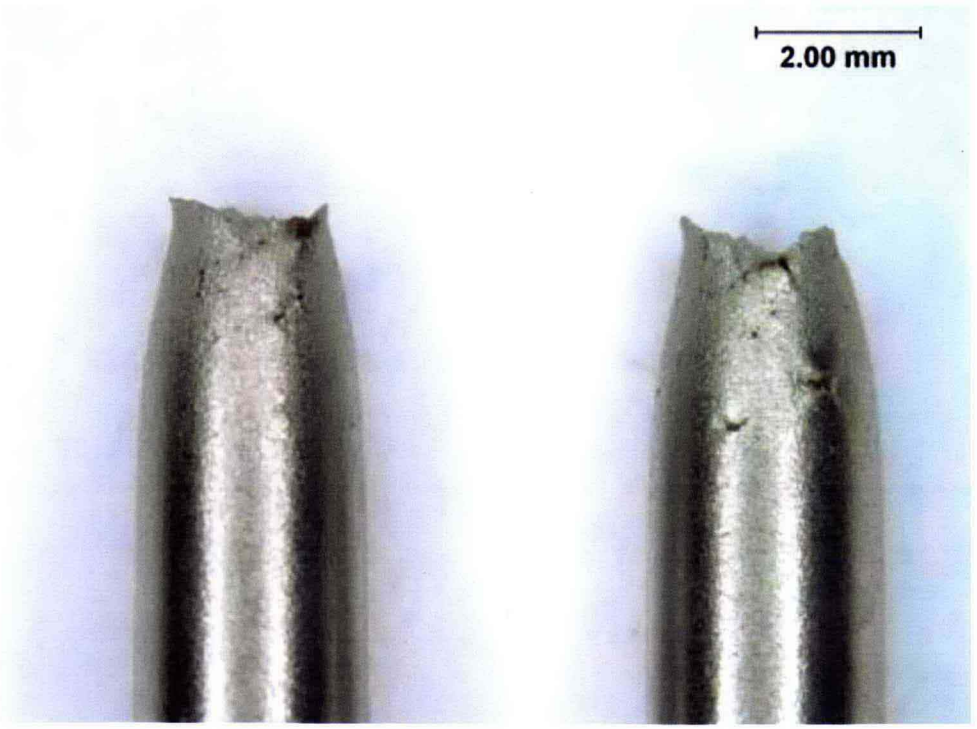


Figure C-15. An Electron-Micrograph of a Secondary Crack in the Shaft of SSRT 51 Performed in AP105-PSC Standard Simulant at 50°C, pH 13+ and at OCP (-249 mV vs. SCE).

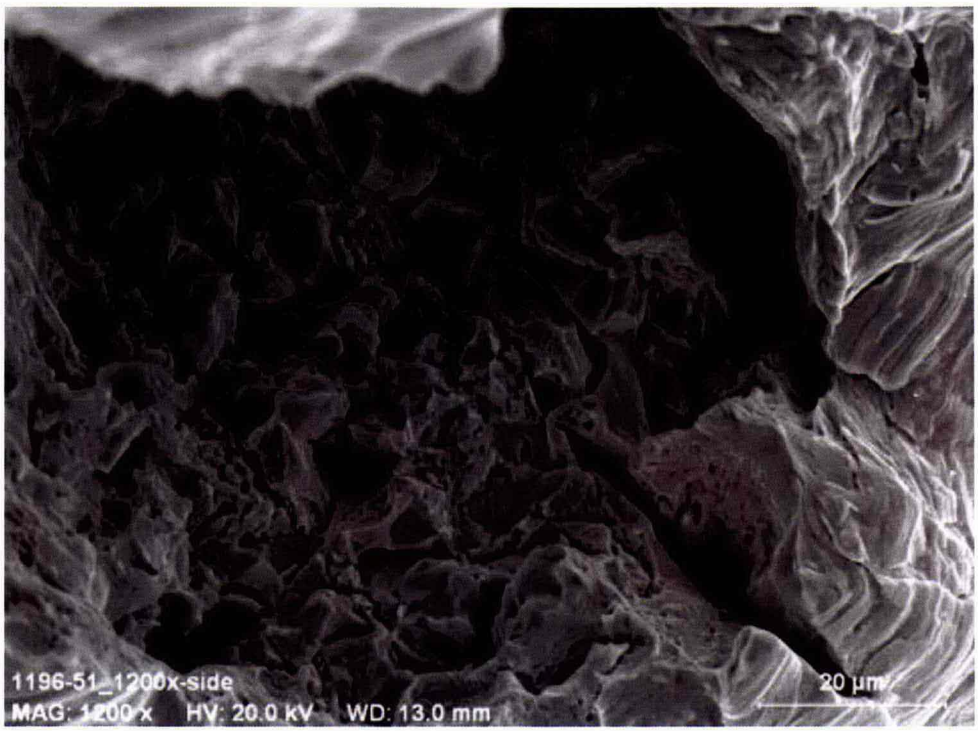


Figure C-16. The Stress-Strain Curve from SSRT 52 Performed in AP105-PSC Standard Simulant at 50°C, pH 13+ and at OCP (-289 mV vs. SCE).

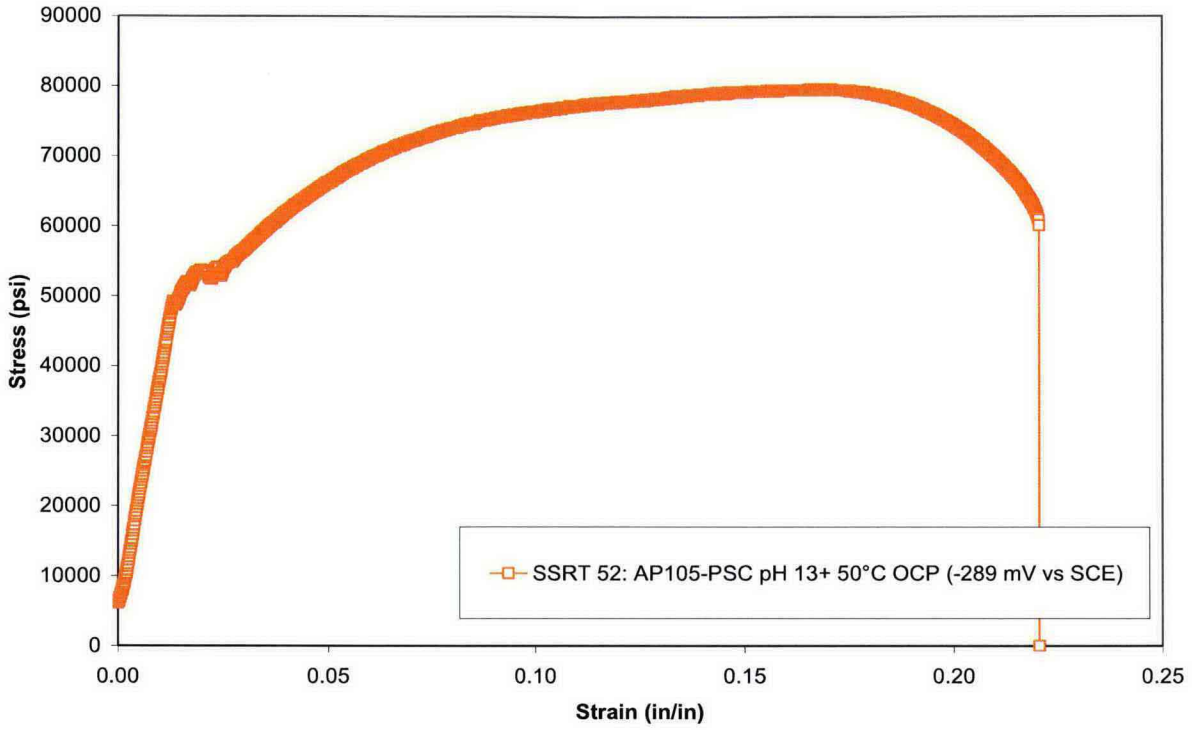


Figure C-17. A Stereo-Micrograph of the Sample from SSRT 52 Performed in AP105-PSC Standard Simulant at 50°C, pH 13+ and at OCP (-289 mV vs. SCE).

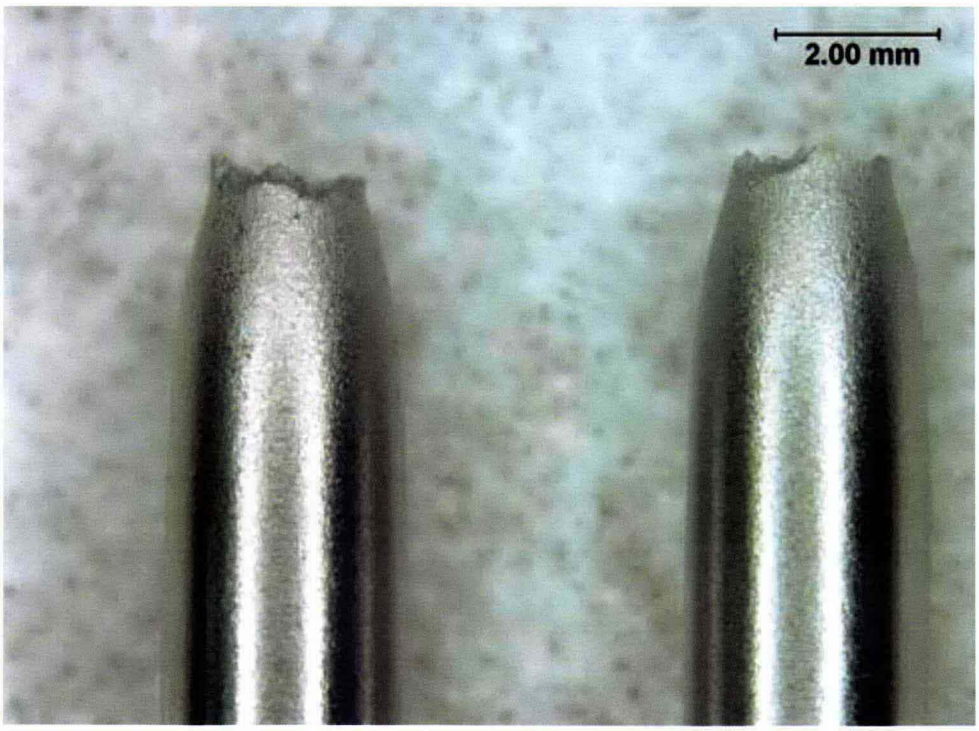


Figure C-18. An Electron-Micrograph of the Fracture Surface from SSRT 52 Performed in AP105-PSC Standard Simulant at 50°C, pH 13+ and at OCP (-289 mV vs. SCE).

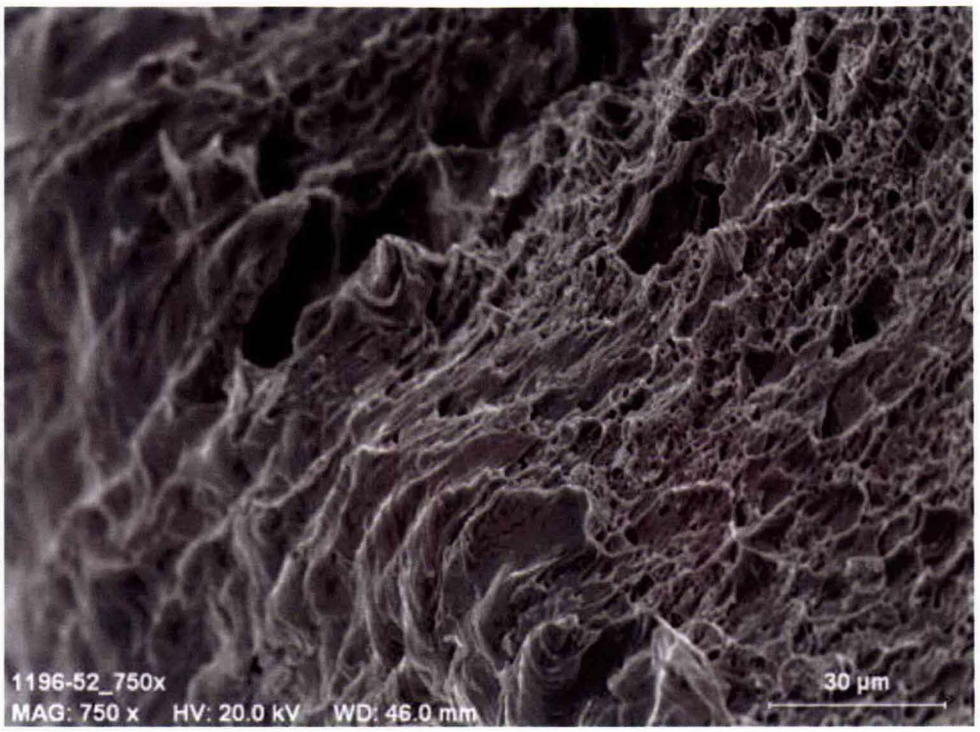


Figure C-19. The Stress-Strain Curve from SSRT 53 Performed in AP105-PSC Standard Simulant at 50°C, pH 13+ and at 0 mV vs. SCE.

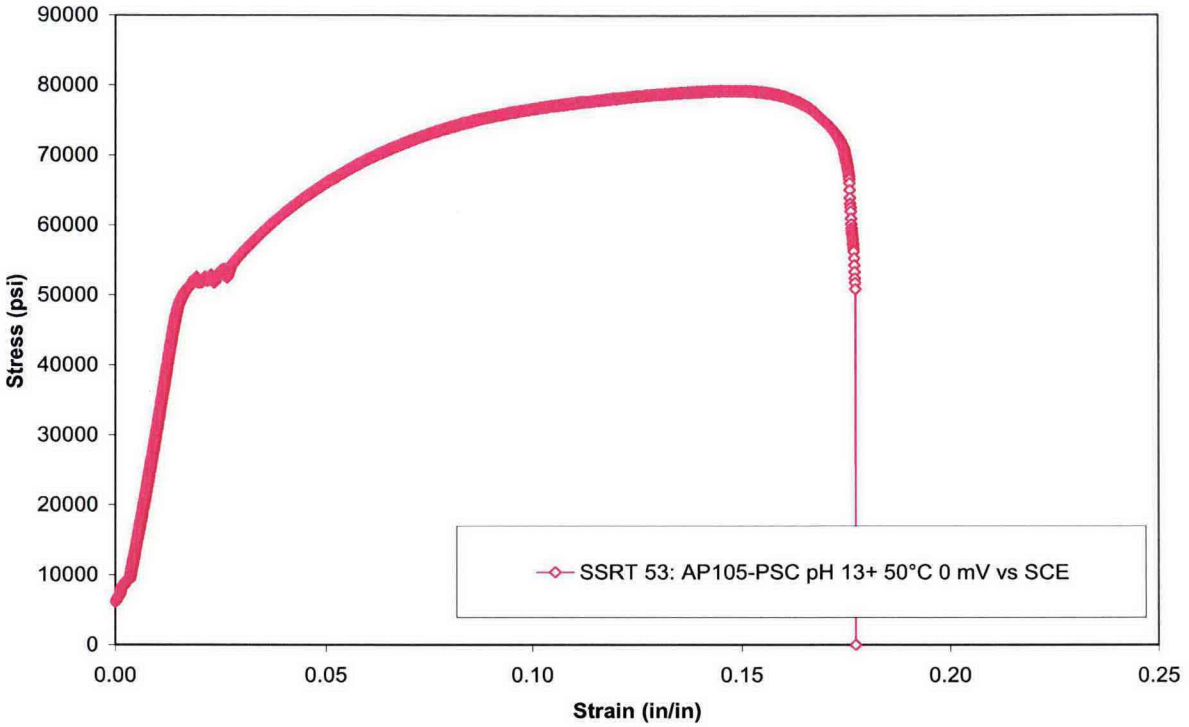


Figure C-20. A Stereo-Micrograph of the Sample from SSRT 53 Performed in AP105-PSC Standard Simulant at 50°C, pH 13+ and at 0 mV vs. SCE.

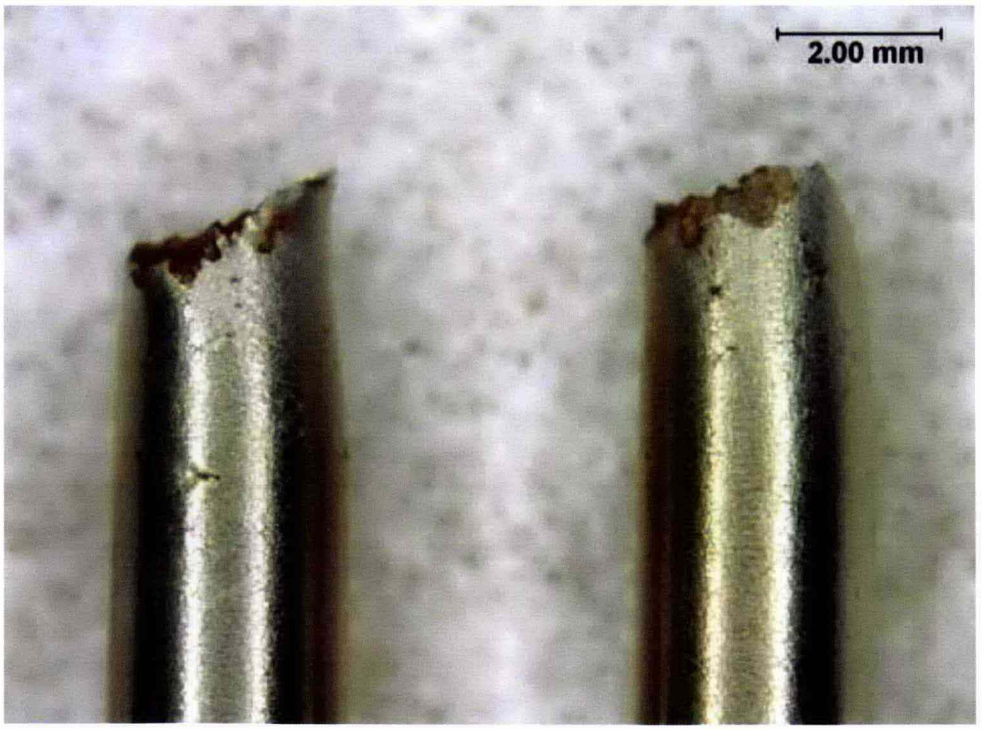


Figure C-21. An Electron-Micrograph of the Fracture Surface from SSRT 53 Performed in AP105-PSC Standard Simulant at 50°C, pH 13+ and at 0 mV vs. SCE.

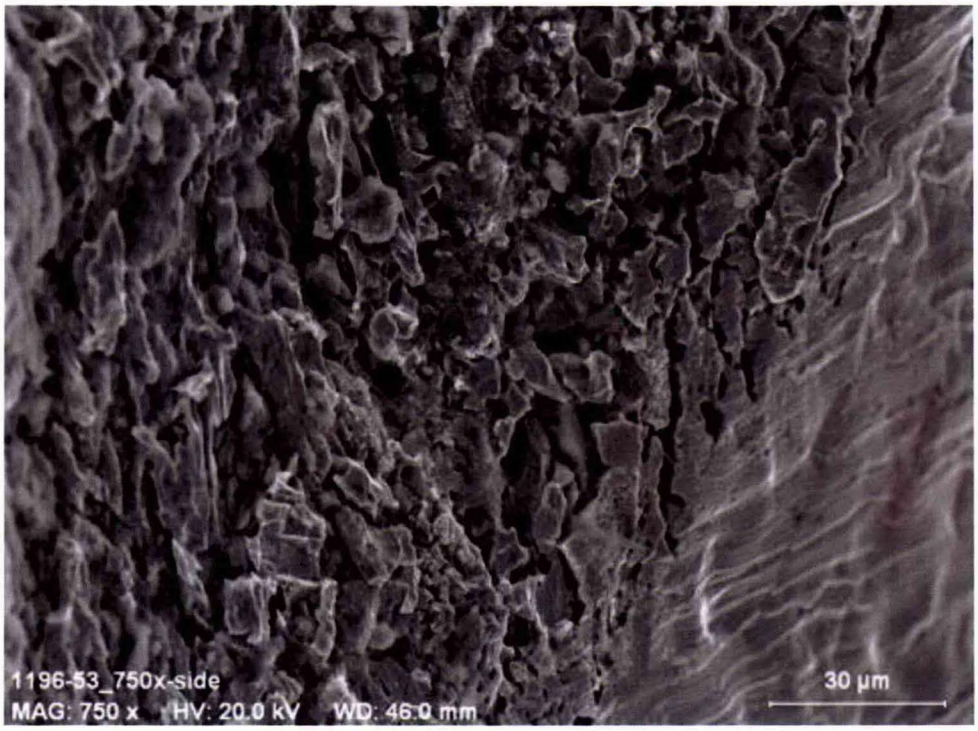


Figure C-22. The Stress-Strain Curve from SSRT 54 Performed in AP105-PSC Standard Simulant at 50°C, pH 13+ and at 0 mV vs. SCE.

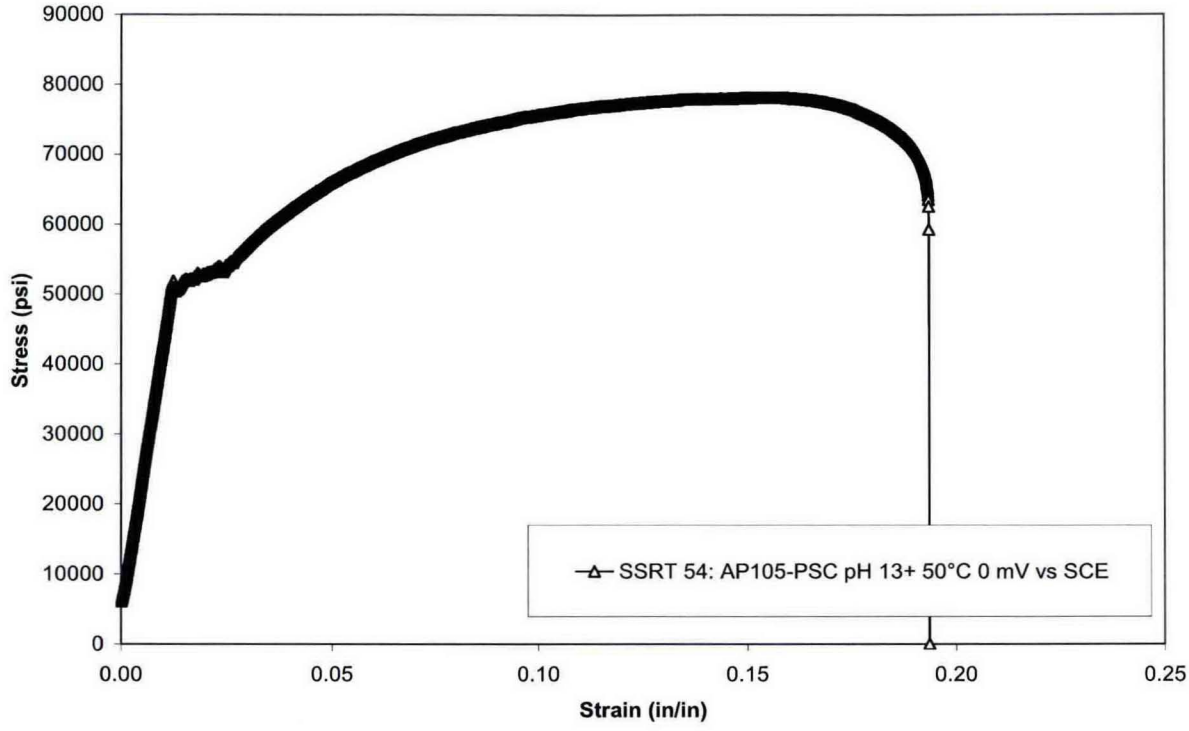


Figure C-23. A Stereo-Micrograph of the Sample from SSRT 54 Performed in AP105-PSC Standard Simulant at 50°C, pH 13+ and at 0 mV vs. SCE.

