

## List of Tables

TABLE NO.	TITLE	PAGE NO.
2.1	Comparison of ESSC with SASC process of basic features	17
2.2	Compression of welding parameters of ESSC with SASC	18
2.3	Industrial application of ESSC Process	19
2.4	Stainless steels & Nickel alloys strip for SASC and ESSC process	33
2.5	Chemical analysis of single-layer overlay in the bulk weld metal	48
2.6	EDS (SEM) chemical analysis in the interface transition zone in single-layer overlay	49
2.7	List of Etchant for various alloys	52
2.8	Peak Current value of EPR test	66
2.9	Applicability of ASTM standard practices in A 262 for testing of IGC in austenitic stainless steels	68
2.10	Ranking of ultrasonic test results according to ASTM G 146-01	76
2.11	The maximum heat input rate and volumetric phase fractions (%) of RPV clad	88
3.1	Chemical Composition of base metal and strip electrodes (weight%)	93
3.2	Design of Experiments	93
3.3	Strip welding conditions	94
3.4	Operating Parameters for Potentio-dynamic test	98
3.5	Operating Parameters for Cyclic polarization test	101
4.1	Electrochemical Parameters of Potentio-dynamic 309 L cladded weld overlay develop with 160mm / min. welding speed at different location in 0.1 N HHO <sub>3</sub> Solution	109

4.2	Electrochemical Parameters of Potentio-dynamic 309 L cladded weld overlay develop with 180mm / min. welding speed at different location in 0.1 N HHO <sub>3</sub> Solution	110
4.3	Electrochemical Parameters of Potentio-dynamic 309 L cladded weld overlay develop with 200 mm / min. welding speed at different location in 0.1 N HHO <sub>3</sub> Solution	111
4.4	Electrochemical Parameters of Potentio-dynamic 309 L Nb cladded weld overlay develop with 160mm / min. welding speed at different location in 0.1 N HHO <sub>3</sub> Solution	112
4.5	Electrochemical Parameters of Potentio-dynamic 309 L Nb cladded weld overlay develop with 180mm / min. welding speed at different location in 0.1 N HHO <sub>3</sub> Solution	113
4.6	Electrochemical Parameters of Potentio-dynamic 309 L Nb cladded weld overlay develop with 200 mm / min. welding speed at different location in 0.1 N HHO <sub>3</sub> Solution	114
4.7	Electrochemical Parameters of Potentio-dynamic 309 L cladded weld overlay develop with 160mm / min. welding speed at different location in 0.1 N HCl Solution	116
4.8	Electrochemical Parameters of Potentio-dynamic 309 L cladded weld overlay develop with 180mm / min. welding speed at different location in 0.1 N HCl Solution	117
4.9	Electrochemical Parameters of Potentio-dynamic 309 L cladded weld overlay develop with 200 mm / min. welding speed at different location in 0.1 N HCl Solution	118
4.10	Electrochemical Parameters of Potentio-dynamic 309 L Nb cladded weld overlay develop with 160mm / min. welding speed at different location in 0.1 N HCl Solution	119
4.11	Electrochemical Parameters of Potentio-dynamic 309 L Nb cladded weld overlay develop with 180mm / min. welding speed at different location in 0.1 N HCl Solution	120

4.12	Electrochemical Parameters of Potentio-dynamic 309 L Nb cladded weld overlay develop with 200 mm / min. welding speed at different location in 0.1 N HCl Solution	121
4.13	Electrochemical Parameters of Potentio-dynamic 309 L cladded weld overlay develop with 160mm / min. welding speed at different location in 0.1 N H <sub>2</sub> SO <sub>4</sub> Solution	123
4.14	Electrochemical Parameters of Potentio-dynamic 309 L cladded weld overlay develop with 180mm / min. welding speed at different location in 0.1 N H <sub>2</sub> SO <sub>4</sub> Solution	124
4.15	Electrochemical Parameters of Potentio-dynamic 309 L cladded weld overlay develop with 200 mm / min. welding speed at different location in 0.1 N H <sub>2</sub> SO <sub>4</sub> Solution	125
4.16	Electrochemical Parameters of Potentio-dynamic 309 L Nb cladded weld overlay develop with 160mm / min. welding speed at different location in 0.1 N H <sub>2</sub> SO <sub>4</sub> Solution	126
4.17	Electrochemical Parameters of Potentio-dynamic 309 L Nb cladded weld overlay develop with 180mm / min. welding speed at different location in 0.1 N H <sub>2</sub> SO <sub>4</sub> Solution	127
4.18	Electrochemical Parameters of Potentio-dynamic 309 L Nb cladded weld overlay develop with 200 mm / min. welding speed at different location in 0.1 N H <sub>2</sub> SO <sub>4</sub> Solution	129
4.19	Electrochemical Parameters of Potentio-dynamic 309 L cladded weld overlay develop with 160mm / min. welding speed at different location in 3.5 % NaCl Solution	130
4.20	Electrochemical Parameters of Potentio-dynamic 309 L cladded weld overlay develop with 180mm / min. welding speed at different location in 3 .5 % NaCl Solution	131
4.21	Electrochemical Parameters of Potentio-dynamic 309 L cladded weld overlay develop with 200 mm / min. welding speed at different location in 3.5 % NaCl Solution	132
4.22	Electrochemical Parameters of Potentio-dynamic 309 L Nb cladded weld overlay develop with 160mm / min. welding speed at different location in .5 % NaCl Solution	133

