



Cairo University

**EFFECT OF TEMPERATURE ON
MICROSTRUCTURE AND PROPERTIES OF 2205-
DUPLEX STAINLESS STEEL WELDMENTS**

By

Mohammed Ahmed El-Saady Ali AWAD

**. A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
DOCTOR OF PHILOSOPHY**

In

Metallurgical Engineering

**FACULTY OF ENGINEERING, CAIRO UNIVERSITY
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Under the Supervision of

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Title of Thesis: Effect of Temperature on Microstructure and properties of 2205-Duplex stainless steel weldments

Key Words

Duplex stainless steel; Sigma phase; Chi phase; Pitting corrosion; Welding method

Summary: This study aims at evaluating both pitting corrosion and microstructure of duplex stainless steel (2205) welded by (2209) as filler after exposure to increased service temperatures. In this work selected welded samples were aged at different temperatures (650°C, 850°C, 950°C and 1050°C), in order to simulate heat exposure during processing or service stages. The results showed that the pitting corrosion rate increased in chloride environments with increasing aging temperature till 850°C, afterwards pitting corrosion rate started to decrease and the joints restored their original pitting resistance at 1050°C, by the increasing the aging to above 1050°C, pitting resistance was found to decrease again. Also, The results showed that the formation of brittle phases increased as the temperature and holding time are increased in the temperature range (475-850°C), and it dissolved to form ferrite phase again on increasing the temperature to above 850°C. When the temperature reached 1050°C all brittle phases completely disappeared and the ferrite to austenite ratio was restored. As the temperature increased to 1150 the ratio γ/δ was decreased due to increase of the ferrite phase. A correlation between different welding processes and aging times were also conducted.



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DEDICATION

To Soul of my Father

Table of Contents

<i>Number</i>	<i>Description</i>	<i>Page</i>
ACKNOWLEDGEMENT		i
DEDICATION		ii
LIST OF TABLES		vi
LIST OF FIGURES		vii
NOMENCLATURES & ABBREVIATION		viii
ABSTRACT		ix
Chapter 1:	INTRODUCTION	1
Chapter 2:	LITERATURE SURVEY	3
2.1	Duplex Stainless Steel	4
2.1.1	Different commercial types of DSS	5
2.1.1.1	Hyper Duplex stainless steel-SAF 2707-HDSS	5
2.1.1.2	Hyper Duplex stainless steel-SAF 3207-HDSS	5
2.1.1.3	Super-duplex stainless steel- SAF 2507-SDSS	6
2.1.1.4	Lean-duplex stainless steel- SAF 2304-LDSS	6
2.1.1.5	Duplex stainless steel- DSS-2205	6
2.2	Role of alloying elements in DSS-2205	7
2.3	Intermetallic Compounds in DSS-2205	8
2.3.1	Sigma Phase	8
2.3.1.1	Types Of Sigma Phase	9
2.3.1.1.1	Grain Boundary Precipitation	9
2.3.1.1.2	Triple Point Precipitation	9
2.3.1.1.3	Corner Precipitation	9
2.3.1.1.4	Cellular Precipitation	10
2.3.2	Chi Phase	10
2.3.3	Chromium Nitrides-Cr ₂ N	10
2.3.4	Secondary-Austenite (γ_2)	10
2.3.4.1	Eutectoid reaction	10
2.3.4.2	Widmannstatten precipitates	10
2.3.4.3	Martensitic process	11
2.3.5	R-phase	11
2.3.6	Pi-phase- π	11
2.3.7	Carbides	11
2.3.8	G-phase	12
2.3.3	Effect of Intermetallic Compounds on Different Properties of DSS	13
2.3.4.1	Formation of Brittle Regions	13
2.3.3.2	Hot Cracking Occurrence During Welding	13
2.3.3.3	The Formation of Depleted Cr and Mo Regions	13
2.5	Pitting Corrosion	14
2.5.1	Pitting Corrosion Phenomenology	14
2.5.2	Pitting Corrosion Stages	14