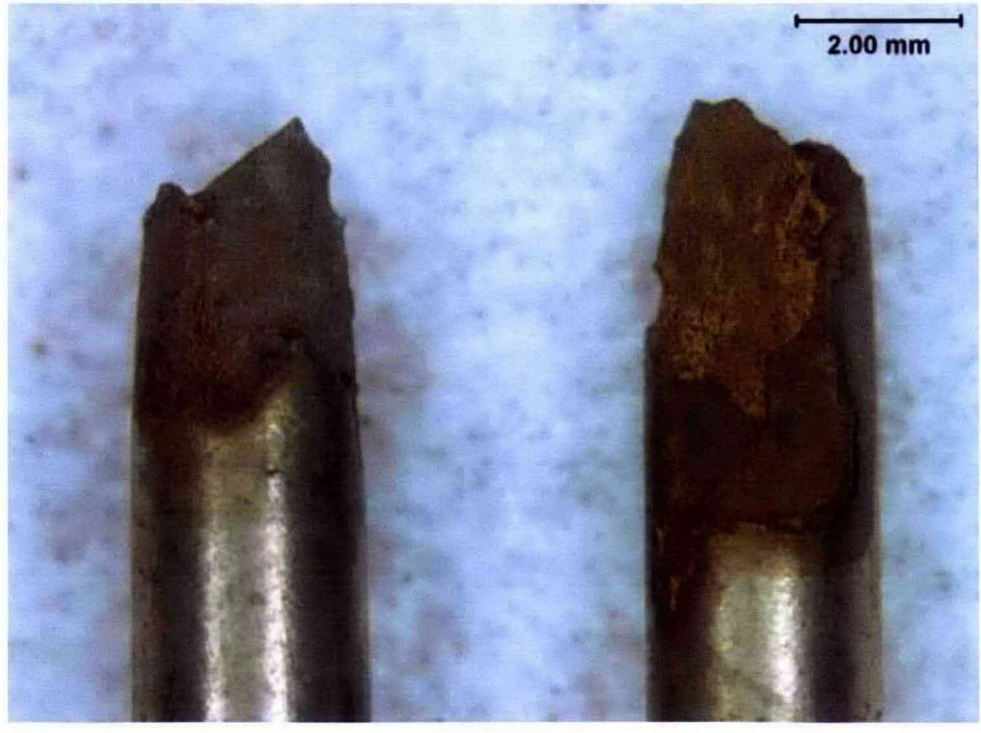


Figure C-24. An Electron-Micrograph of the Fracture Surface from SSRT 54 Performed in AP105-PSC Standard Simulant at 50°C, pH 13+ and at 0 mV vs. SCE.

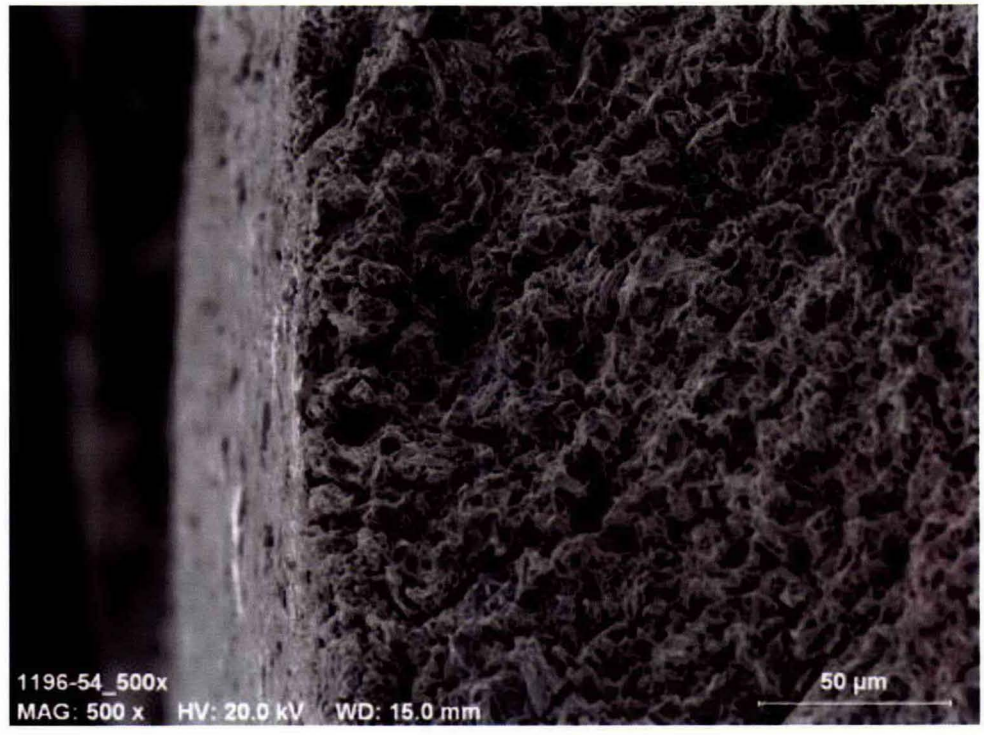


Figure C-25. The Stress-Strain Curve from SSRT 55 Performed in SY103-PIL Standard Simulant at 50°C, pH 14 and at OCP (-424 mV vs. SCE).

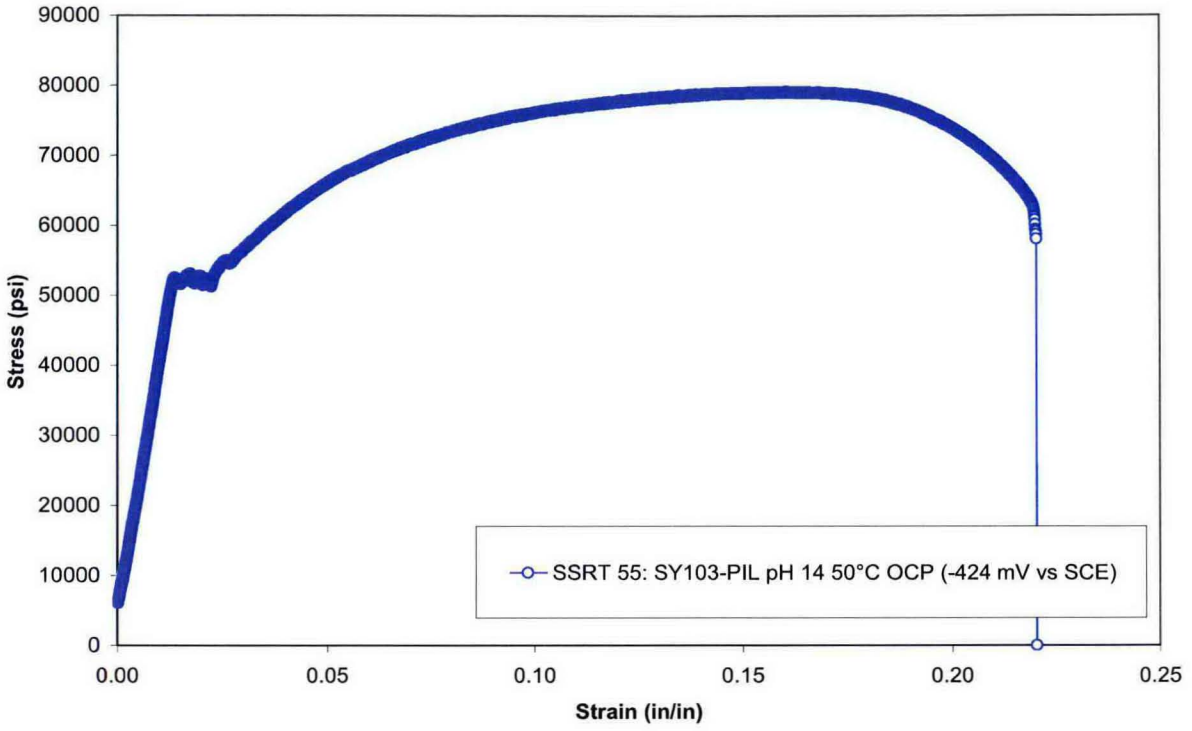


Figure C-26. A Stereo-Micrograph of the Sample from SSRT 55 Performed in SY103-PIL Standard Simulant at 50°C, pH 14 and at OCP (-424 mV vs. SCE).

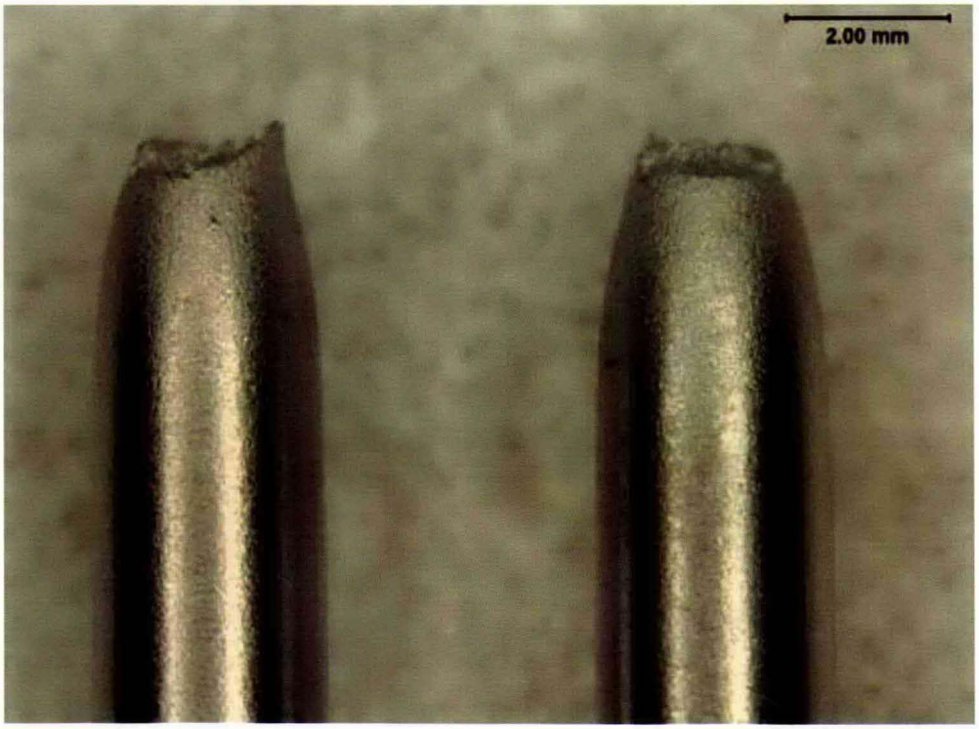


Figure C-27. An Electron-Micrograph of the Fracture Surface from SSRT 55 Performed in SY103-PIL Standard Simulant at 50°C, pH 14 and at OCP (-424 mV vs. SCE).

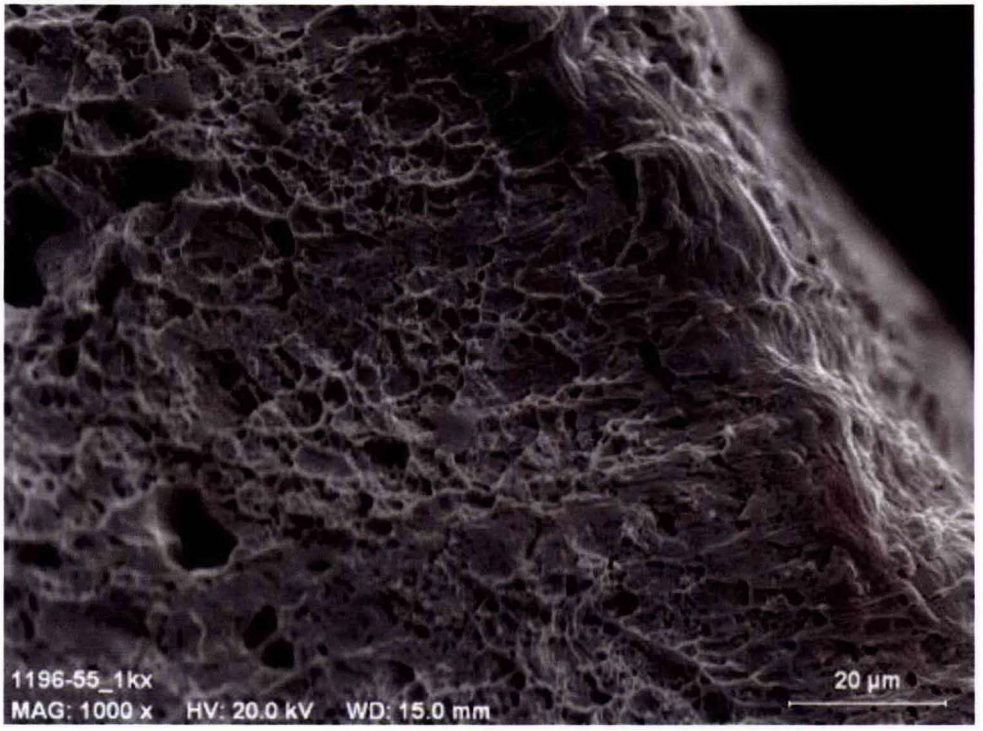


Figure C-28. The Stress-Strain Curve from SSRT 56 Performed in AW105-PIL Standard Simulant at 50°C, pH 13+ and at OCP (-290 mV vs. SCE).

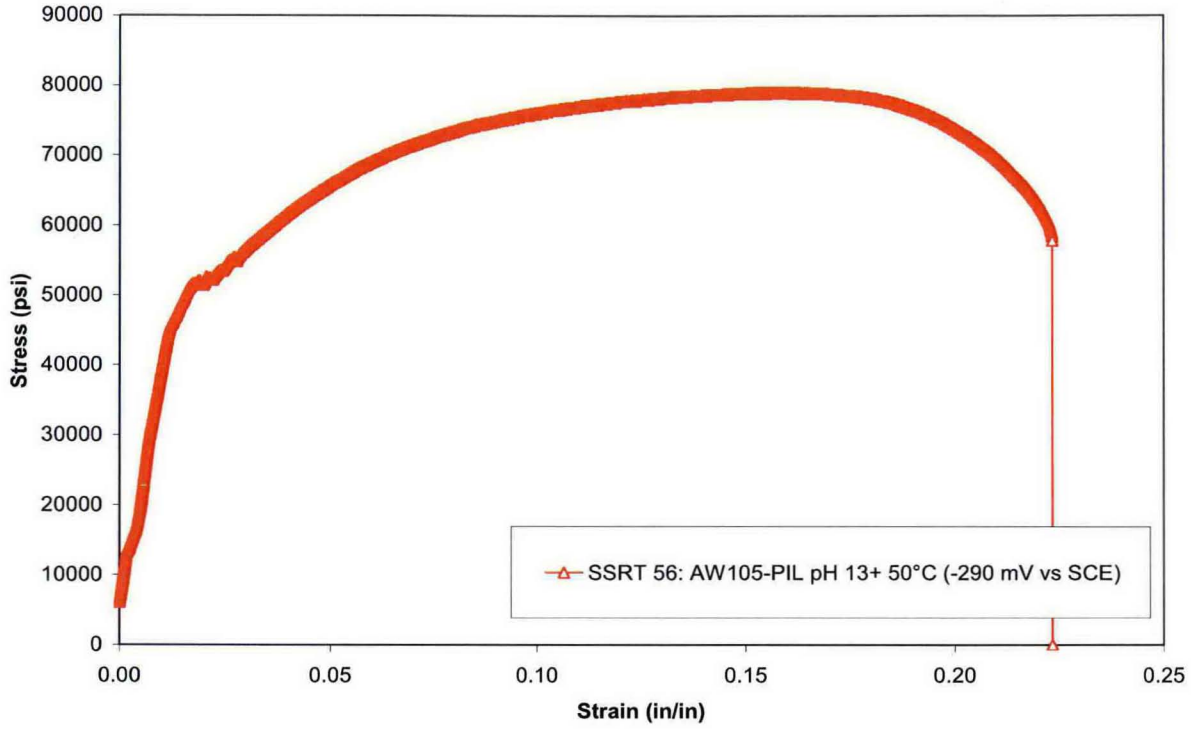


Figure C-29. A Stereo-Micrograph of the Sample from SSRT 56 Performed in AW105-PIL Standard Simulant at 50°C, pH 13+ and at OCP (-290 mV vs. SCE).

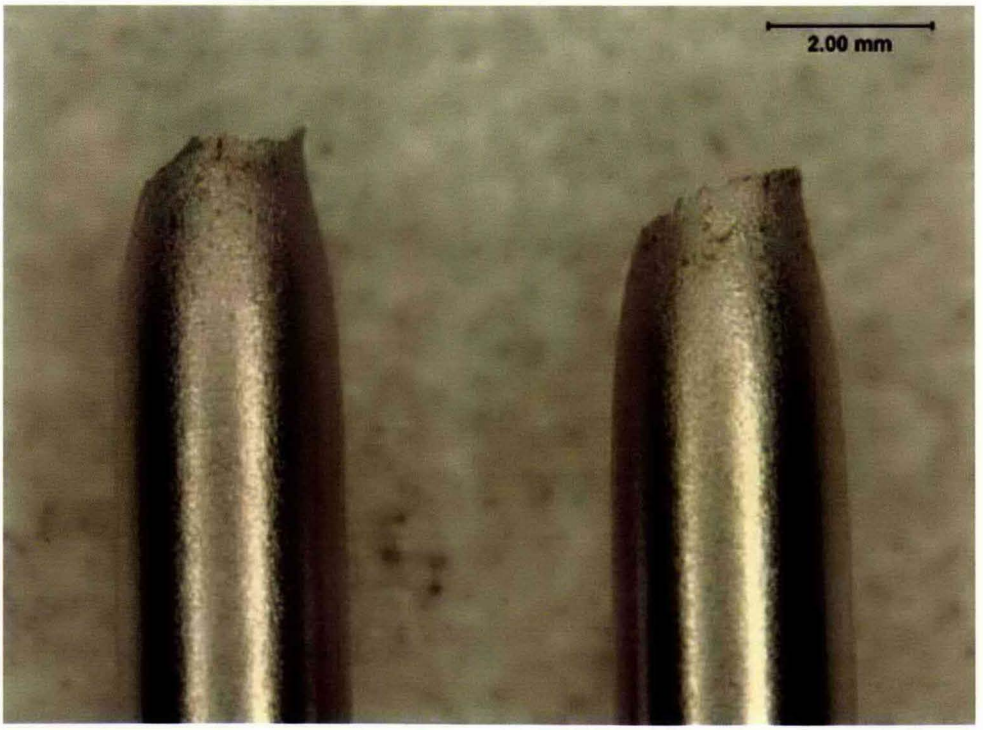


Figure C-30. An Electron-Micrograph of the Fracture Surface from SSRT 56 Performed in AW105-PIL Standard Simulant at 50°C, pH 13+ and at OCP (-290 mV vs. SCE).

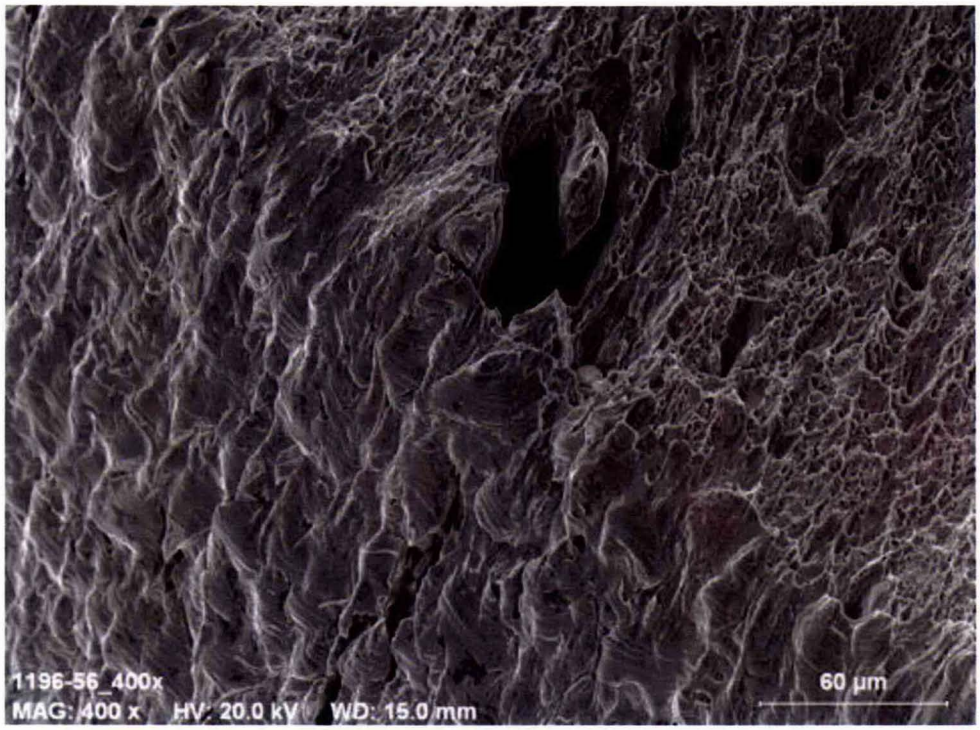


Figure C-31. The Stress-Strain Curve from SSRT 57 Performed in SY103-PIL Standard Simulant at 50°C, pH 14 and at 0 mV vs. SCE.

