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**SUSCEPTIBILITY OF 12% CR STEELS TO
SENSITISATION DURING WELDING OF
THICK GAUGE PLATE**

**A thesis submitted in fulfilment of the requirements for the
award of the degree of**

**MASTER OF ENGINEERING
(Materials Engineering)**

from



THE UNIVERSITY OF WOLLONGONG

by

MARTIN NICHOLAS VAN WARMELO, BE

FACULTY OF ENGINEERING

2006

Declaration

I, Martin Nicholas van Warmelo, declare that this thesis, submitted in fulfilment of the requirements for the award of Master of Engineering, in the Faculty of Engineering, University of Wollongong, is wholly my own work unless otherwise referenced or acknowledged. The document has not been submitted for qualifications at any other academic institution.

Martin Nicholas van Warmelo, BE

Wednesday, 01 August 2007

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Abstract

In recent years, the subject of sensitisation in unstabilised ferritic/martensitic dual phase 11-14%Cr steels has been investigated in some detail after a number of failures in service due to accelerated corrosion. It was found that sensitisation could occur due to a number of different mechanisms which were dependant on the heat treatment, the number of thermal cycles and the phases present in the material. All the detected modes of sensitisation could be prevented by stabilisation with titanium or niobium and suitable design of the material composition to produce a suitably high ferrite factor. However, these options could not readily be applied to thick gauge plate and therefore 12%Cr material available in the market above 10mm thickness still tends to be unstabilised.

This project was initiated with the intention of determining how sensitisation would manifest itself during welding of thicker plates and whether the degree of sensitisation could be controlled to acceptable levels by appropriate control of the welding parameters. This was done in two phases, namely evaluation of actual welds produced using varying heat input parameters and by simulation of the thermal treatment using a Gleeble 3500 thermomechanical simulator. The samples were evaluated using standard immersion tests (Strauss test) and electrochemical techniques.

Mode 2 sensitisation was found to occur on all samples and on all materials, irrespective of the welding parameters. This occurred at all points where the heat affected zone (HAZ) from one weld bead intersected with the HAZ from a previous bead. However, the sensitised regions were generally well below the surface of the material and would

therefore not be exposed to the atmosphere and any corrosive environment. The exception to this rule occurred when very high heat input resulted in an excessively large HAZ or when poor weld bead positioning and inappropriate bead overlap resulted in sensitisation of the HAZ on the surface.

Mode 3 sensitisation did not occur within the range of welding parameters investigated.

Mode 4 sensitisation was found to occur on all materials but could not reliably be detected by the Strauss test. Electrochemical evaluation clearly showed that sensitisation was present in the subcritical HAZ on all materials, irrespective of welding conditions. However, the degree of sensitisation was very low.

From a practical perspective, problems in service due to sensitisation are most likely to arise from very high heat input levels and welding defects such as excessive overlap of weld beads and incomplete fusion.

Table of Contents

Acknowledgements	I
Abstract	II
Table of Contents	IV
Table of Figures	VI
List of Tables	X
1 Introduction	1
2 Literature Survey.....	2
2.1 Sensitisation	2
2.1.1 Definition	2
2.1.2 Background	2
2.1.3 Mechanism	3
2.1.4 Prevention	6
2.1.4.1 Reducing Interstitial Content	7
2.1.4.2 Stabilisation.....	8
2.1.4.3 Controlling The Ferrite Factor	11
2.2 Sensitisation In 11-14% Chromium Steels	13
2.2.1 Metallurgical Overview	13
2.2.2 Modes Of Sensitisation	21
2.2.2.1 Mode 1	21
2.2.2.2 Mode 2	22
2.2.2.3 Mode 3	23
2.2.2.4 Mode 4	27
2.3 3CR12 Production And Processing.....	28
2.4 Detection Methods For Sensitisation	30