<i>Number</i>	<i>Description</i>	<i>Page</i>
2.5.2.1	Passive Film Breakdown	15
2.6	Effect of Heat Treatment on The Microstructure of Duplex Stainless Steel	16
2.6.1	Aging Temperature and Microstructure	16
2.7	Welding Characteristics	18
2.7.1	Welding Considerations	18
2.7.1.1	Thermal Properties	18
2.7.1.2	Electrical Resistivity	18
2.7.1.3	Oxidation And Depletion of Chromium	19
2.8	Review of Welding Parameters Relevant to Stainless Steels	19
2.9	Welding Associated Problems	20
2.9.1	Sensitization	20
2.9.2	Stress-Corrosion Cracking	21
2.9.3	Cracking	21
2.9.4	Solidification Cracking	21
2.10	Review of some research considered the inhibiting of mechanical and corrosion properties for DSS-2205	22
2.11	Investigation on Failure Cases of DSS-2205 welds joints in different plants.	25
2.11.1	Desalination of Water plant (SAUDI ARABIA)	25
2.11.2	Weld failure analysis of 2205-DSS nozzle in the head of the reactor	28
2.11.3	Failure cases due to the presence of σ -phase investigated by the welding institute	29
2.11.4	Metallurgical Analysis on a Cracked DSS- 2205 Flange	33
Chapter 3:	EXPERIMENTAL WORKS	36
3.1	Materials	36
3.2	Welding Procedures	38
3.2.1	Welded Plates Using GTAW And SMAW	38
3.2.2	Welds Made By Shielded Metal Arc Welding (SMAW)	38
3.2.3	Welds Made by Gas Tungsten Arc Welding (GTAW)	38
3.3	Thermal Aging	39
3.4	Metallographic examination	42
3.4.1	Chemical Etching	42
3.4.2	Electro Etching	42
3.4.3	Surface Preparation	42
3.4.4	Optical Microscopy	42
3.5	Pitting Corrosion Tests	44
3.6	Tensile Strength Test	46

<i>Number</i>	<i>Description</i>	<i>Page</i>
3.7	Ferrite measurement Test (δ – Ferrite content)	48
3.8	SEM and EDX Analysis	49
3.9	Macro hardness Evaluation	50
Ch. 4	RESULTS AND DISCUSSION	51
4.1	Failure Investigation of Assil & Karam gas plant(EGYPT)	51
4.1.2	Ferrite content	52
4.1.3	Macrographs and micrographs of internal pits	53
4.1.4	Microstructure investigation	55
4.1.5	SEM Micrographs	56
4.1.6	Chemical analysis of welded Joint	57
4.1.6.1	Chemical analysis at weld face 1	57
4.1.6.2	Chemical analysis at weld face 2	58
4.1.6.3	Chemical analysis at weld root 1	59
4.1.6.4	Chemical Analysis at weld root 2	60
4.1.6.5	Chemical Analysis at base metal 1	61
4.1.6.6	Chemical Analysis at Base Metal 2	62
4.1.7	Pitting investigation	63
4.1.8	Water analysis	67
4.1.9	Conclusion	68
4.2	Results of experimental works	69
4.2.1	Ferrite Measurements	69
4.2.2	Microstructure Examination	73
4.2.3	Tension test Results	89
4.2.4	Macro-hardness test Results	90
4.2.5	Examination of Pits	93
4.2.5.1	Corrosion test Results	93
4.2.5.2	Macrostructure of pits	96
4.2.5.3	Microstructure of Pits	98
Ch. 5	Conclusion2	103
Ch. 6	Recommendations	105
	References	106

List of Tables

<i>Tables Number</i>	<i>Description</i>	<i>Page</i>
2.1	Commercials types of DSS and their chemical compositions	4
2.2	Chemical composition of SAF 2707-HDSS in %	5
2.3	Chemical composition of SAF 3207-HDSS in %	5
2.4	Chemical composition of SAF 2507-SDSS in %	6
2.5	Chemical composition of SAF 2304-LDSS in %	6
2.6	Chemical composition of SAF DSS-2205 in %	6
2.7	Chemical composition of R-phase	11
2.8	Chemical composition of π -phase	11
3.1	Chemical composition of the welded plates	36
3.2	The welding variables for GTAW and SMAW	38
3.3	The chemical composition of ER2209 and E2209 in Wt. %	38
3.4	Aging cycle for plates welded by SMAW	39
3.5	Aging cycle for plates welded by GTAW	39
3.6	Aging cycle for plates welded by GTAW+SMAW	40
4.1	Ferrite content (%) at several locations on the face and root of pipe	52
4.2	Water analysis of dissolved solids, chloride and fluoride	68
4.3	EDX analysis of different phases in Fig. 4.28	75
4.4	EDX analysis of Fig 4.30	77
4.5	EDX analysis of Fig.4.32	79
4.6	EDX chemical composition of 3 points in Figure 4.34	80
4.7	EDX chemical composition of points in Figure 4.35	81
4.8	EDX analysis of different phases in Fig. 4.36	82
4.9	EDX analysis of Fig. 4.37	83
4.10	EDX chemical composition Figure 4.38	84
4.11	EDX analysis of Fig 4.42 (a)	87
4.12	EDX analysis of Fig 4.42 (b)	87
4.13	EDX chemical composition Figure 4.43	88
4.14	Failure locations in test specimen aged for 3 hrs	89
4.15	EDX analysis inside the pit in Fig.4.52	99