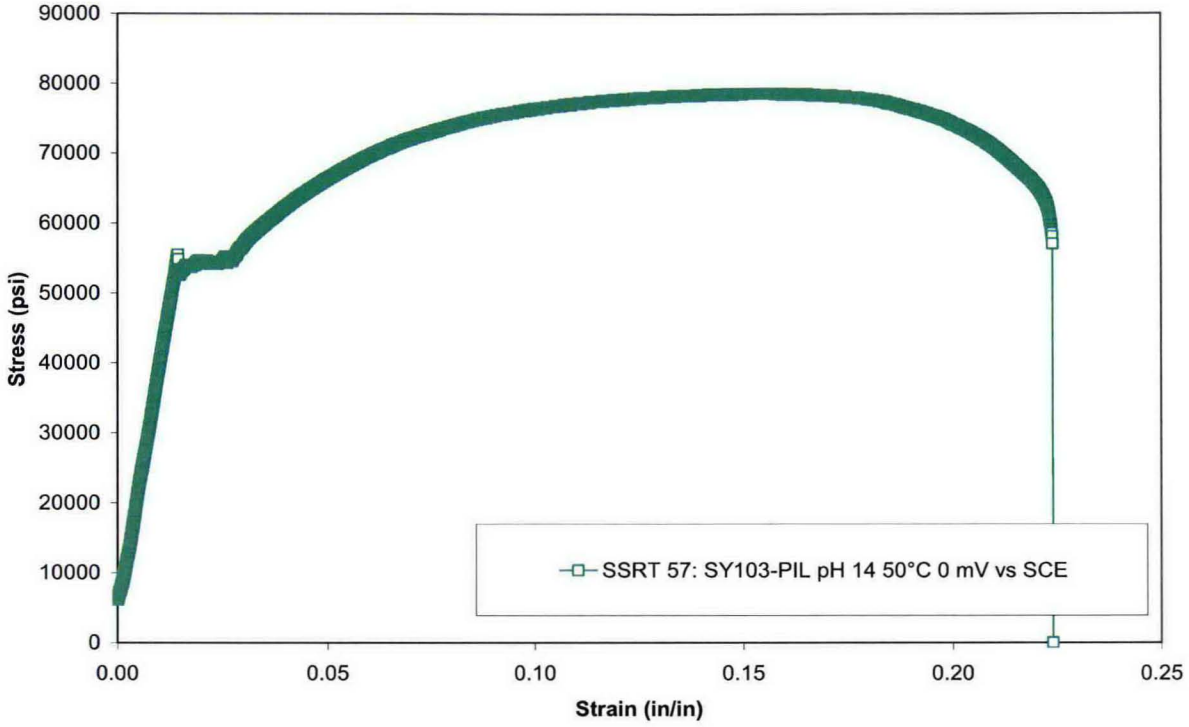


Figure C-32. A Stereo-Micrograph of the Sample from SSRT 57 Performed in SY103-PIL Standard Simulant at 50°C, pH 14 and at 0 mV vs. SCE.

Figure C-33. An Electron-Micrograph of the Fracture Surface from SSRT 57 Performed in SY103-PIL Standard Simulant at 50°C, pH 14 and at 0 mV vs. SCE.

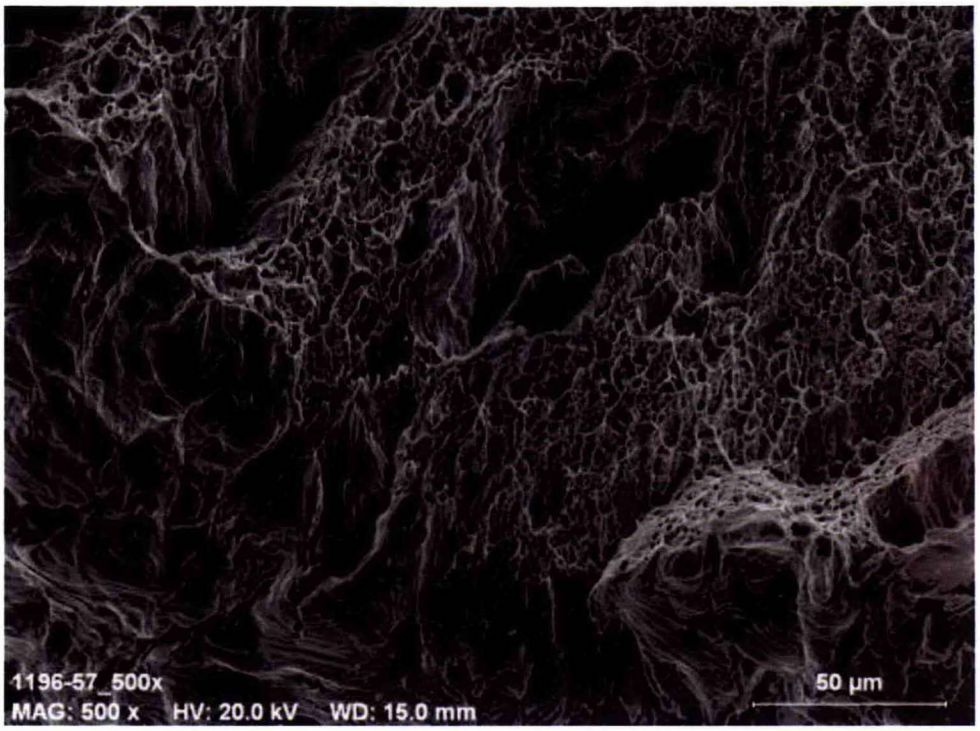


Figure C-34. The Stress-Strain Curve from SSRT 58 Performed in AW105-PIL Standard Simulant at 50°C, pH 13+ and at 0 mV vs. SCE.

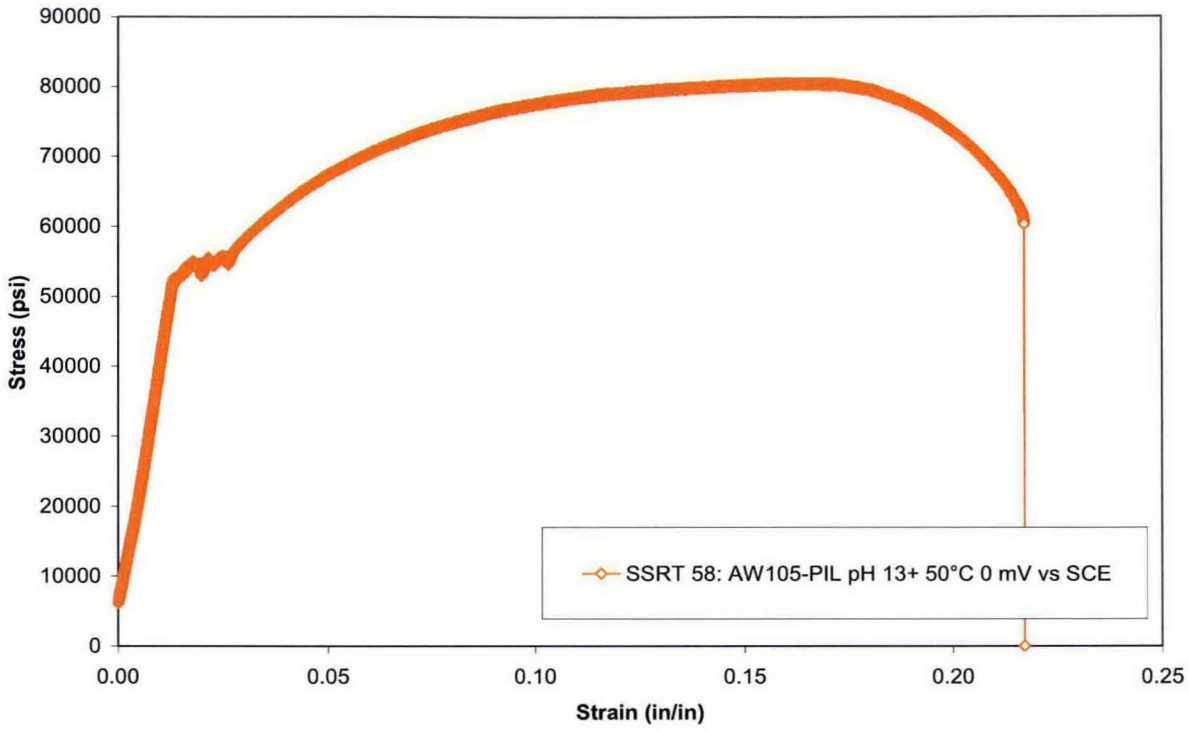


Figure C-35. A Stereo-Micrograph of the Sample from SSRT 58 Performed in AW105-PIL Standard Simulant at 50°C, pH 13+ and at 0 mV vs. SCE.

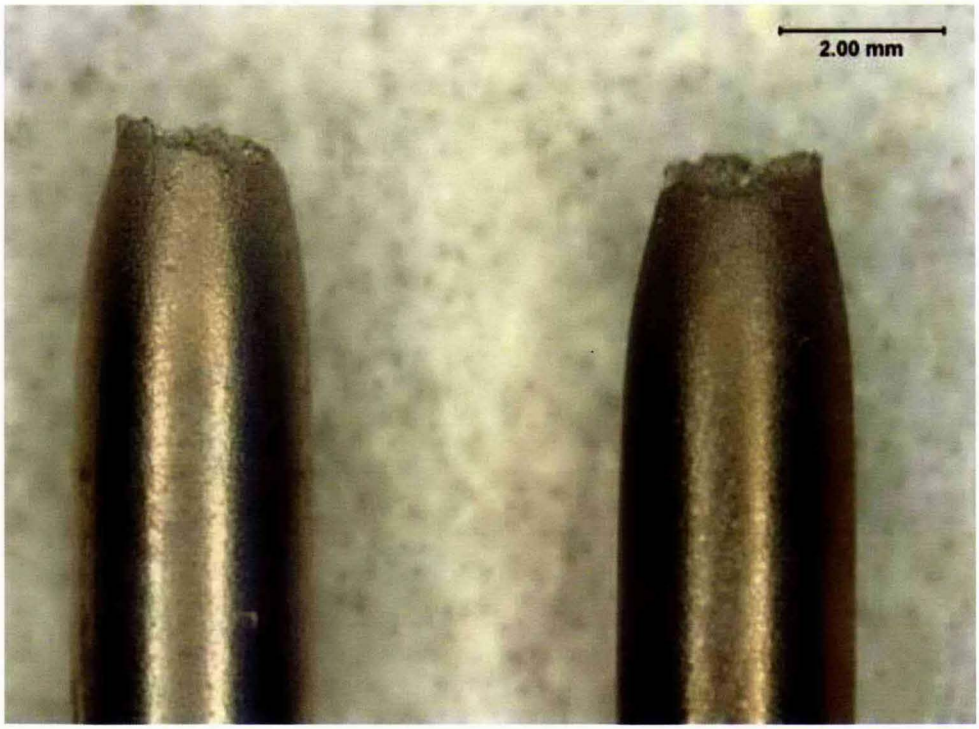


Figure C-36. An Electron-Micrograph of the Fracture Surface from SSRT 58 Performed in AW105-PIL Standard Simulant at 50°C, pH 13+ and at 0 mV vs. SCE.

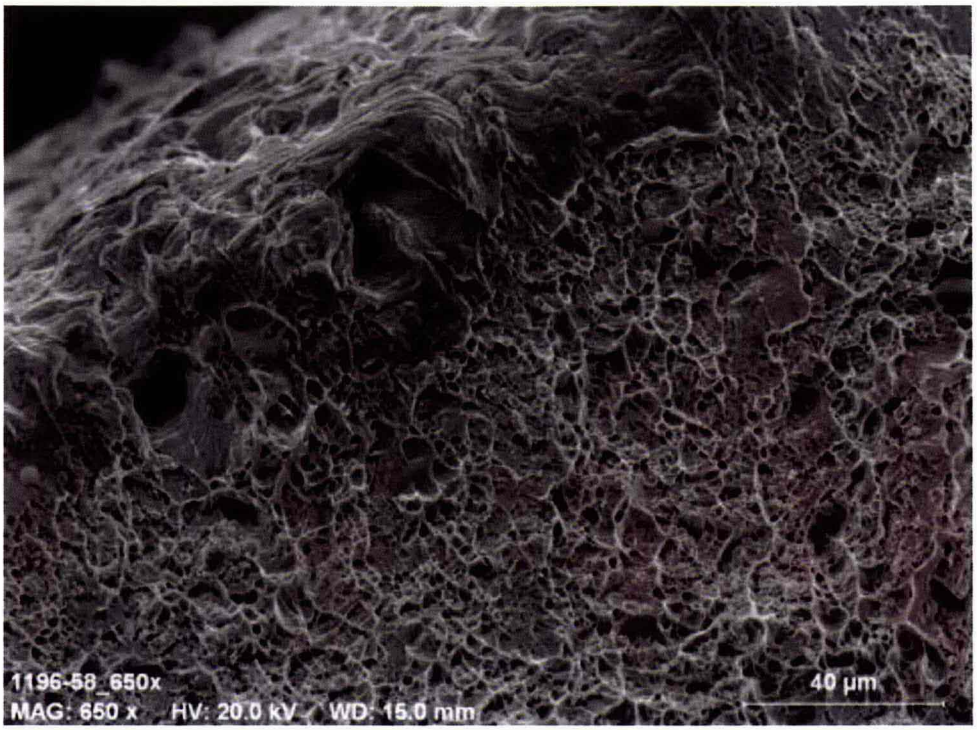


Figure C-37. The Stress-Strain Curve from SSRT 59 Performed in AP105-Evaporated Simulant at 50°C, pH 13+ and at OCP (-510 mV vs. SCE).

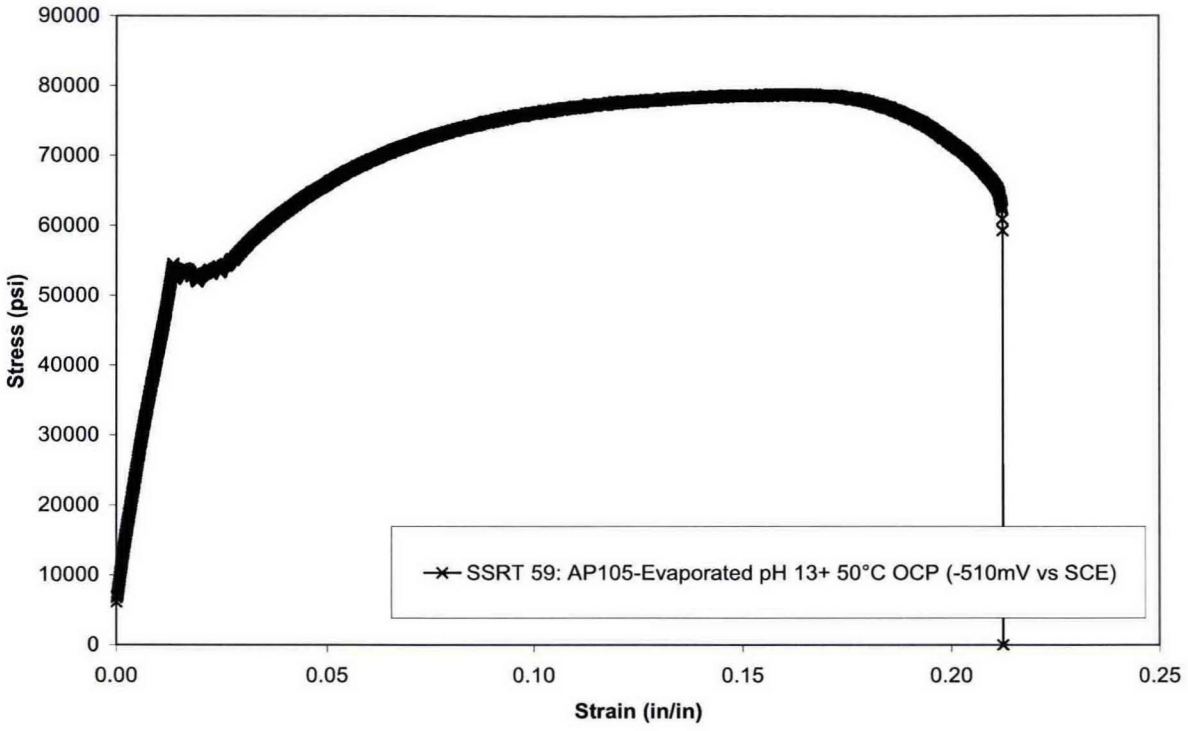


Figure C-38. A Stereo-Micrograph of the Sample from SSRT 59 Performed in AP105-Evaporated Simulant at 50°C, pH 13+ and at OCP (-510 mV vs. SCE).

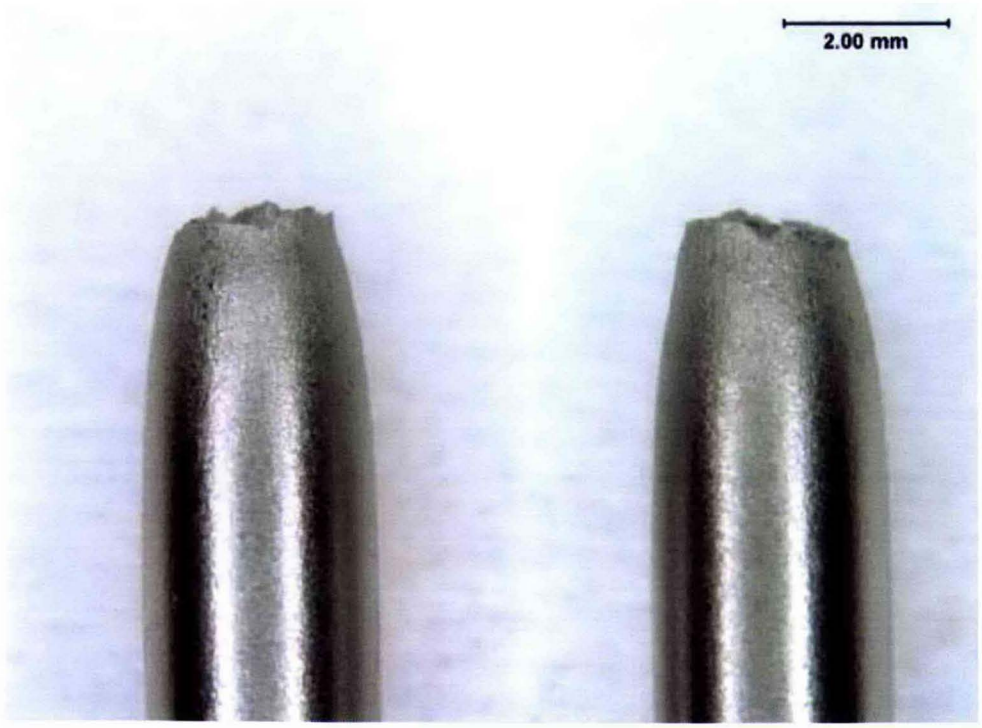


Figure C-39. An Electron-Micrograph of the Fracture Surface from SSRT 59 Performed in AP105-Evaporated Simulant at 50°C, pH 13+ and at OCP (-510 mV vs. SCE).

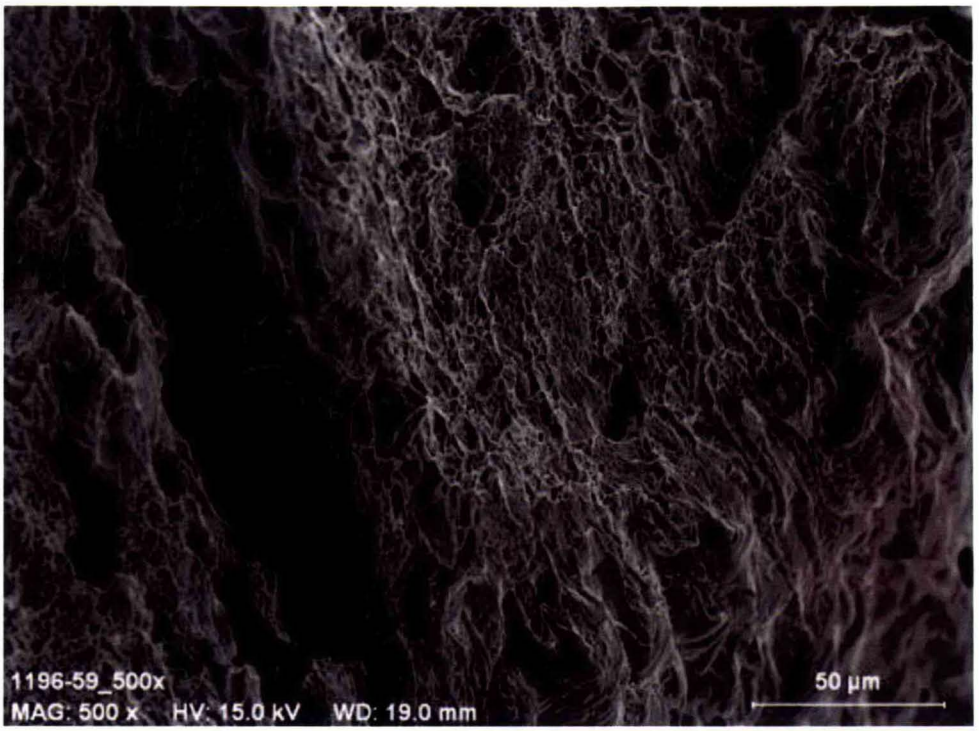


Figure C-40. The Stress-Strain Curve from SSRT 60 Performed in AP105-PSC Simulant at 50°C, pH 13+ and at OCP (-277 mV vs. SCE). Tested to UTS and stopped.

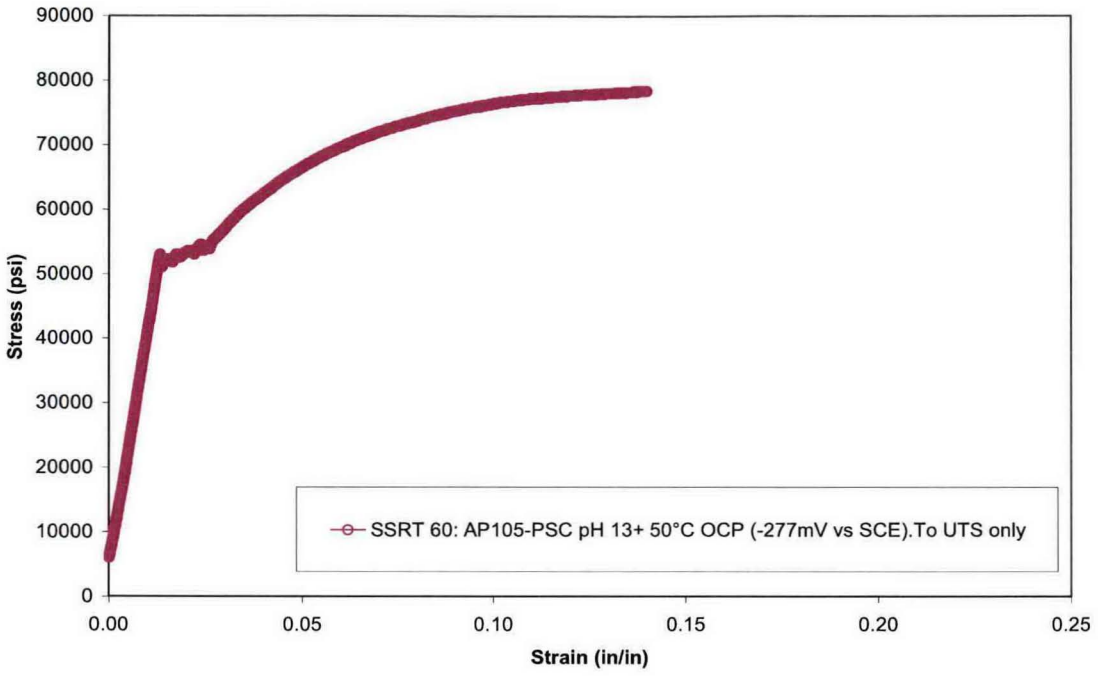


Figure C-41. A Stereo-Micrograph of the Sample from SSRT 60 Performed in AP105-PSC Simulant at 50°C, pH 13+ and at OCP (-277 mV vs. SCE). Tested to UTS and stopped.