2.4.1	Immersion Testing Methods	30
2.4.2	Electrochemical Detection Methods	31
2.5	Scope Of Work.....	34
3	Experimental Procedure.....	36
3.1	Bead On Plate Welds	38
3.2	Straight Butt Welds.....	39
3.3	Modified Strauss Test	41
3.4	Welding Simulation	42
3.5	Electrochemical Testing.....	46
4	Results and Discussion.....	49
4.1	Bead on Plate Welds	49
4.1.1	Welding Results	49
4.1.2	Discussion: BOP Welding Results.....	55
Full Butt Welds		57
4.1.3	Preliminary Welding Trials: Material A1	57
4.1.4	Comparative Welding Trials: Material A2 And C1	66
4.1.5	Full Butt Welds: Discussion	70
4.2	Electrochemical Evaluation	74
4.2.1	Electrochemical Potentiodynamic Reactivation (EPR)	74
4.2.1.1	Butt Welded Samples.....	74
4.2.1.2	Gleeble Simulation Samples	81
4.2.1.3	EPR Discussion.....	90
4.3	General Discussion	94
5	Conclusions	99
6	References.....	100

Table of Figures

Figure 1 : Effect Of Steel Composition On Sensitising Behaviour (Sensitised Within Bounding Lines) [12]	4
Figure 2 : Calculated Cr Content At Grain Boundary For 18.7Cr- 0.01C Ferritic Stainless Steel (After Arai et al [14]).....	6
Figure 3 : Influence of Steel Ferrite Factor on HAZ Martensite Content [Gooch et al] [28].....	12
Figure 4 : Typical Fe-Cr Phase Diagram Illustrating The Position Of The Gamma Loop [11].....	14
Figure 5 : Shifting Of The Boundary Line ($\gamma + \alpha$)/ α In The Fe-Cr System Through Increasing Additions Of Carbon Or Nitrogen [7]	15
Figure 6 : Positions of Transformation Temperatures on Fe-Cr Phase Diagram after Folkhard [11].....	16
Figure 7 : Proposed Continuous Cooling Transformation Diagram For The Transformation Of δ -Ferrite To γ In The High Temperature Heat Affected Zone During The Weld Thermal Cycle [34].....	18
Figure 8 : Constitution Diagram For 12-18% Cr Steel Weld Metals [28].....	20
Figure 9 : Preliminary Constitution Diagram For Arc Weld HAZ In Low Carbon 13% Cr Steels [28]	20
Figure 10 : Influence Of Weld Geometry And Welding Sequence On Mode 2 Sensitisation [27].....	22
Figure 11 : Effect Of Ferrite Factor On Performance In IGC Test For Mode 3 Sensitisation [27].....	26
Figure 12 : Schematic Diagram of the Double Loop EPR Test. Evaluation is by the Ratio $I_r : I_a$ [51].....	33

Figure 13 : Schematic Layout For BOP Welds.....	38
Figure 14 : Recommended Joint Preparation [37]	40
Figure 15 : Schematic Of Gleeble Sample Indicating The Thermocouple Positions And Dimensions.....	43
Figure 16 : Heat Treatment Temperature Profile For Various Cooling Rates.....	44
Figure 17 : Heat Treatment Temperature Variation By Thermocouple Position.....	45
Figure 18 : Schematic Illustration Of Sample Positions With Reference To The Weld Bead.....	47
Figure 19 : Hardness Profile Across BOP Weld.....	52
Figure 20 : BOP Weld, Etched In 10% Oxalic Acid (Electrolytic 15s) Dark Grey Areas Represent Fresh Martensite	52
Figure 21 : Area Plot Illustrating Variation In Hardness Values On BOP Welds	52
Figure 22 : Microstructure Revealed By Oxalic Acid Etch – (a) Base Material (b) Unattacked HAZ, Fresh Martensite With No Precipitates (c) Extensive Attack On Precipitates In Tempered Martensite (Distance Bar - 75µm, 100x)	53
Figure 23 : (a) Cu Deposition At The Weld Intersections And (b) Extent Of Corrosion After Strauss Test.....	54
Figure 24 : HAZ Interaction Highlighted By Oxalic Acid Etch	59
Figure 25 : Cu Deposition On Overlapping HAZ After Strauss Test.....	60
Figure 26 : Cross-Section Of HAZ Showing Less Cu Deposition On Vertically Positioned Sample.....	61
Figure 27 : Results Of Modified Strauss Test With Extensive Martensite Corrosion (a) Attack On Exposed Surface (b) Attack Perpendicular To Exposed Surface (200x).....	62