List of Figures

Figure Number	Description	Page
2.1	Microstructure DSS etched in 40% NaOH solution longitudinal section (rolling direction). The darker phase is δ ferrite and the lighter phase is γ austenite.	3
2.2	Schaeffler diagram showing composition range in which stainless steels exhibit a DSS-2205 structure	4
2.3	The initiation of sigma phase on the grain boundaries of δ / γ	8
2.4	Sigma phase (black) surrounding ferrite phase.	9
2.5	Isothermal cooling curve showing possible precipitation in DSS	16
2.6	Sensitization location of the welded joint	20
2.7	Section of the cage of a pressure control valve showing heavy corrosion above the stellite/duplex interface.	25
2.8	Stellite ring of the pressure control valve showing cavitation marks.	26
2.9	Back scattered camp. mode microstructure of a cross section of cage showing stellite, duplex steel and interface.	26
2.10	Optical micrograph of above showing decarburization at the interface	27
2.11	Schematic structure and crack between nozzle and the heat for the reactor with (a) outside and (b) inside.	28
2.12	Fracture surface of piping spool with the crack	29
2.13	SEM of the weld metal	29
2.14	Weld/HAZ crack	31
2.15	Fracture surface of the orifice flange	32
2.16	σ -phase precipitation in HAZ/Weld metal	32
2.17	Crack propagation	33
2.18	SEM of the fracture surface	33
2.19	Microstructure of the fracture surface	34
3.1	The cap side of the welded plates	36
3.2	The root side of the welded plates	37
3.3	100 KVA Heat Treatment Unit	40
3.4	The Connection Sequence	41
3.5	The optical microscope	43
3.6	Specimens subjected to immersion test	44
3.7	a) Test solution in the glass cradle, b) The tested sample	44
3.8	The design of the tension test specimen	46
3.9	The machine of the tension test	46
3.10	Tension test samples after aging treatment	47
3.11	Ferrite number device	48
3.12	Overall view of scanning electron microscopy	49
3.13	The internal chamfer of scanning electron microscopy	49

3.14	Micro-Hardness tester	50
4.1	General appearance of surface damage	51
4.2	General appearance of un-surface damage	51
4.3	General appearance of internal wall in the as received condition	51
4.4	General appearance of internal wall after water wash	51
4.5	Macro-graphs showing pitting damage at the internal surface of the pipe after service	54
4.6	Micrograph showing duplex microstructure at the weld root	55
4.7	SEM micrograph at base metal	56
4.8	SEM micrograph at HAZ metal	56
4.9	SEM micrograph at weld root	56
4.10	SEM micrograph at weld face	56
4.11	Chemical composition at weld face	56
4.12	Chemical composition at weld face position 2	58
4.13	Chemical composition at root position 1	59
4.14	Chemical composition at root position 2	60
4.15	Chemical composition at base metal 1	61
4.16	Chemical composition at base metal 2	62
4.17	Micrographs showing pitting damage at the internal surface of the pipe after service: (a) macrograph graph at root pit at the cross-section view (b) macrograph for the root pit shown in (a) taken from the root side, (c) larger magnification for (a), (b) (d) optical micrograph showing duplex structure around pits , and (e) SEM micrographs for the same pit in (c) show at cross-section	63
4.18	Location of EDS microanalysis at the root and pit area, (a) location of microanalysis at the max penetration area, (b) location of microanalysis inside the pit area	64
4.19	Microanalysis at the max penetration area in Fig. 4.18(a).	65
4.20	Microanalysis inside the pit area in Fig. 4.18(b).	66
4.21	Location of ferrite measurement at the hot root pass (maximum root penetration)	69
4.22	Ferrite measurement in weld metal of SMAW vs. weld metal of GTAW with holding time 3 hours	70
4.23	Ferrite measurement in the base metal	71
4.24	Ferrite measurement in the weld metal of SMAW	71
4.25	Ferrite volume fraction of weld metal and HAZ	72
4.26	Microstructure of plates welded by (GTAW+SMAW) before thermal aging, a) location of each micrograph, b) Base metal as recieved, c) Weld metal, d) Heat affected zone (HAZ)	73