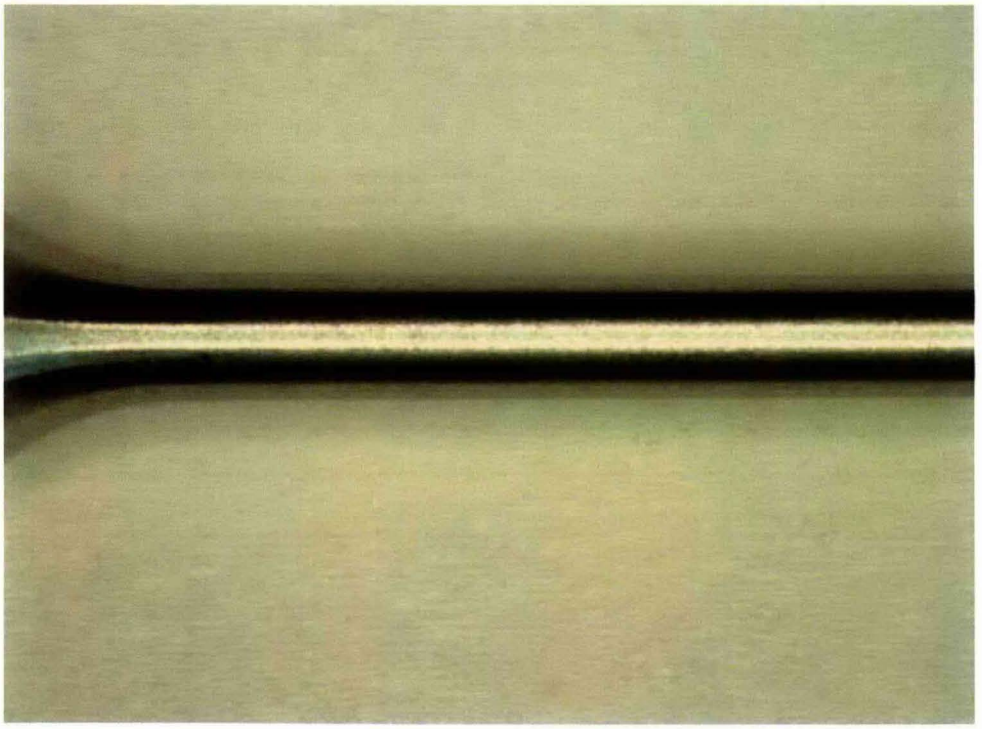


Figure C-42. A Stereo Micrograph of the Liquid / Vapor Interface Region from SSRT 60 Performed in AP105-PSC Simulant at 50°C, pH 13+ and at OCP (-277 mV vs. SCE). Tested to UTS and stopped.

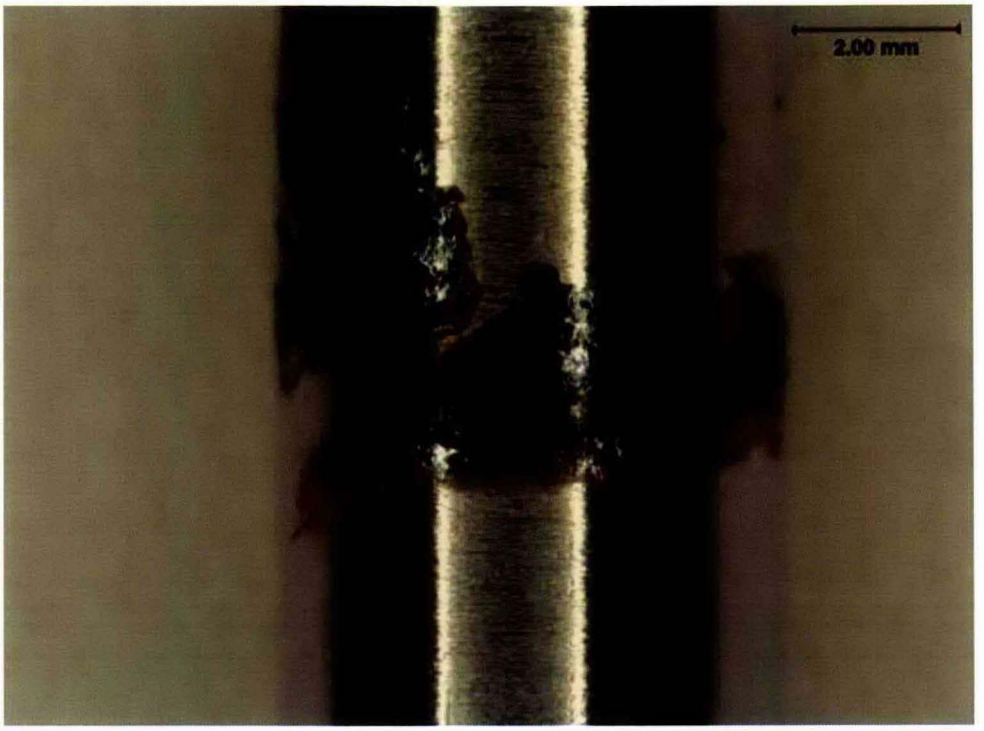


Figure C-43. The Stress-Strain Curve from SSRT 61 Performed in AZ102 Simulant at 77°C, pH 12+ and at OCP (-239 mV vs. SCE).

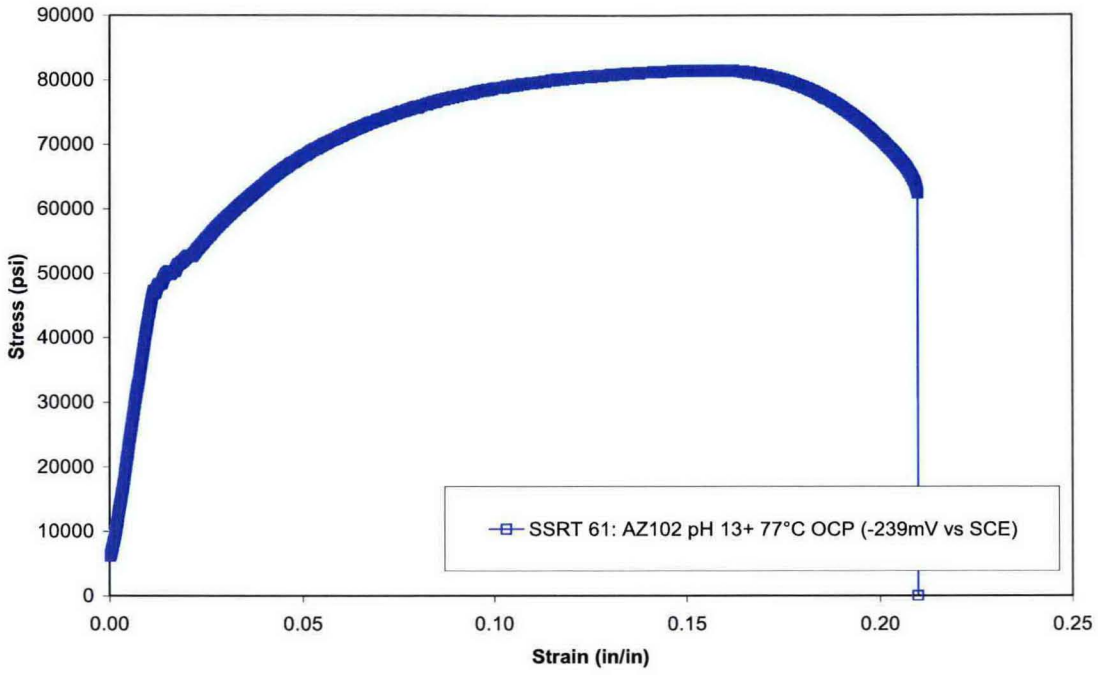


Figure C-44. A Stereo-Micrograph of the Sample from SSRT 61 Performed in AZ102 Simulant at 77°C, pH 12+ and at OCP (-239 mV vs. SCE).

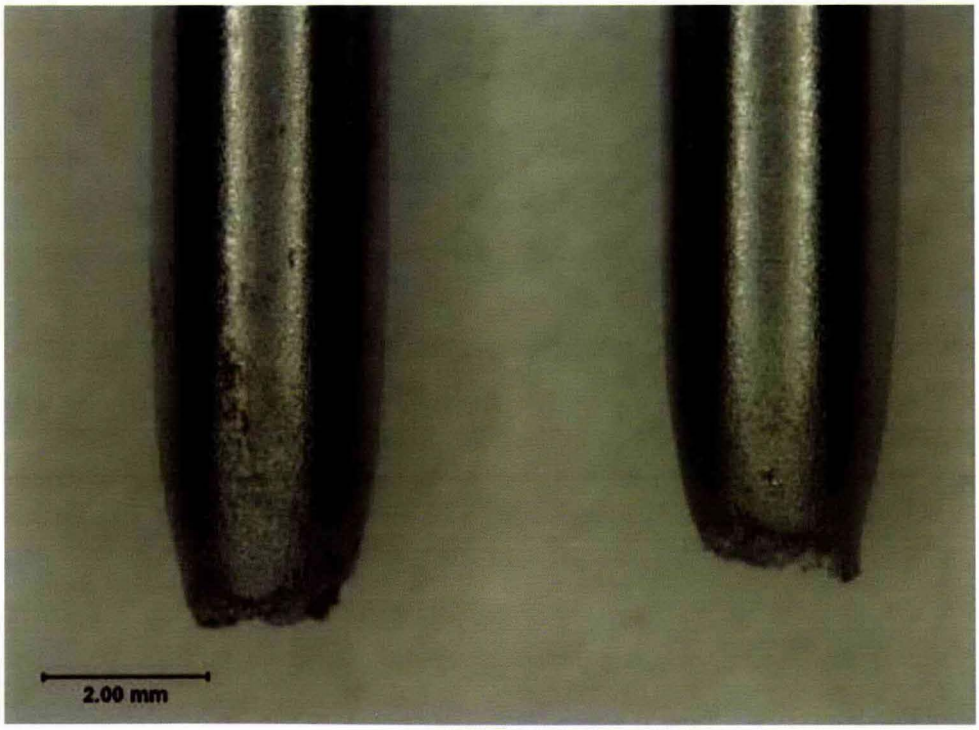


Figure C-45. An Electron-Micrograph of the Fracture Surface from SSRT 61 Performed in AZ102 Simulant at 77°C, pH 12+ and at OCP (-239 mV vs. SCE).

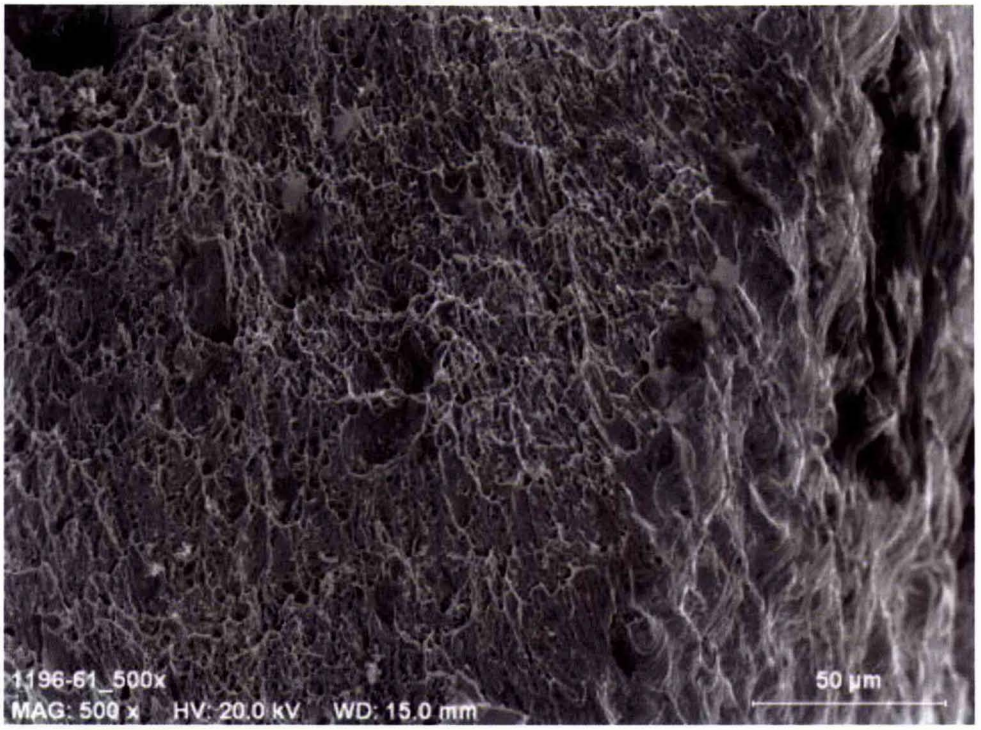


Figure C-46. The Stress-Strain Curve from SSRT 62 Performed in AP105-Evaporated Simulant with Nitrite/Nitrate ratio of 0.1 at 50°C, pH 13+ and at OCP (-333 mV vs. SCE).

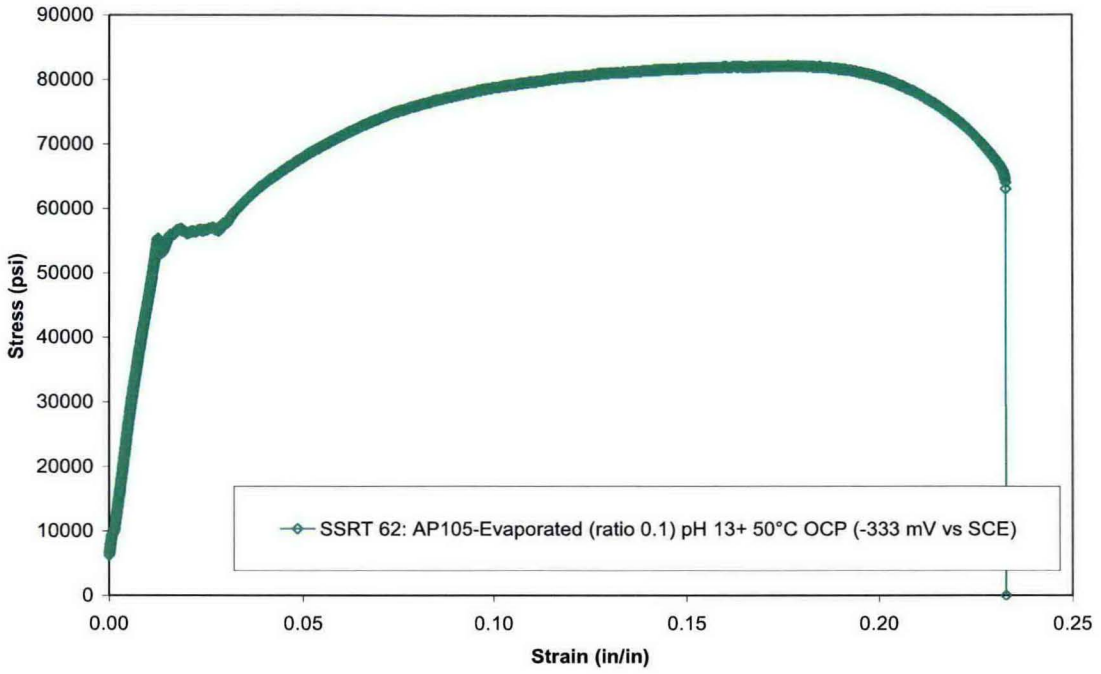


Figure C-47. A Stereo-Micrograph of the Sample from SSRT 62 Performed in AP105-Evaporated Simulant with Nitrite/Nitrate ratio of 0.1 at 50°C, pH 13+ and at OCP (-333 mV vs. SCE).

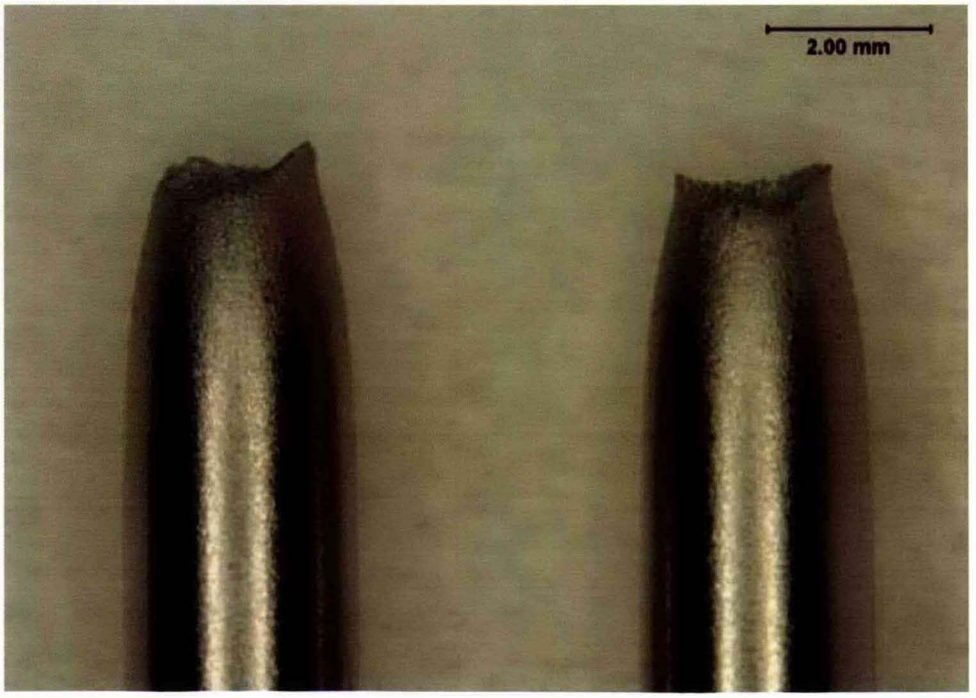


Figure C-48. An Electron-Micrograph of the Fracture Surface from SSRT 62 Performed in AP105-Evaporated Simulant with Nitrite/Nitrate ratio of 0.1 at 50°C, pH 13+ and at OCP (-333 mV vs. SCE).

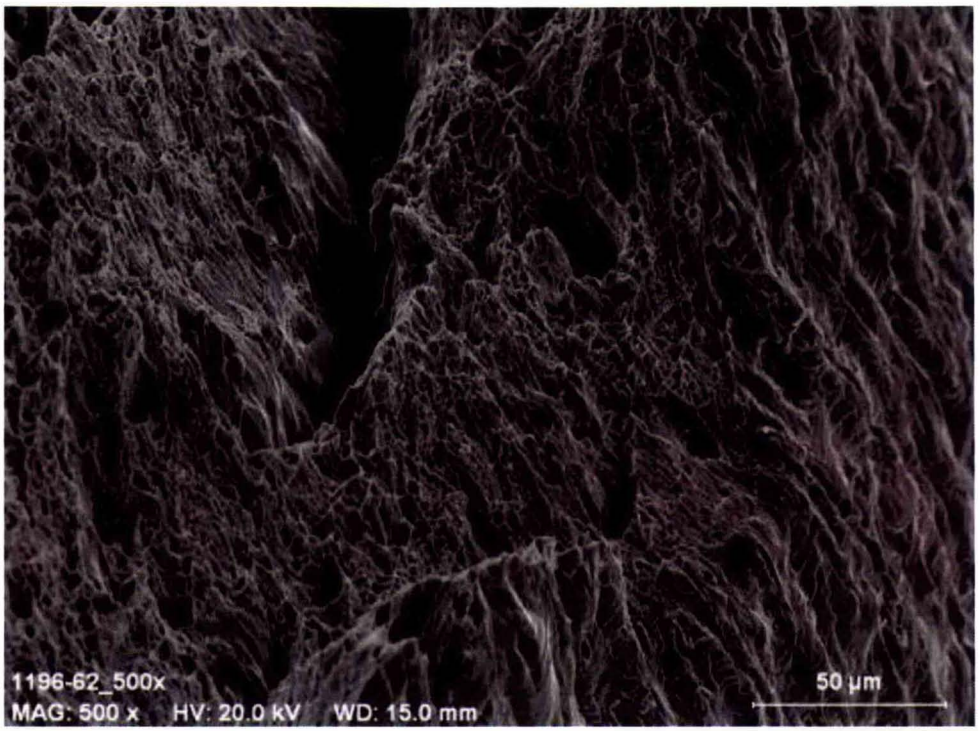


Figure C-49. The Stress-Strain Curve from SSRT 63 Performed in AP105-Mixed Simulant with Nitrite/Nitrate ratio of 0.1 at 50°C, pH 13+ and at OCP (-259 mV vs. SCE).

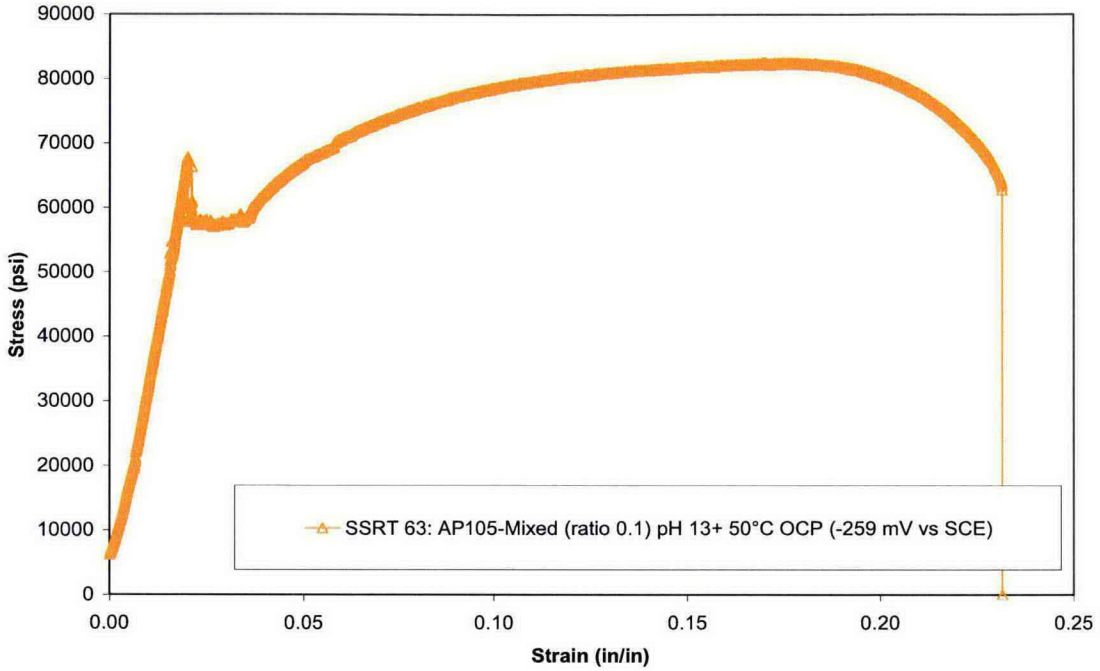


Figure C-50. A Stereo-Micrograph of the Sample from SSRT 63 Performed in AP105-Mixed Simulant with Nitrite/Nitrate ratio of 0.1 at 50°C, pH 13+ and at OCP (-259 mV vs. SCE).