Figure 28 : Corrosion Of Martensite Surrounding δ -Ferrite In HTHAZ (Distance Bar – 38 μ m, 200x).....	62
Figure 29 : (a) Preferential Corrosion On Martensite Phase Along Sub-Grains (Scale Bar – 20 μ m, 500x) (b) Cu Deposition Along Sub-Grains Within Martensite (1000x).....	63
Figure 30 : Corrosion Attack On Martensite (a) Surface Directly Exposed During Strauss Test	64
Figure 31 : Variation In Extent Of Corrosion Within Sensitised Regions.....	65
Figure 32 : CGHAZ After Annealing Free Of Corrosion (a) Scale Bar 75 μ m (b) Scale Bar 50 μ m.....	65
Figure 33 : Differences In Cu Deposition For Different Materials.....	68
Figure 34 : Mode 2 Sensitisation At Weld Toe Due To Poor Positioning And High Degree Of Overlap.	69
Figure 35 : Mode 2 Sensitisation Occurring As A Result Of Bad Weld Positioning	69
Figure 36 : Extensive Corrosion At Weld Toe Resulting From Mode 2 Sensitisation...	70
Figure 37 : Mode 4 Sensitisation At The Surface Of Sample BWA 09	72
Figure 38 : Mode 4 Sensitisation And IGC On Material C.....	73
Figure 39 : Typical EPR Scan Chart.....	76
Figure 40 : EPR Scan For Material A202 Showing Strong Cathodic Loop	77
Figure 41 : Sample A202 After EPR Testing Showing Corrosion At The Edge Of The LTHAZ.	78
Figure 42 : Corrosion Attack On Sample A202 (a) 50x, Scale Bar 150 μ m (b) 200x, Scale Bar 38 μ m.....	79

Figure 43 : Grain Boundary Attack On Sample A202 (a) 200x, Scale Bar 38 μ m (b)	
500x, Scale Bar 15 μ m.....	80
Figure 44 : Grain Boundary Attack On Sample A109 (a) 200x Scale Bar 38 μ m (b)	
500x, Scale Bar 15 μ m.....	80
Figure 45 : Grain Boundary Attack In CGHAZ On Material C101 (a) 200x Mag (b)	
500x Mag	81
Figure 46 : Cooling Rate And Current Density Ratio For Material A.....	83
Figure 47 : Cooling Rate And Current Density Ratio For Material C	84
Figure 48 : Microstructures Of EPR Samples From Material A 111 And 113.....	85
Figure 49 : Microstructures Of EPR Samples For Material A 062 And 063	86
Figure 50 : Microstructures Of EPR Samples For Material C 063 And 122	88
Figure 51 : EPR Scan Of Material C122.....	89
Figure 52 : EPR Scan For Material A 092	90

List of Tables

Table 1 : Chemical Analysis Of Tested Material (All Values In Wt %)	36
Table 2 : Material Characteristics Of The Supplied Plate (Temperatures In °C)	37
Table 3 : Hardness Values (HV10) Corresponding To Indentations In Figure 17	52
Table 4 : Welding Parameters Used For Preliminary Butt Welds	58
Table 5 : Welding Parameters For Comparative Trials On Materials A2 And C1	67
Table 6 : EPR Test Results For Welded Samples	75
Table 7 : Summary Of EPR Scan Results For Material A	82
Table 8 : Summary Of EPR Scan Results For Material C	84