4.27	Microstructure of as weld form sample welded by SMAW+GTAW: a) HAZ, b) weld metal	74
4.28	SEM of the weld metal root side using (GTAW & SMAW) as welded condition	75
4.29	Microstructure of specimens aged at 650oC for 3 hours, a) base metal, and b) weld metal by using (GTAW+SMAW)	76
4.30	SEM of base metal aged at 650°C for 3 hrs.	77
4.31	TTT curves for various duplex stainless steel grades showing relation between time and temperature that leads to formation of various intermetallic phases	78
4.32	SEM of WELD metal aged at 650°C for 3 hrs aged at 650oC for 3 hours, by using (GTAW+SMAW).	78
4.33	Electro etching microstructure of the sample aged at 850°C for three hours. a) The base metal. b) the weld metal	79
4.34	SEM of the weld metal root side using (GTAW & SMAW) aged at 850°C for three hours	80
4.35	The decomposed microstructure of ferrite at high magnification	81
4.36	SEM in HAZ for sample welded by SMAW & GTAW aged at 850°C for 3 hrs	82
4.37	SEM of base metal aged at 850°C for 1 hr	83
4.38	SEM of weld metal using (GTAW & SMAW) at aging temperature of 475 for 20hrs	84
4.39	SEM in base metal aged at 475°C for 20 hrs	85
4.40	SEM of HAZ using (GTAW & SMAW) at aging temperature of 475 for 20hrs	85
4.41	a) Surface fracture in the weld metal using (GTAW & SMAW), b) High magnification of (a)	86
4.42	SEM of DSS-2205 and location of EDX at 950°C for 3 hrs a) base metal, b) weld metal	87
4.43	Weld metal microstructure by using (GTAW & SMAW) after aging at 1050oC for an hour	88
4.44	Effect of aging temperature and welding process on UTS	89
4.45	Macro hardness values for specimens welded by SMAW & GTAW aged to 3 hours	90
4.46	Macro-hardness at different aging temperature and holding times for samples welded by SMAW & GTAW	91
4.47	Hardness values with different welding processes and aging temperatures	92
4.48	(a) Metal losses measurements for specimens welded by SMAW with different aging time, (b) metal losses measurements for specimens welded by GTAW with different aging time	93

4.49	Metal losses measurements for specimens welded by GTAW with aging time of an hour	95
4.50	Optical macrographs after immersion test, for the specimens aged for 3 hrs. at (a) 650°C (root side), (b) 650°C (cap side), (c) 850°C (root side), (d) 1050°C (root side), Magnification ×8	96
4.51	SEM of specimens welded by SMAW: (a) SEM of Base metal aged at 650 °C for three hours including a small pit, (b) SEM of weld metal aged at 650 °C for three hours including a small pit	98
4.52	SEM and EDX location of aged weld metal at 650 °C for three hours inside a large pit	99
4.53	Optical micrograph of the aged weld metal at 850°C for three hrs	100
4.54	Microstructure of the propagated pit in weld metal aged at 850°C for 3 hrs	100
4.55	Microstructure of propagated pit containing small pits in weld metal aged at 850°C for 3 hrs	101
4.56	Intergranular corrosion of the base metal in DSS aged at 850°C for 3 hrs	102

Nomenclatures and Abbreviation

<i>Abbreviation</i>	<i>Description</i>
AISI	American iron standard institute
ASME	American society for mechanical engineers
ASS	Austenitic stainless steel
BCC	Body center cubic
CPT	Critical pitting temperature
CS	Carbon steel
Cr eq	Chromium equivalent
DSS	Duplex stainless steel
EDX	Energy – dispersive X-ray spectroscopy
FCC	Face center cubic
FACW	Flux cored arc welding
GMAW	Gas metal arc welding
GTAW	Gas tungsten arc welding
HAZ	Heat affected zone
HDSS	Hyper duplex stainless steel
LDSS	Lean duplex stainless steel
Ni eq	Nickel equivalent
PREN	Pitting resistance number
PWHT	Post weld heat treatment
SAW	Submerged arc welding
SCC	Stress corrosion cracking
SDSS	Super duplex stainless steel
SEM	Scanning electron microscopy
SMAW	Shielded metal arc welding
SS	Stainless steel
UNS	Unified number system
UTS	Ultimate tensile strength
σ	Sigma phase
χ	Chi phase
δ	Delta ferrite phase
γ	Austenite phase
γ_2	Secondary austenite