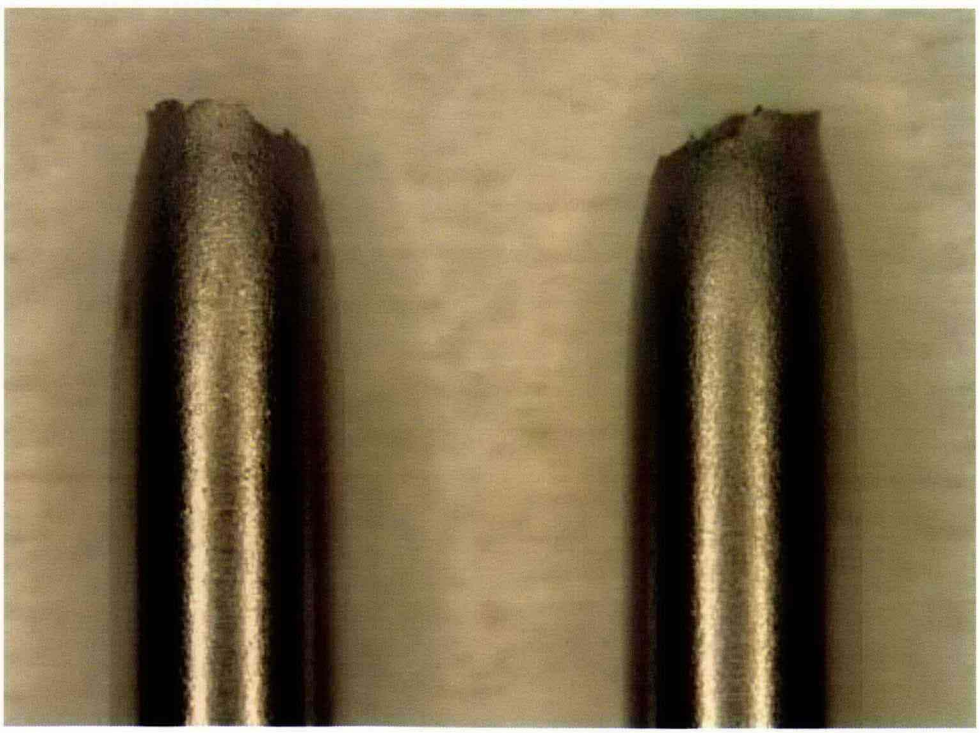


Figure C-51. An Electron-Micrograph of the Fracture Surface from SSRT 63 Performed in AP105-Mixed Simulant with Nitrite/Nitrate ratio of 0.1 at 50°C, pH 13+ and at OCP (-259 mV vs. SCE).

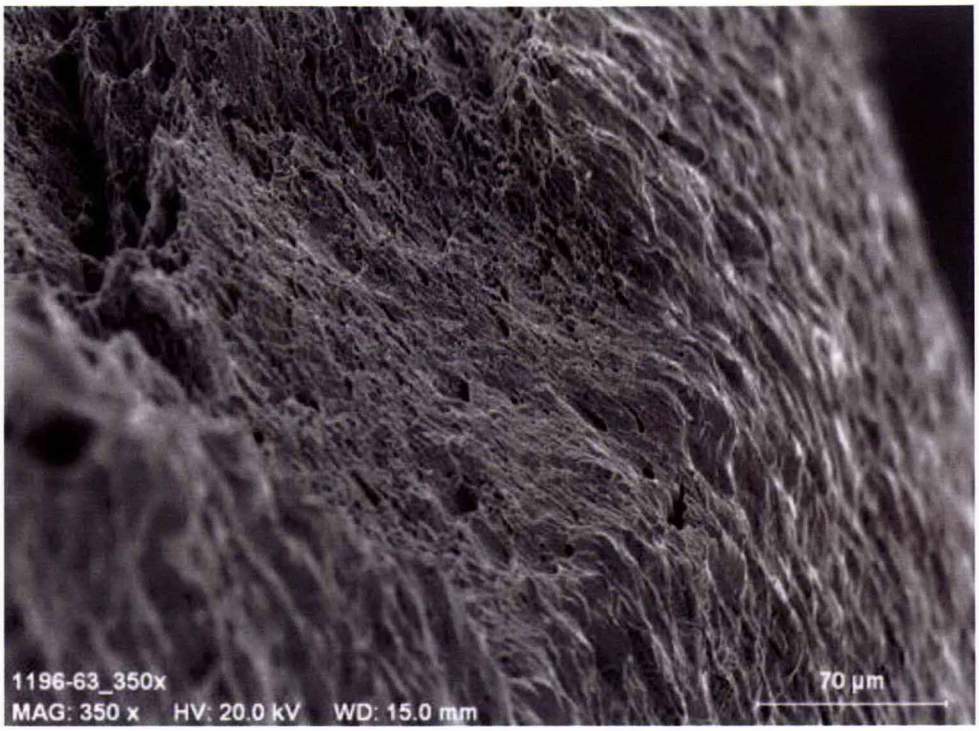


Figure C-52. The Stress-Strain Curve from SSRT 64 Performed in AP105-Mixed Simulant at 50°C, pH 13+ and at OCP (-312 mV vs. SCE).

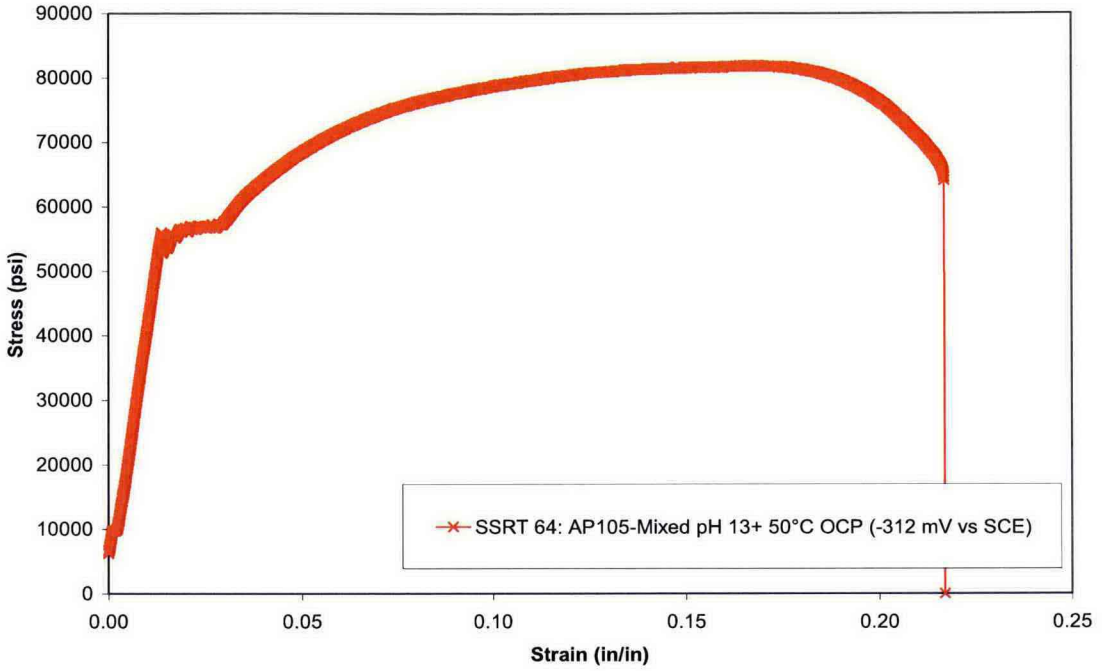


Figure C-53. A Stereo-Micrograph of the Sample from SSRT 64 Performed in AP105-Mixed Simulant at 50°C, pH 13+ and at OCP (-312 mV vs. SCE).

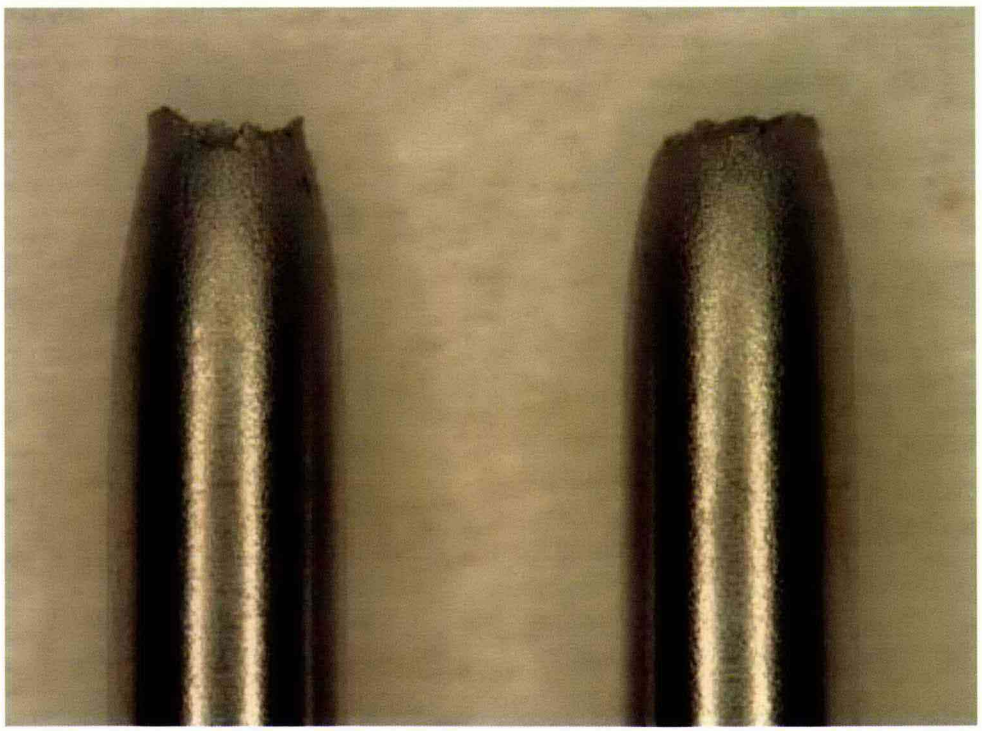


Figure C-54. An Electron-Micrograph of the Fracture Surface from SSRT 64 Performed in AP105-Mixed Simulant at 50°C, pH 13+ and at OCP (-312 mV vs. SCE).

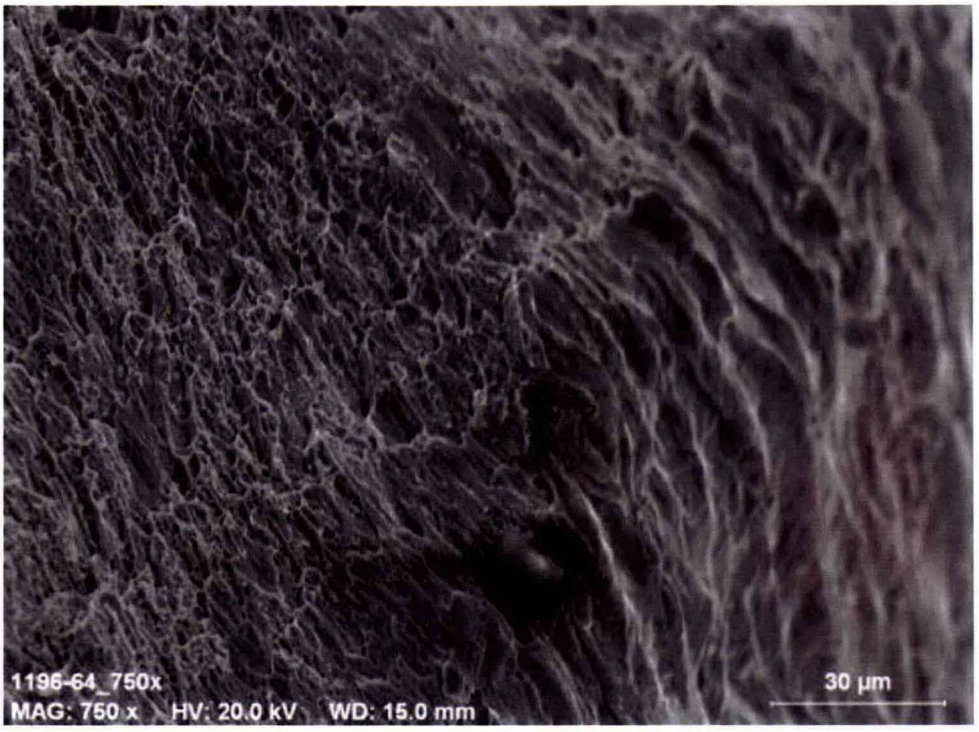


Figure C-55. The Stress-Strain Curve from SSRT 65 Performed in AP105-PSC Simulant at 50°C, pH 13+ and at -250 mV vs. SCE. Test stopped at UTS.

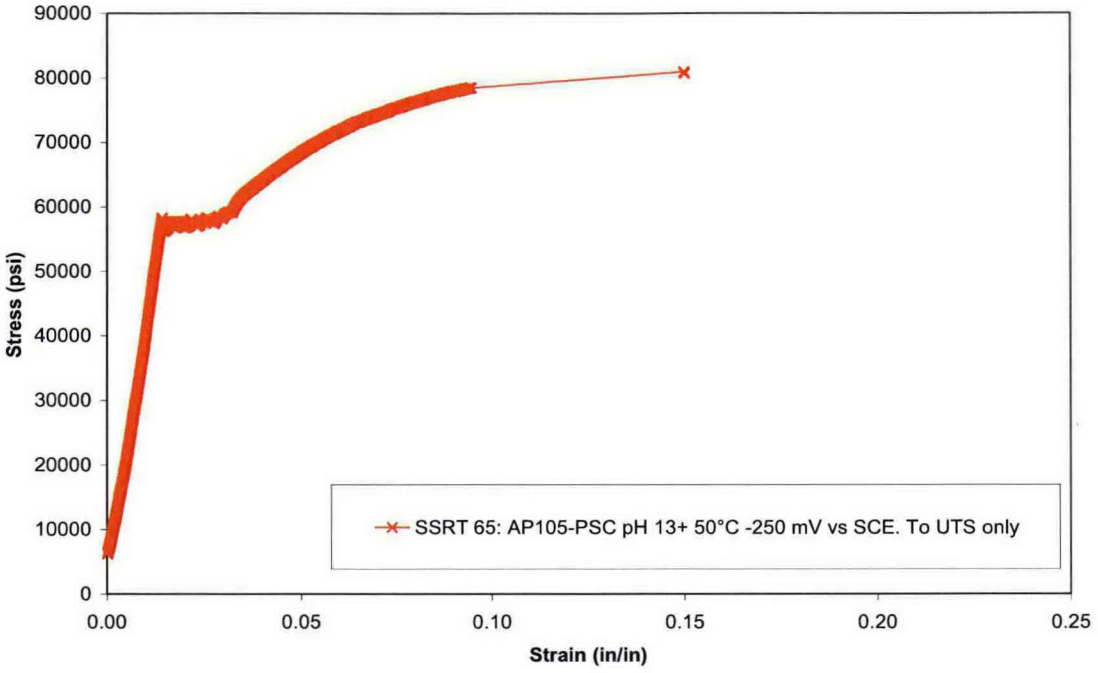


Figure C-56. A Stereo-Micrograph of the Sample from SSRT 65 Performed in AP105-PSC Simulant at 50°C, pH 13+ and at -250 mV vs. SCE. Test stopped at UTS.

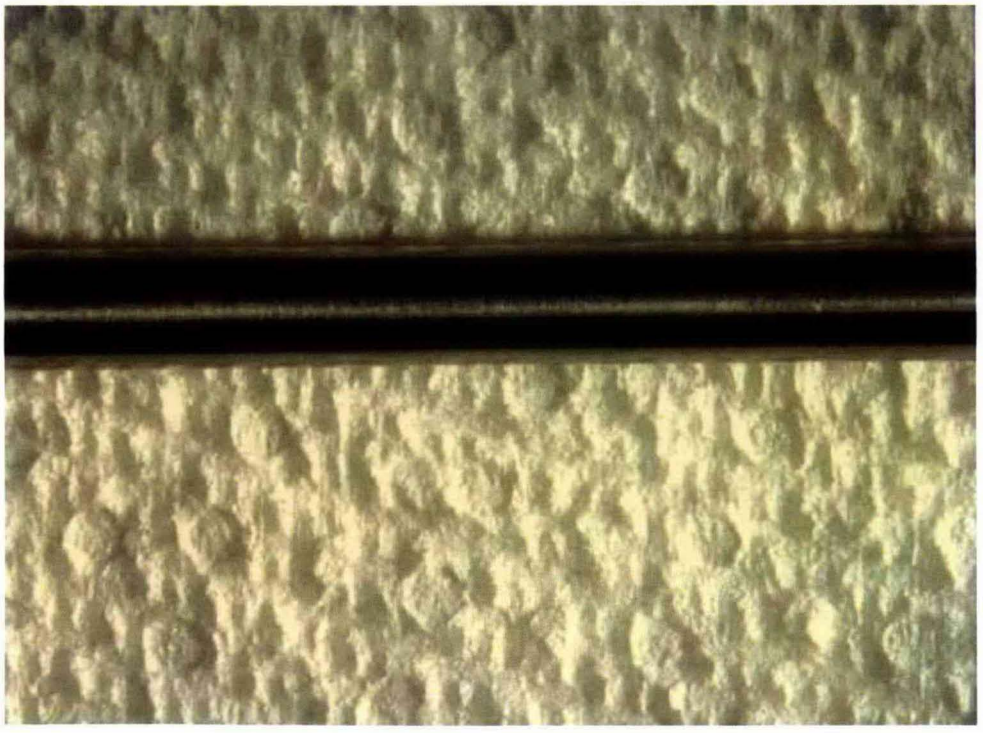


Figure C-57. The Stress-Strain Curve from SSRT 66 Performed in AW105-PSC Simulant at 50°C, pH 13+ and at OCP (-235 mV vs. SCE).

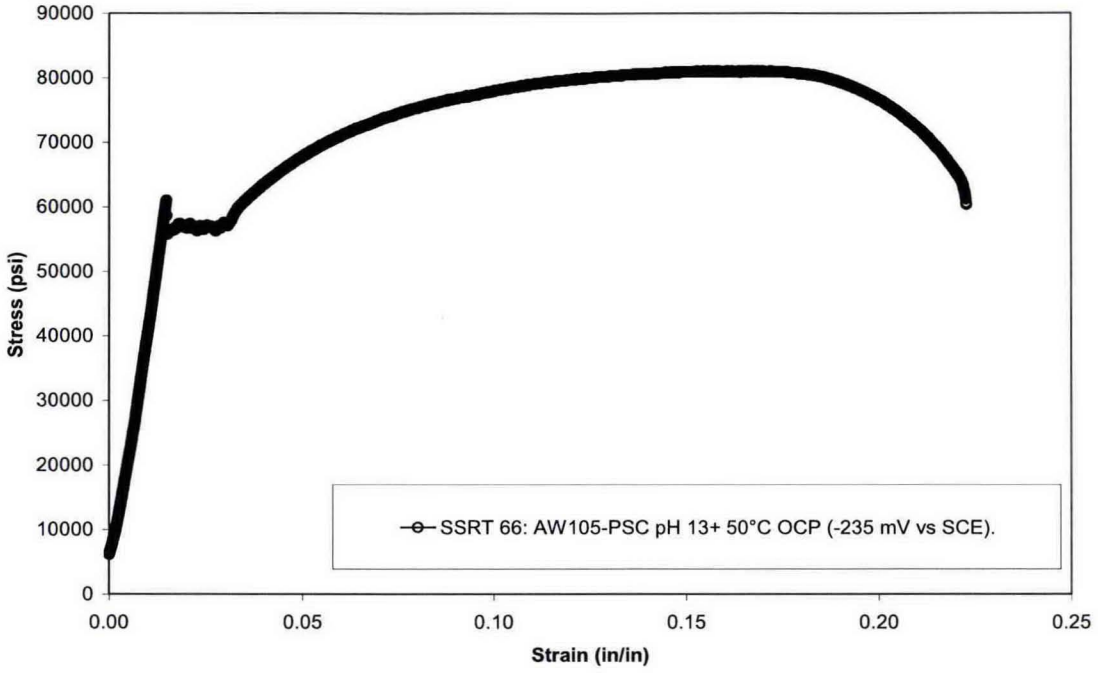


Figure C-58. A Stereo-Micrograph of the Sample from SSRT 66 Performed in AW105-PSC Simulant at 50°C, pH 13+ and at OCP (-235 mV vs. SCE).

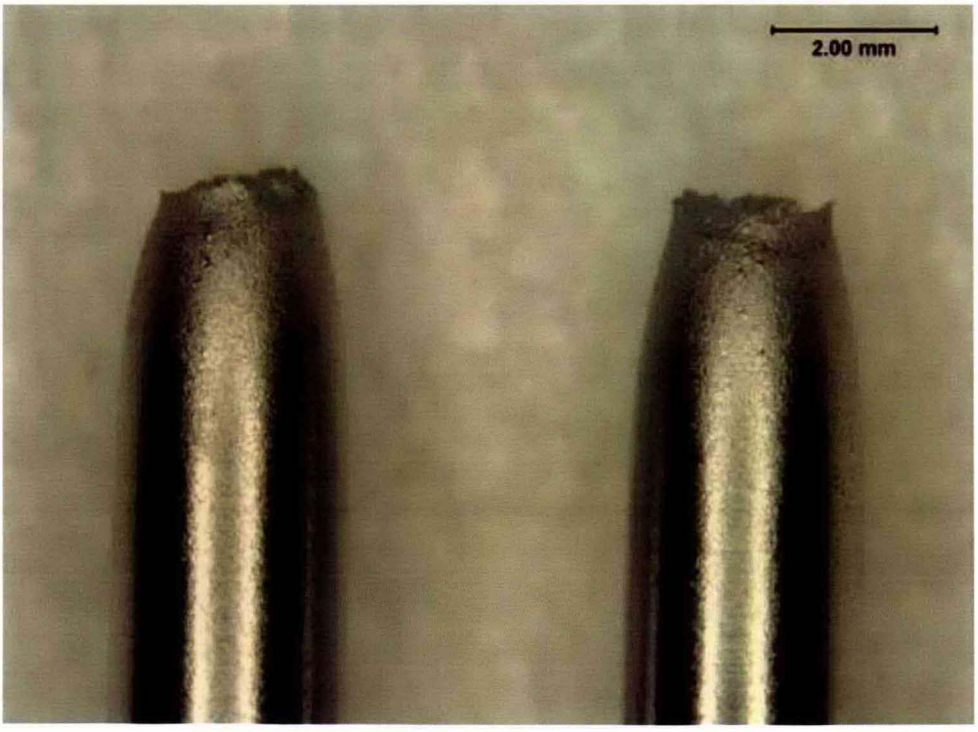


Figure C-59. An Electron-Micrograph of the Fracture Surface from SSRT 66 Performed in AW105-PSC Simulant at 50°C, pH 13+ and at OCP (-235 mV vs. SCE).

