

CORROSION OF WELDMENTS



The Materials
Information Society

Contents

Preface	vii
Chapter 1 Basic Understanding of Weld Corrosion	1
Factors Influencing Corrosion of Weldments	1
Weld Microstructures	1
Forms of Weld Corrosion	3
Welding Practice to Minimize Corrosion	10
Chapter 2 Corrosion of Carbon Steel and Low-Alloy Steel	13
Weldments	13
Classification of Steels and Their Welding	
Characteristics	13
Carbon Steels	13
Low-Alloy Steels	14
Corrosion Considerations for Carbon and Low-Alloy	
Steel Weldments	15
Corrosion of Carbon Steel Weldments	19
Influence of Weld Microstructure	19
Residual Stress	19
Geometrical Factors	19
Preferential HAZ Corrosion	20
Preferential Weld Metal Corrosion	21
Mitigation of Preferential Weldment Corrosion	21
Galvanic Corrosion	23
Environmentally Assisted Cracking (EAC)	24
Wet Hydrogen Sulfide Cracking	25
Stress-Corrosion Cracking	25
Hydrogen-Induced Cracking	33
Effect of Welding Practice on Weldment Corrosion	35
Chapter 3 Corrosion of Austenitic Stainless Steel Weldments	43
Grade Designations	43
Standard Grades	43
Nonstandard Grades	43
Properties	47
General Welding Considerations	48
Corrosion Behavior	48
Intergranular Corrosion	49

Preferential Attack Associated with Weld	
Metal Precipitates	52
Pitting and Crevice Corrosion	53
Stress-Corrosion Cracking	58
Microbiologically Induced Corrosion	62
Other Factors Influencing Corrosion of Weldments	66
Chapter 4 Corrosion of Ferritic Stainless Steel Weldments	77
Grade Classifications	77
Properties	79
General Welding Considerations	80
Corrosion Behavior	82
Hydrogen Embrittlement	82
Intergranular Corrosion	83
Avoiding Intergranular Corrosion	84
Example 1: Leaking Welds in a Ferritic Stainless Steel Wastewater Vaporizer	87
Example 2: Weld Failure Due to Intergranular Corrosion and Cracking in a Heat-Recovery Steam Generator	89
Chapter 5 Corrosion of Duplex Stainless Steel Weldments	99
Duplex Stainless Steel Development and Grade Designations	99
Microstructure and Properties	100
General Welding Considerations	103
Corrosion Behavior of Weldments	105
Corrosion Behavior of Alloy 2205 Weldments	109
Chapter 6 Corrosion of Martensitic Stainless Steel Weldments	115
Grade Designations	115
Standard Grades	115
Nonstandard Grades	116
Properties	117
General Welding Considerations	118
Corrosion Behavior	118
Chapter 7 Corrosion of High-Nickel Alloy Weldments	125
Types of Corrosion-Resistant Alloys (CRAs)	125
General Welding Considerations	130
Welding Metallurgy of CRAs Containing Molybdenum	132
Welding Metallurgy of Ni-Cu, Ni-Cr, and Ni-Cr-Fe CRAs	134
Corrosion Behavior	134
Phase Stability of Nickel-Base Alloys and Corrosion Behavior	137
Chapter 8 Corrosion of Nonferrous Alloy Weldments	143
Aluminum and Aluminum Alloys	143
General Welding Considerations	143
Corrosion Behavior of Aluminum Alloy Weldments	144
Copper and Copper Alloys	155
General Welding Considerations	155
Corrosion Behavior of Copper Weldments	155

Titanium and Titanium Alloys	156
General Welding Considerations	157
Corrosion Behavior of Titanium and Titanium Alloy	
Weldments	158
Zirconium and Zirconium Alloys	160
General Welding Considerations	161
Corrosion Behavior of Zirconium and Zirconium Alloy	
Weldments	162
Tantalum and Tantalum Alloys	164
General Welding Considerations	164
Corrosion Behavior of Tantalum and Tantalum Alloy	
Weldments	164
Chapter 9 Corrosion of Dissimilar Metal Weldments ..	169
Factors Influencing Joint Integrity	169
Corrosion Behavior	173
Chapter 10 Weld Corrosion in Specific Industries and Environments ..	177
Corrosion of Weldments in Petroleum Refining and	
Petrochemical Operations	177
Fabricability Considerations	177
Wet H ₂ S Cracking	178
Hydrogen-Induced Disbonding	181
Liquid Metal Embrittlement	181
Stress-Corrosion Cracking of Weldments in BWR Service ..	183
BWR Piping Systems	183
Stress-Corrosion Cracking of Pipe Weldments	183
Model for IGSCC	184
Weld Residual Stresses	185
Mitigation of IGSCC in Boiling Water Reactors	187
Materials Solutions	188
Tensile Stress Reduction Solutions	189
Environmental Solutions	190
Corrosion in the Pulp and Paper Industry	191
Pulp Production	191
Corrosion of Weldments in Pulp Bleach Plants	196
Chapter 11 Monitoring and Testing of Weld Corrosion ..	203
Corrosion Monitoring	203
Direct Testing of Coupons	203
Electrochemical Techniques	206
Nondestructive Testing Techniques	207
Corrosion Testing	208
Tests for Intergranular Corrosion	209
Tests for Pitting and Crevice Corrosion	213
Tests for SCC	213
Tests for MIC	215
Index ..	217