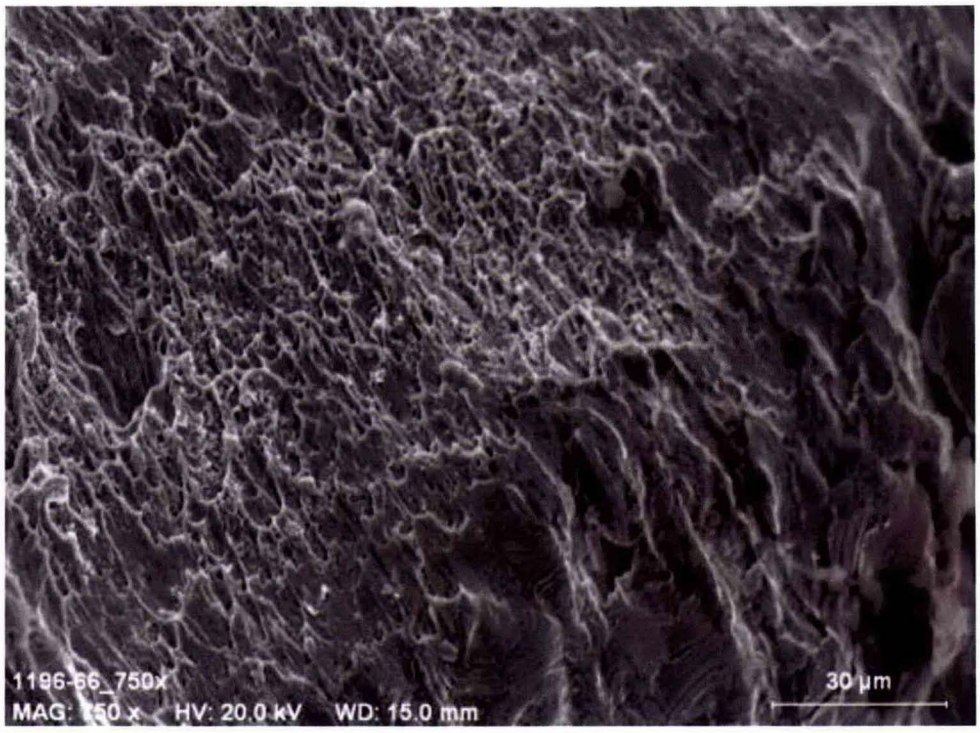


Figure C-60. The Stress-Strain Curve from SSRT 67 Performed in SY101 Simulant at 50°C, pH 13+ and at OCP (-206 mV vs. SCE).

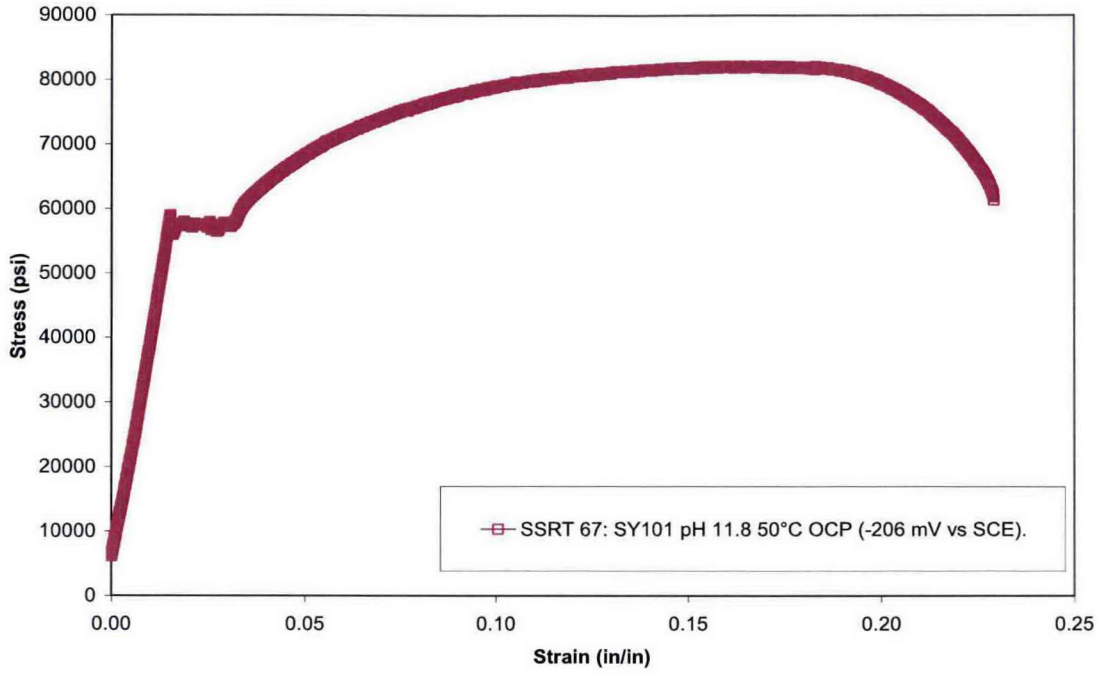


Figure C-61. A Stereo-Micrograph of the Sample from SSRT 67 Performed in SY101 Simulant at 50°C, pH 13+ and at OCP (-206 mV vs. SCE).

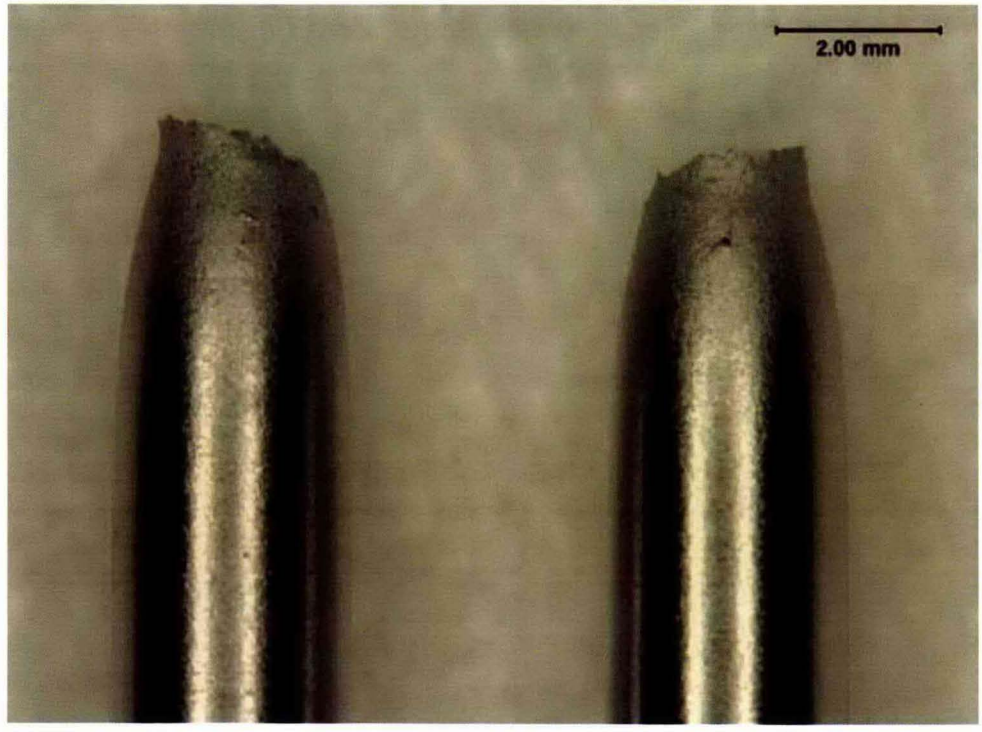


Figure C-62. An Electron-Micrograph of the Fracture Surface from SSRT 67 Performed in SY101 Simulant at 50°C, pH 13+ and at OCP (-206 mV vs. SCE).

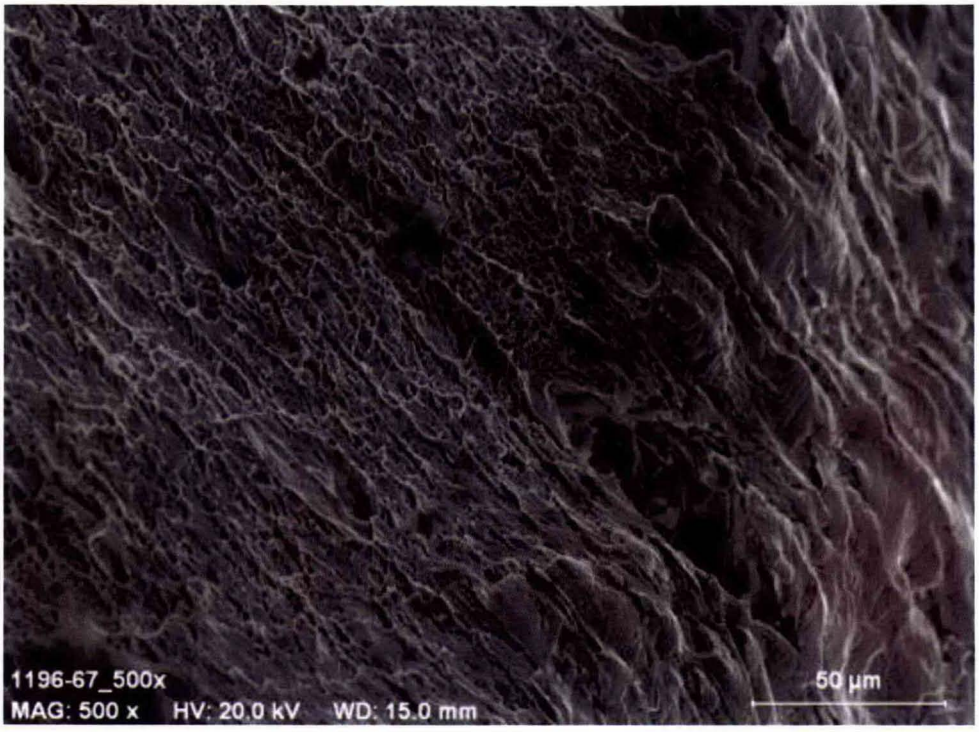


Figure C-63. The Stress-Strain Curve from SSRT 69 Performed in AY101-CSL Simulant at 50°C, pH 11.8 and at OCP (-181 mV vs. SCE).

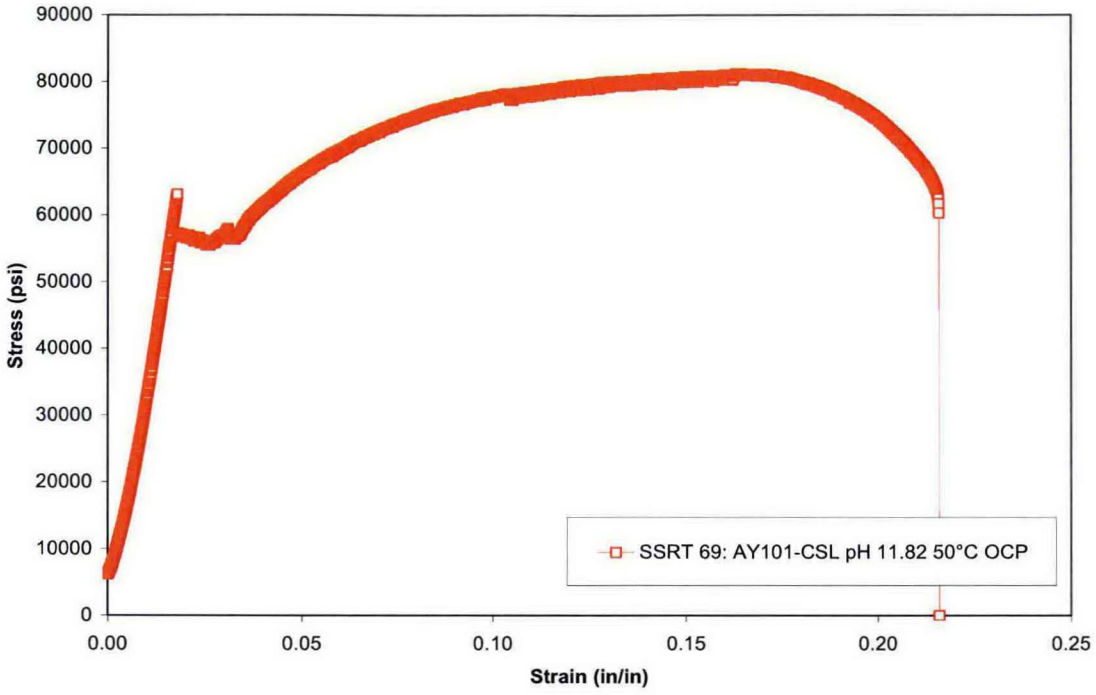


Figure C-64. A Stereo-Micrograph of the Sample from SSRT 69 Performed in AY101-CSL Simulant at 50°C, pH 11.8 and at OCP (-181 mV vs. SCE).

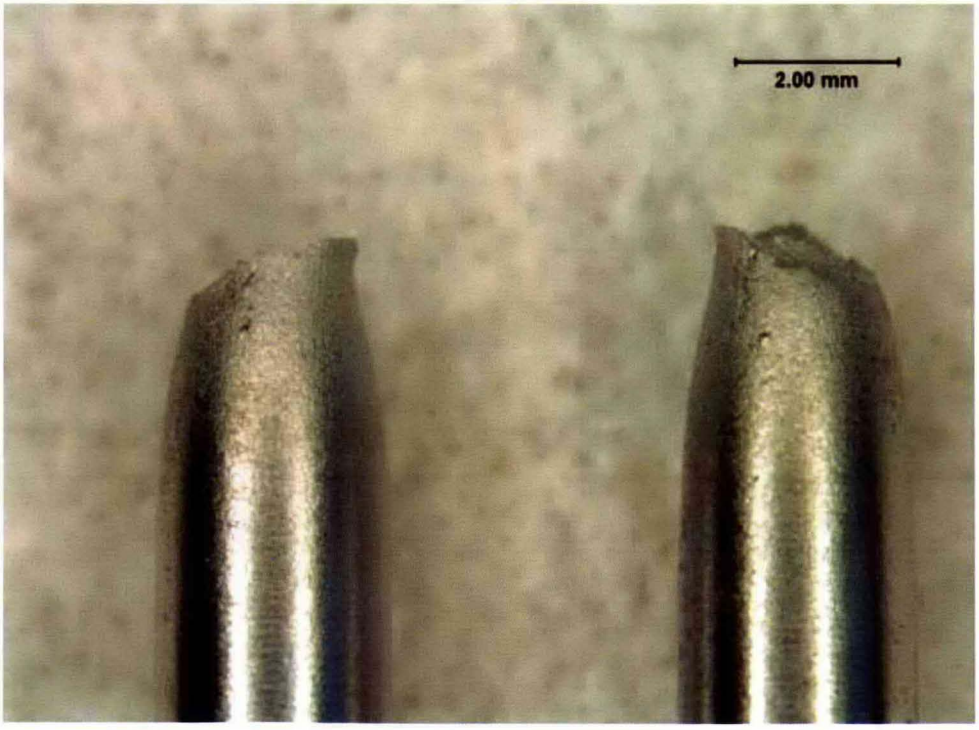


Figure C-65. An Electron-Micrograph of the Fracture Surface from SSRT 69 Performed in AY101-CSL Simulant at 50°C, pH 11.8 and at OCP (-181 mV vs. SCE).

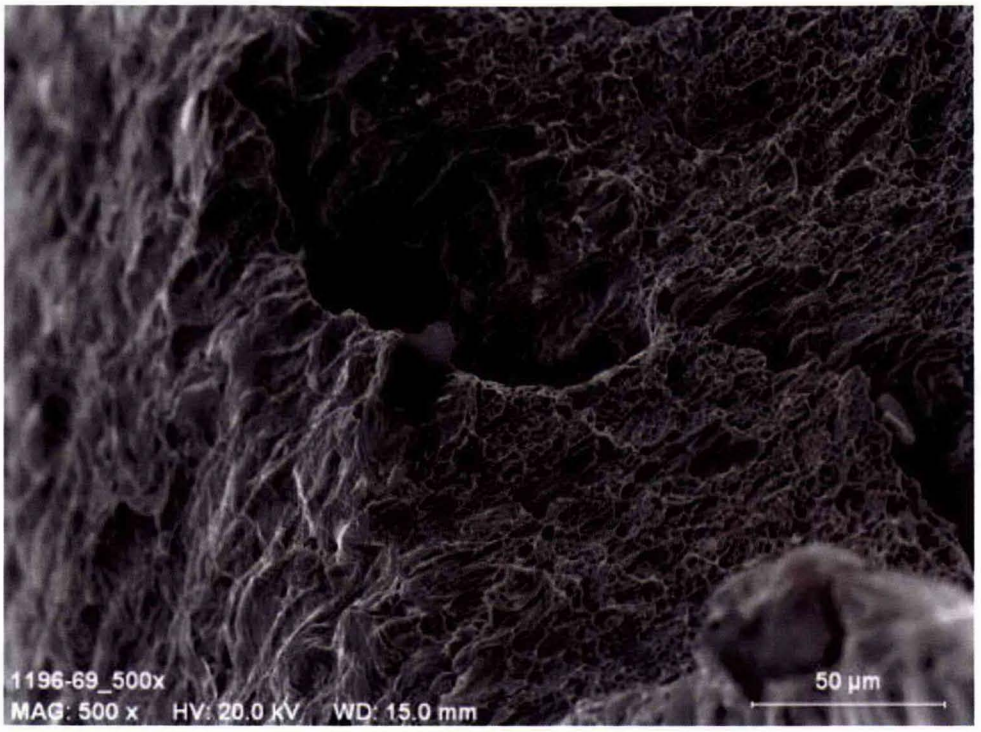


Figure C-66. The Stress-Strain Curve from SSRT 71 Performed in AW105-PSC Simulant at 50°C, pH 13+ and at -100 mV vs. SCE.

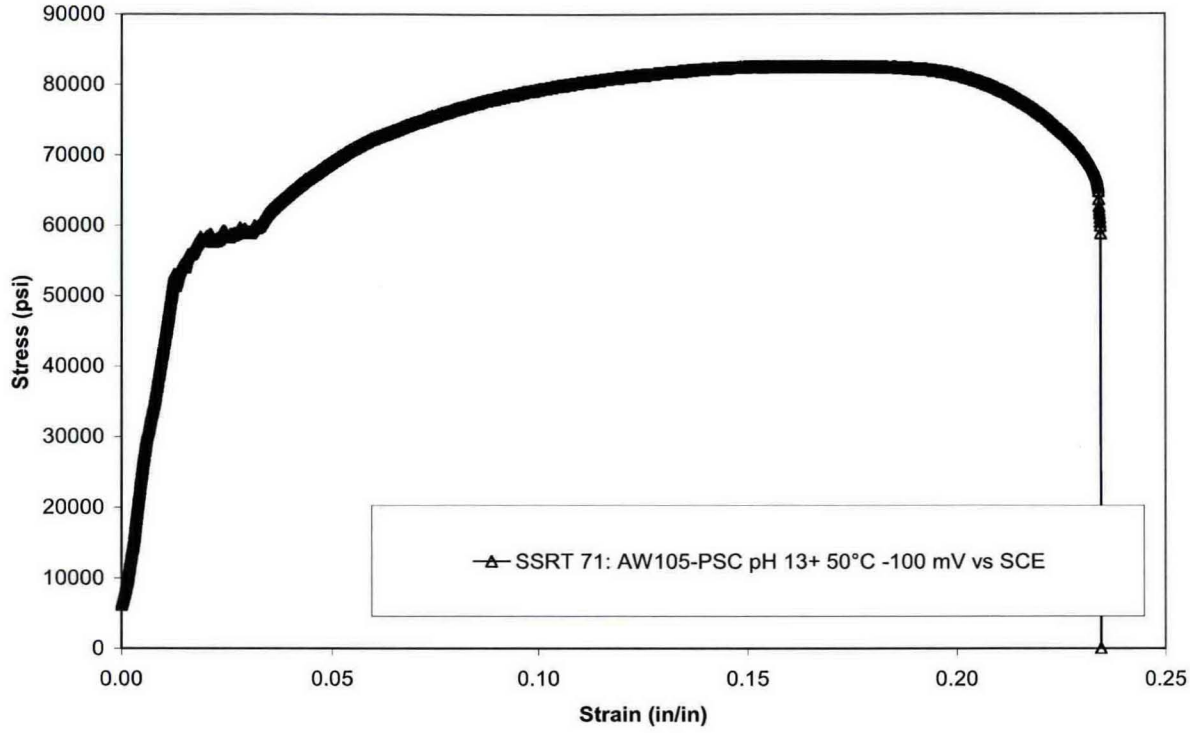


Figure C-67. A Stereo-Micrograph of the Sample from SSRT 71 Performed in AW105-PSC Simulant at 50°C, pH 13+ and at -100 mV vs. SCE.

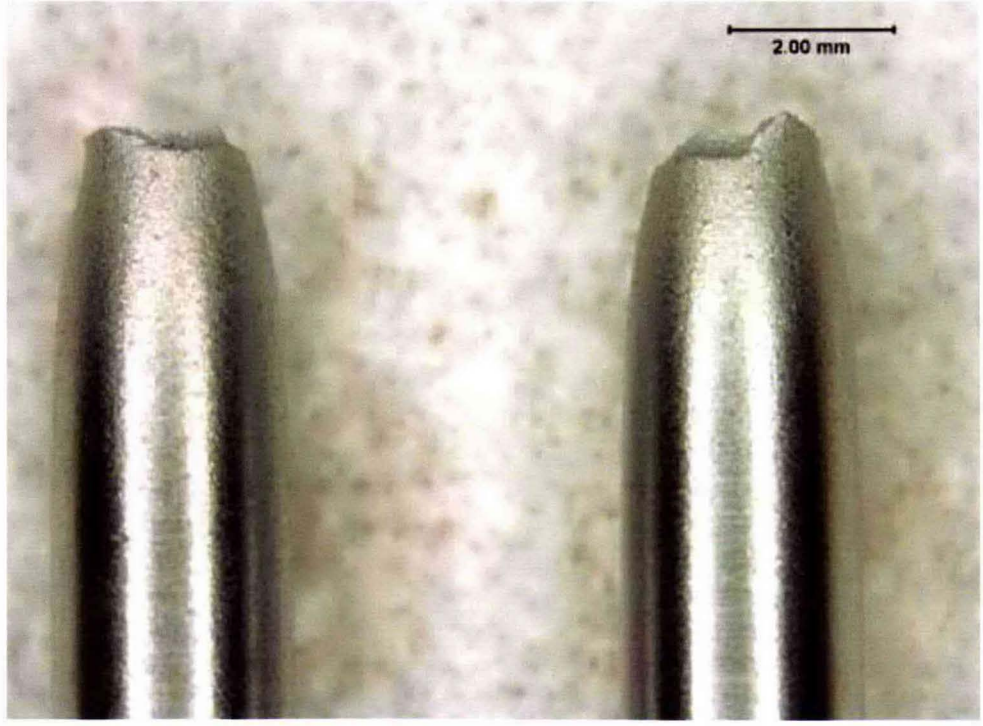


Figure C-68. An Electron-Micrograph of the Fracture Surface from SSRT 71 Performed in AW105-PSC Simulant at 50°C, pH 13+ and at -100 mV vs. SCE.

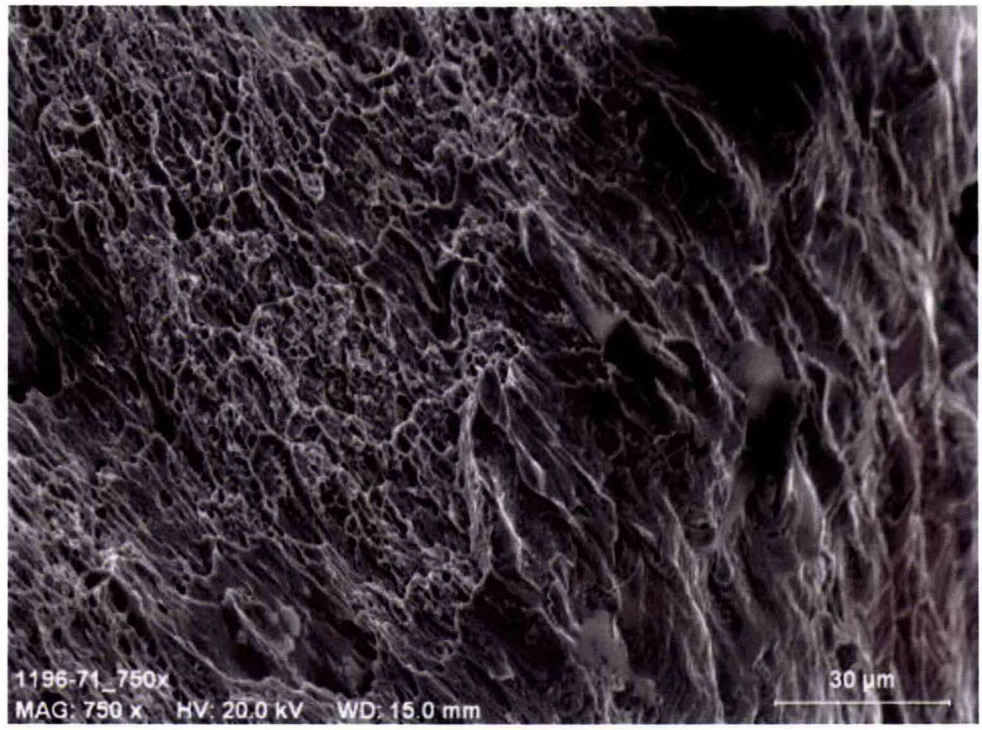


Figure C-69. The Stress-Strain Curve from SSRT 72 Performed in AW105-PSC Simulant at 50°C, pH 13+ and at -50 mV vs. SCE.

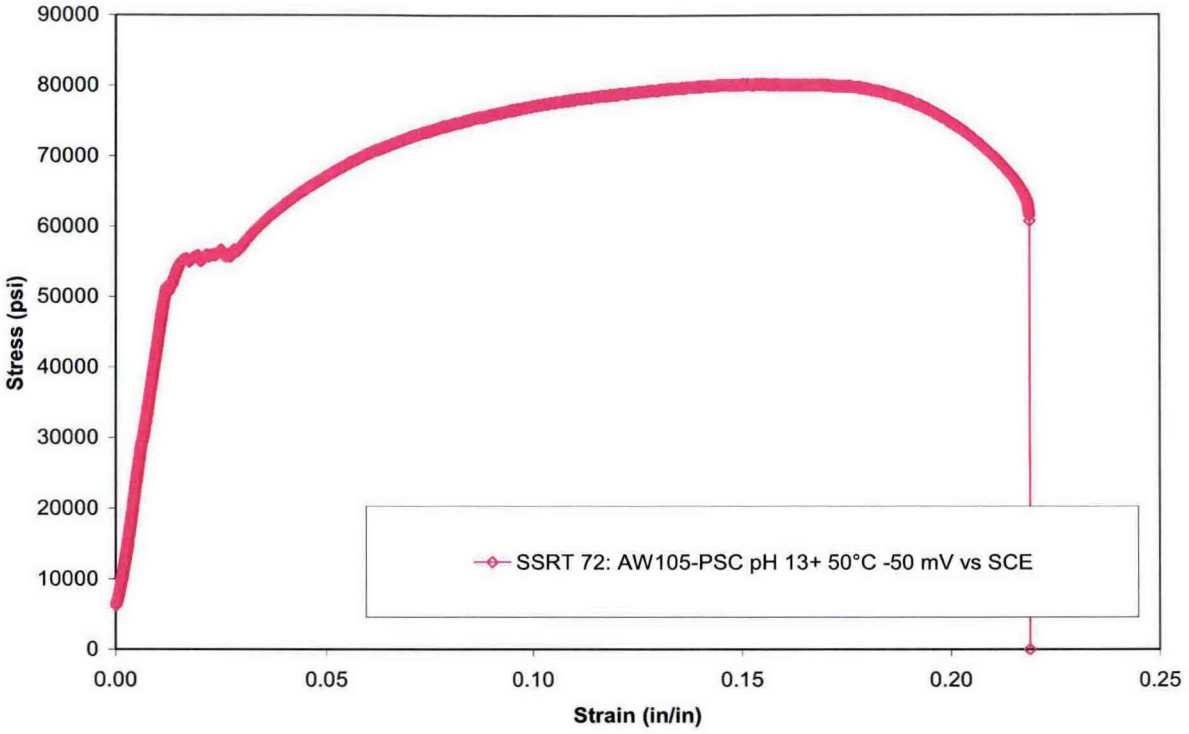


Figure C-70. A Stereo-Micrograph of the Sample from SSRT 72 Performed in AW105-PSC Simulant at 50°C, pH 13+ and at -50 mV vs. SCE.

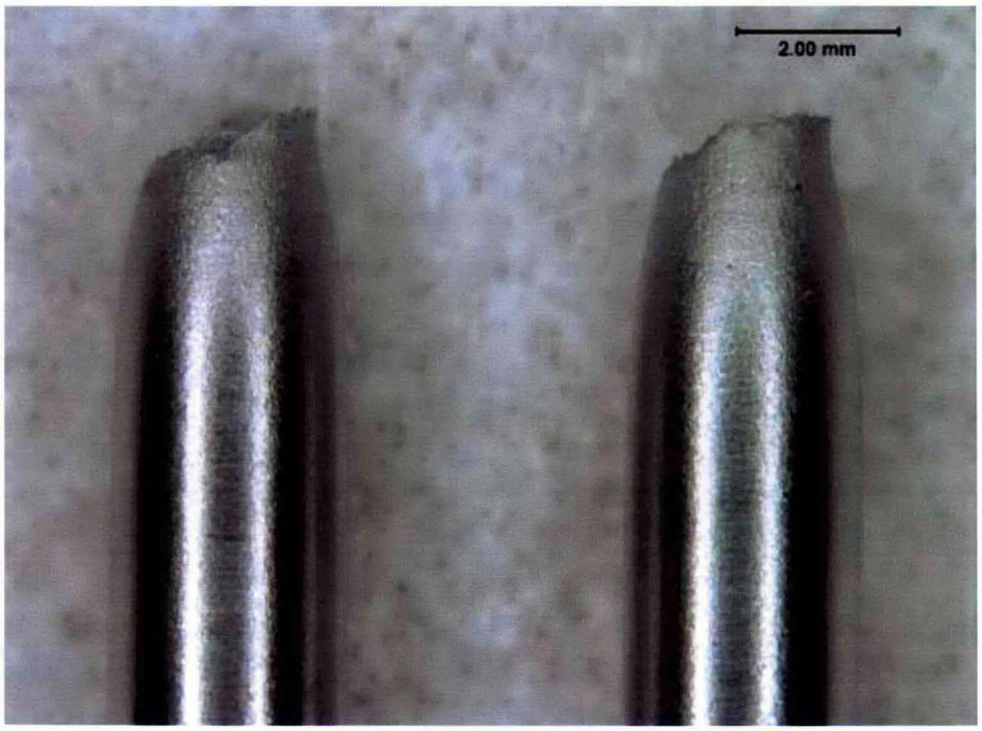


Figure C-71. An Electron-Micrograph of the Fracture Surface from SSRT 72 Performed in AW105-PSC Simulant at 50°C, pH 13+ and at -50 mV vs. SCE.

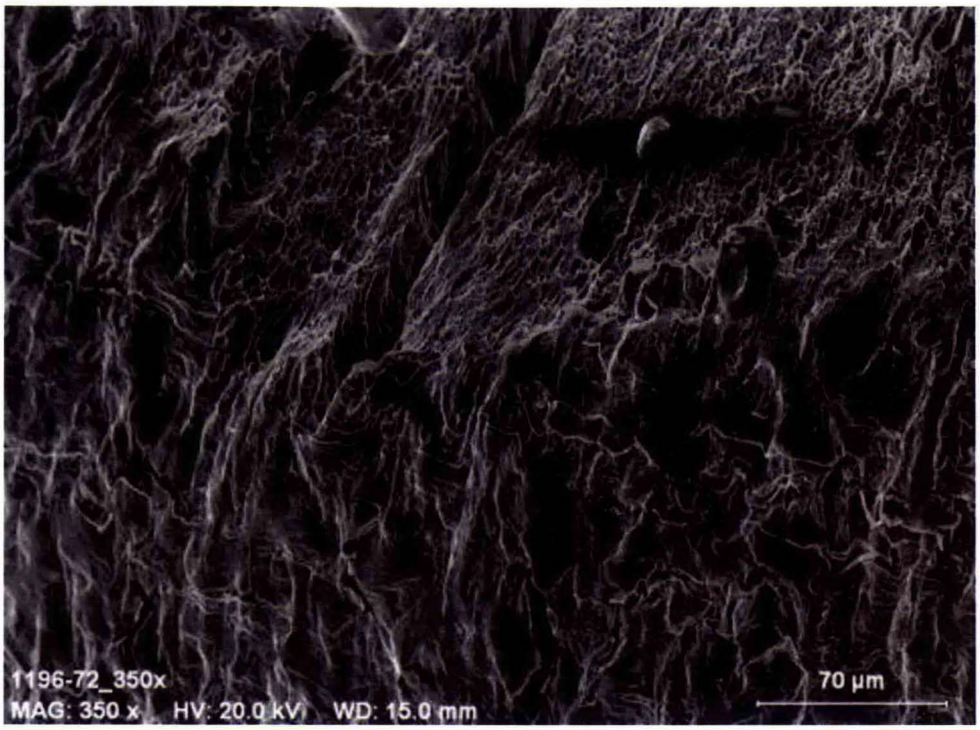


Figure C-72. The Stress-Strain Curve from SSRT 73 Performed in AW105-PSC Half Nitrite Simulant at 50°C, pH 13+ and at -100 mV vs. SCE.

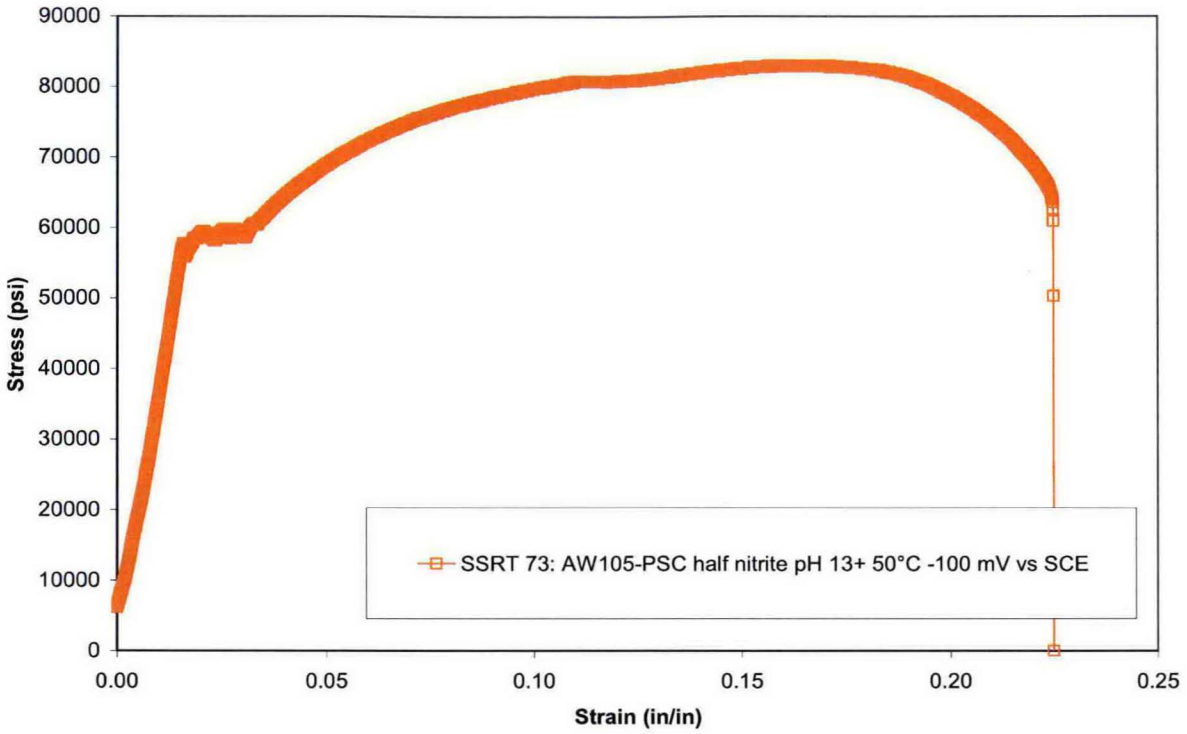


Figure C-73. A Stereo-Micrograph of the Sample from SSRT 73 Performed in AW105-PSC Half Nitrite Simulant at 50°C, pH 13+ and at -100 mV vs. SCE.

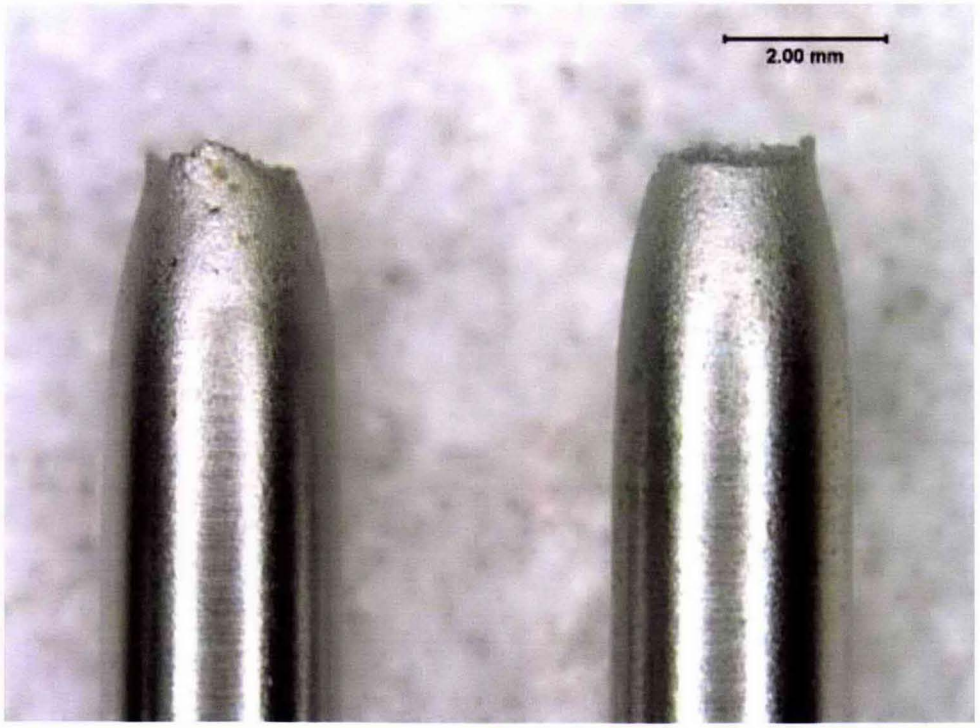


Figure C-74. An Electron-Micrograph of the Fracture Surface from SSRT 73 Performed in AW105-PSC Half Nitrite Simulant at 50°C, pH 13+ and at -100 mV vs. SCE.

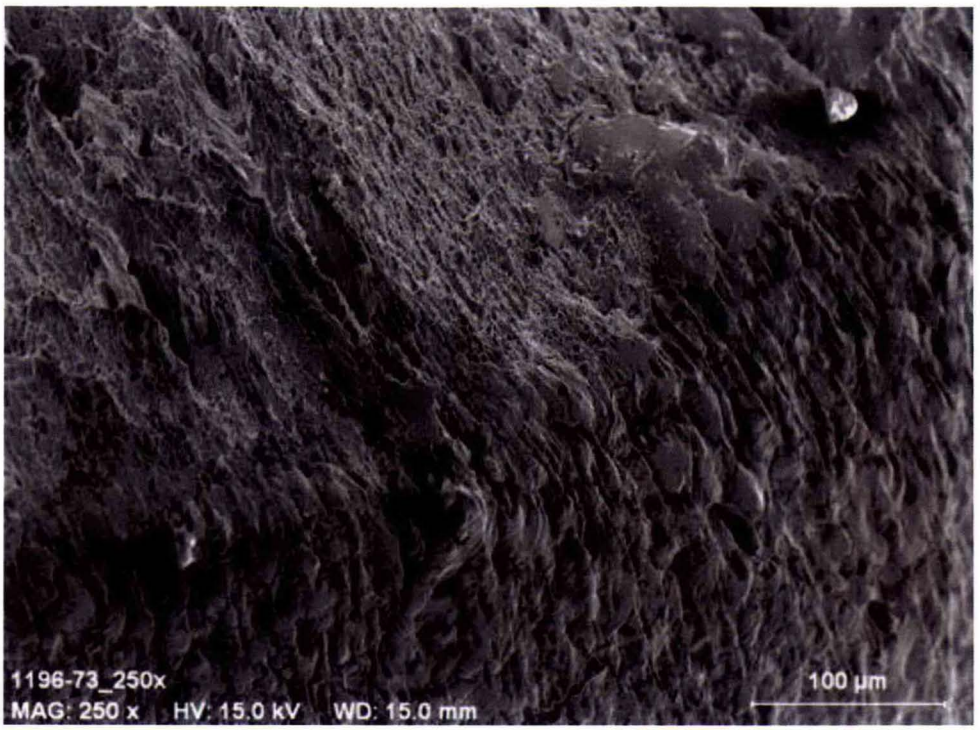


Figure C-75. The Stress-Strain Curve from SSRT 74 Performed in AW105-PSC 6X Simulant at 50°C, pH 13+ and at -100 mV vs. SCE.

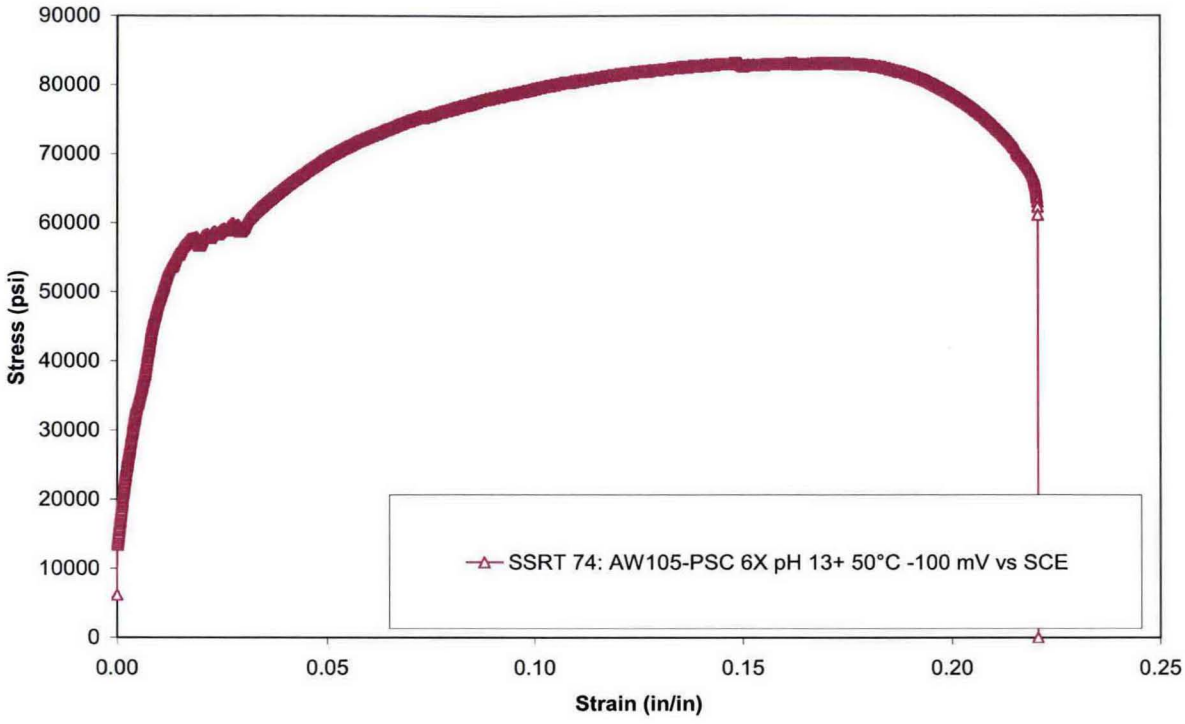


Figure C-76. A Stereo-Micrograph of the Sample from SSRT 74 Performed in AW105-PSC 6X Simulant at 50°C, pH 13+ and at -100 mV vs. SCE.

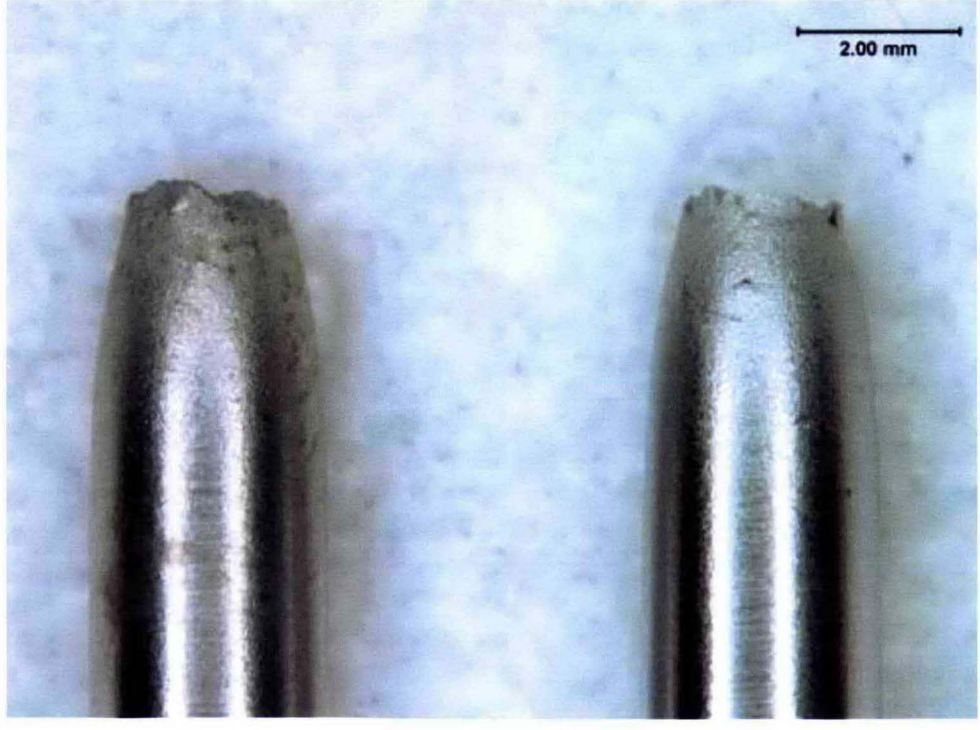


Figure C-77. An Electron-Micrograph of the Fracture Surface from SSRT 74 Performed in AW105-PSC 6X Simulant at 50°C, pH 13+ and at -100 mV vs. SCE.

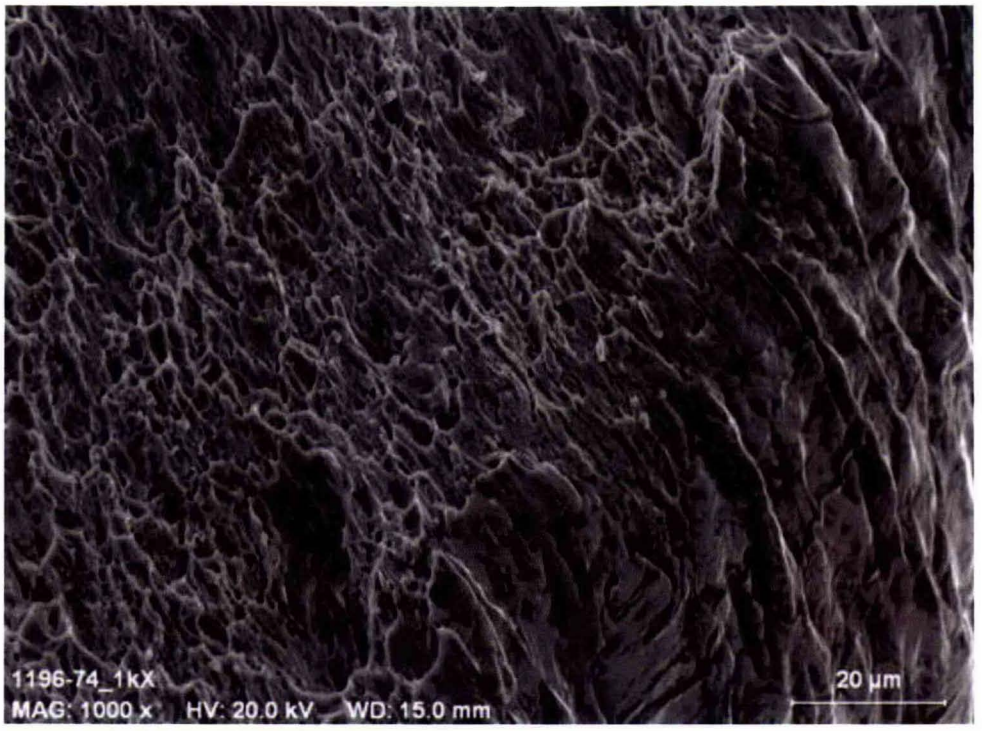


Figure C-78. The Stress-Strain Curve from SSRT 75 Performed in AW105-PSC 6X Simulant at 50°C, pH 13+ and at -50 mV vs. SCE.

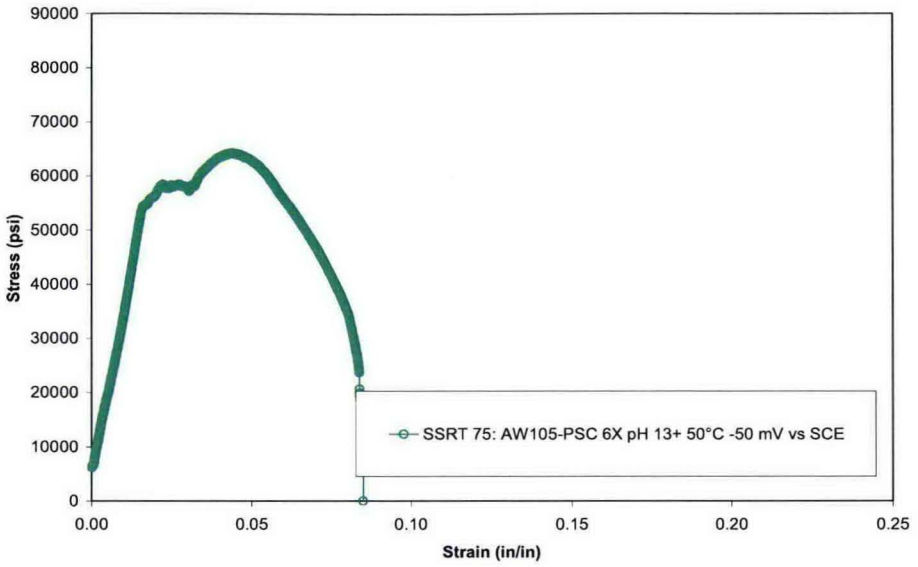
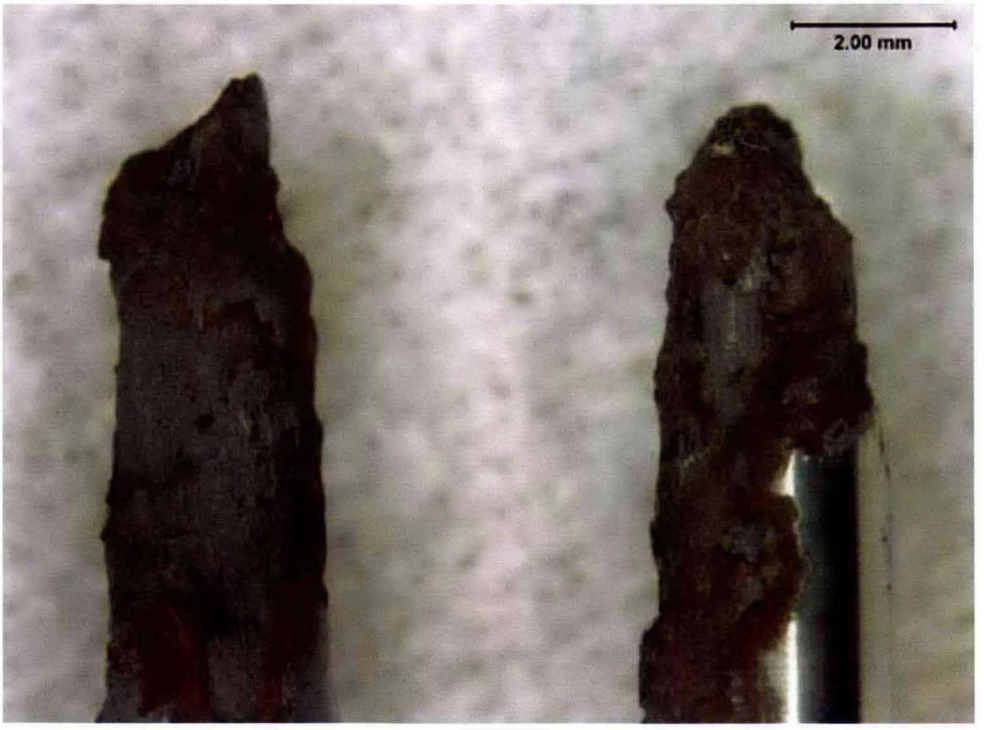


Figure C-79. A Stereo-Micrograph of the Sample from SSRT 75 Performed in AW105-PSC 6X Simulant at 50°C, pH 13+ and at -50 mV vs. SCE.



APPENDIX D

CRACK GROWTH RATE TEST DATA

Figure D-1 The DCPD Calculated Crack Length vs. Time Plot from CT-17 Performed in 5M $NaNO_3$ Solution at 50°C at OCP. Loaded past crack initiation.

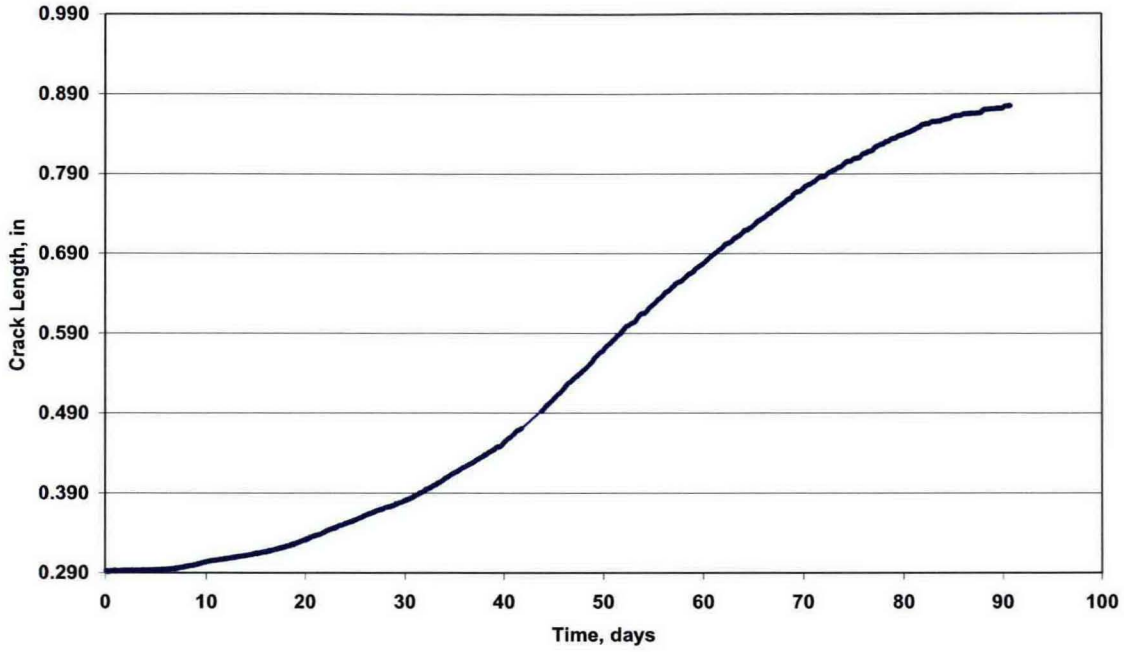


Figure D-2. The Load vs. Time Plot from CT-17 Performed in 5M $NaNO_3$ Solution at 50°C at OCP. Loaded past crack initiation.

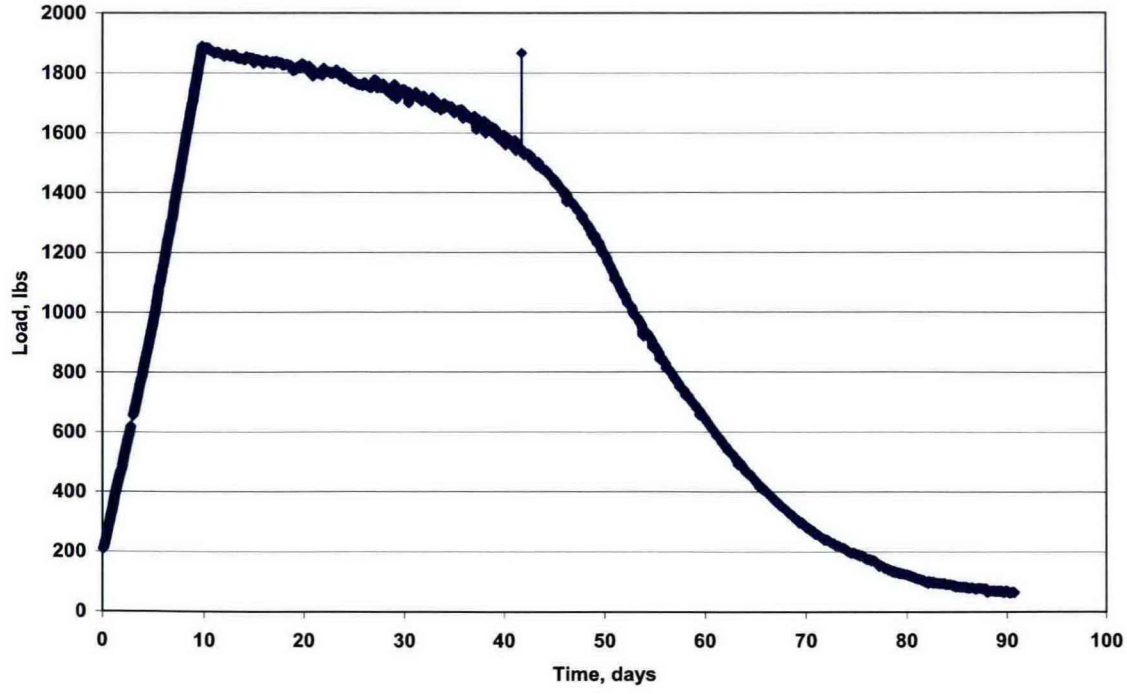


Figure D-3. A Stereo-Micrograph of the Test Sample from CT-17 Performed in 5M $NaNO_3$ Solution at 50°C at OCP. Loaded past crack initiation.

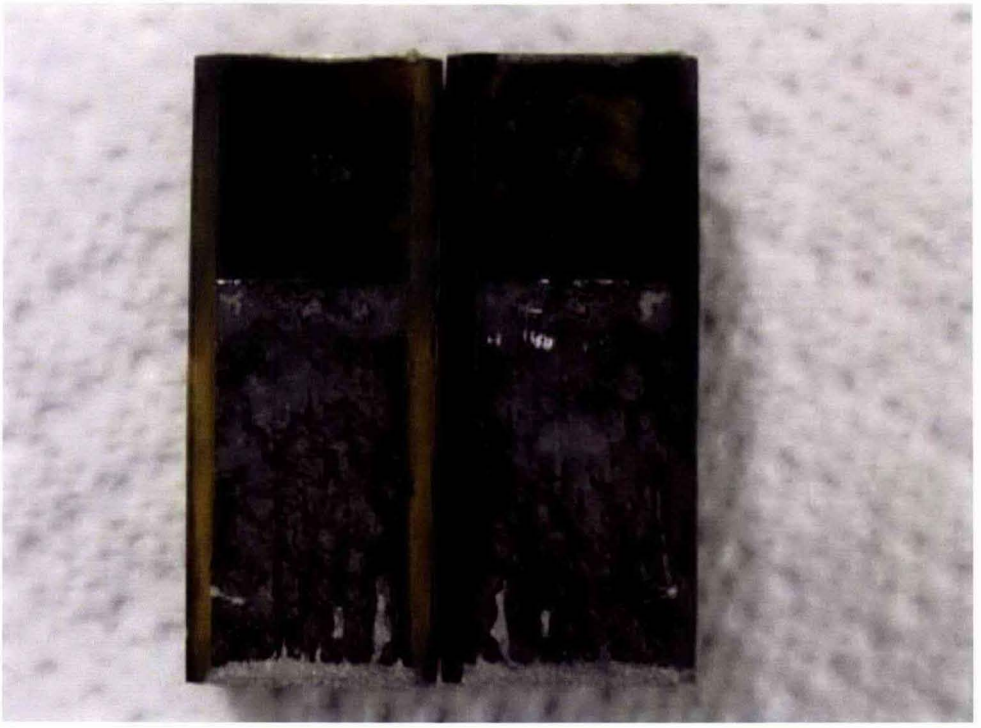


Figure D-4. An Electron-Micrograph of the Test Sample from CT-17 Performed in 5M $NaNO_3$ Solution at 50°C at OCP. Loaded past crack initiation.

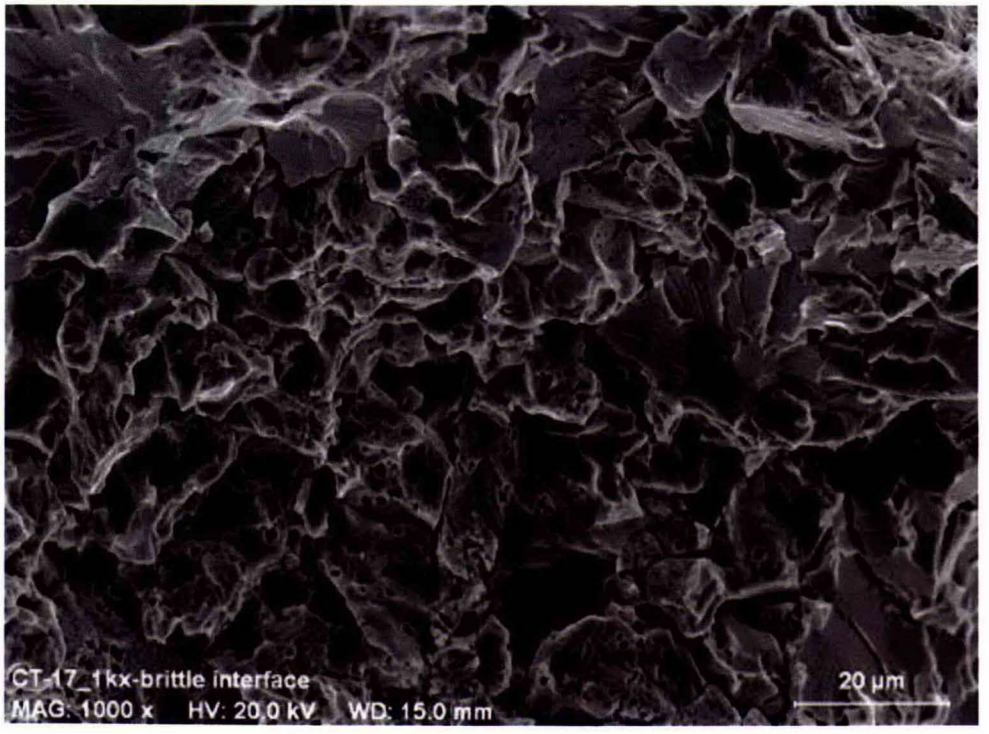


Figure D-3 The DCPD Calculated Crack Length vs. Time Plot from CT-18 Performed in AY101-PSC Standard Simulant at 50°C, pH 11 and at 0 mV vs. SCE. Loaded to K = 45 ksi√in.

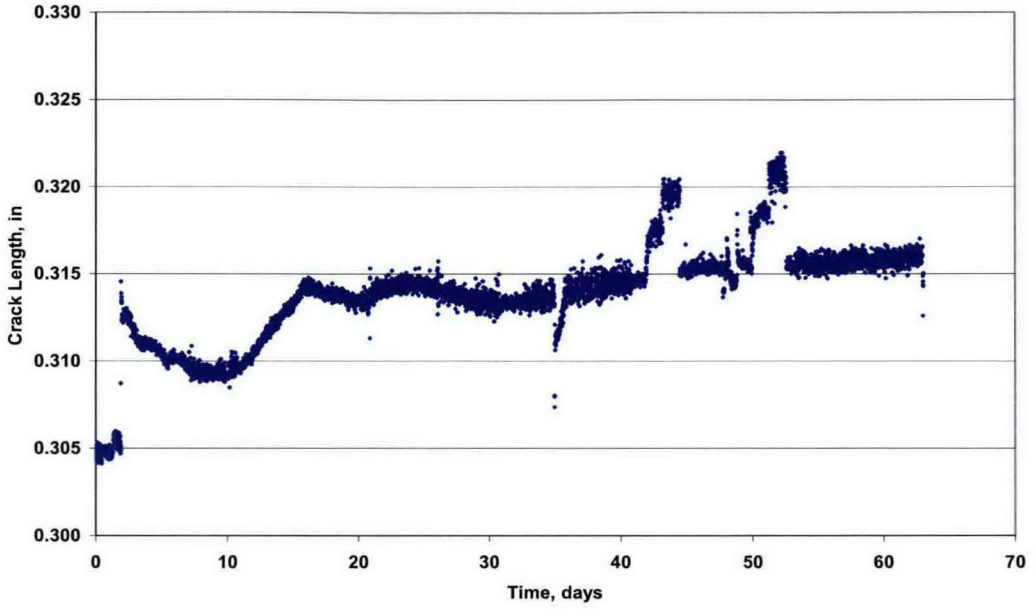


Figure D-4. The Load vs. Time Plot from CT-18 Performed in AY101-PSC Standard Simulant at 50°C, pH 11 and at 0 mV vs. SCE. Loaded to K = 45 ksi√in.

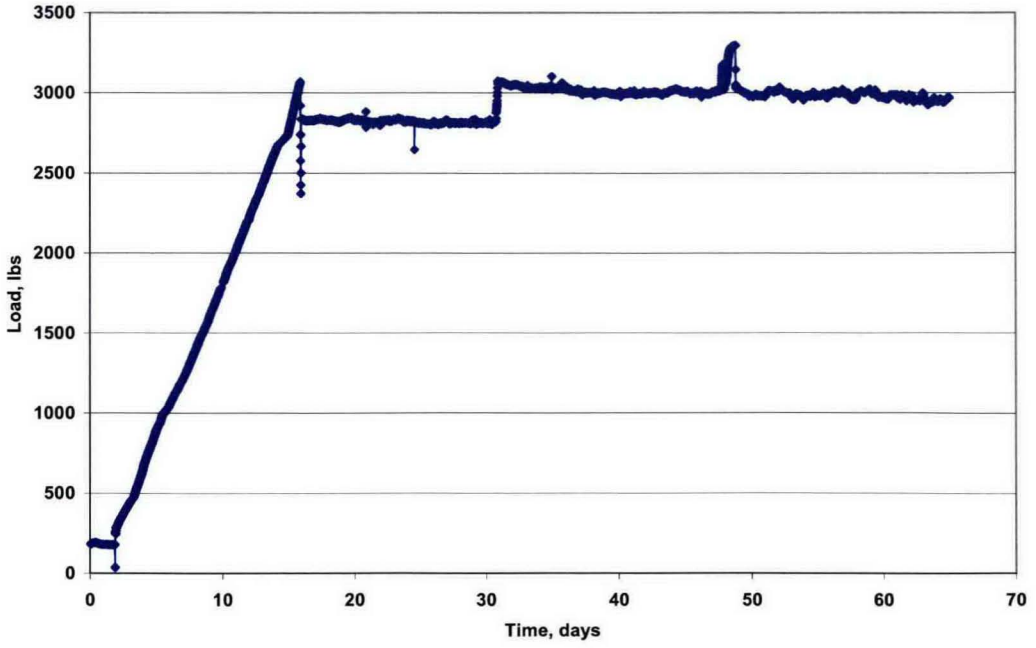


Figure D-5. An Electron-Micrograph of the Test Sample from CT-18 Performed in AY101-PSC Standard Simulant at 50°C, pH 11 and at 0 mV vs. SCE. Loaded to K = 45 ksi√in.