4.23	Electrochemical Parameters of Potentio-dynamic 309 L Nb cladded weld overlay develop with 180mm / min. welding speed at different location in 3 .5 % NaCl Solution	134
4.24	Electrochemical Parameters of Potentio-dynamic 309 L Nb cladded weld overlay develop with 200 mm / min. welding speed at different location in .5 % NaCl Solution	135
4.25	EDAX analysis of cladded region of 309L cladded weld overlay at 160 mm /min. welding speed	144
4.26	EDAX analysis of cladded region of 309L Cladded weld overlay at 180 mm /min. welding speed region of	145
4.27	EDAX analysis of cladded region of 309L Cladded weld overlay at 200 mm /min. welding speed	146
4.28	EDAX analysis of cladded region of 309LNb Cladded weld overlay at 160 mm /min. welding speed region of	147
4.29	EDAX analysis of cladded region of 309L Nb Cladded weld overlay at 180 mm /min. welding speed	148
4.30	EDAX analysis of cladded region of 309LNb Cladded weld overlay at 200 mm /min. welding speed of	149
4.31	EDAX analysis of interface region of 309L cladded weld overlay at 160 mm /min. welding speed	150
4.32	EDAX analysis of interface region of 309L Cladded weld overlay at 180 mm /min. welding speed	151
4.33	EDAX analysis of interface region of 309L Cladded weld overlay at 200 mm /min. welding speed	152
4.34	EDAX analysis of cladded region of 309LNb Cladded weld overlay at 160 mm /min. welding speed	153
4.35	EDAX analysis of interface region of 309L Cladded weld overlay at 180 mm /min. welding speed	154
4.36	EDAX analysis of interface region of 309LNb Cladded weld overlay at 200 mm /min. welding speed region of	155
4.37	Elemental Analysis of cladding by EDAX Analysis	156

4.38	Elemental Analysis of Interface region by EDAX Analysis	157
4.39	Percentage Dilution at interface region	158
4.40	EDAX analysis of white spot at cladded region of 309LNb Cladded weld overlay at 160 mm /min. welding speed region of	159
4.41	EDAX analysis of cladded region of 309LNb Cladded weld overlay at 180 mm /min. welding speed region of	160
4.42	EDAX analysis of white spot at cladded region of 309LNb Cladded weld overlay at 200 mm /min. welding speed region of	161
4.43	EDAX analysis of clad region near to interface of 309L Cladded weld overlay at 180 mm /min. welding speed region of	162
4.44	EDAX analysis at interface of 309L Cladded weld overlay at 180 mm /min. welding speed region of	163
4.45	EDAX analysis of base metal near to interface of 309L Cladded weld overlay at 180 mm /min. welding speed region of	164
4.46	EDAX analysis base metal of 309L Cladded weld overlay at 180 mm /min. welding speed region of	165
4.47	EDAX analysis of clad region near to interface of 309LNb Cladded weld overlay at 180 mm /min. welding speed region of	166
4.48	EDAX analysis at interface of 309L Nb Cladded weld overlay at 180 mm /min. welding speed	167
4.49	EDAX analysis of base metal near to interface of 309L Nb Cladded weld overlay at 180 mm /min. welding speed region of	168
4.50	EDAX analysis base metal of 309LNb Cladded weld overlay at 180 mm /min. welding speed	169
4.51	Percentage elements present at different locationof weld overlay	170
4.52	Variation of ferrite content at different welding speed	171
4.53	Micro harness at different location of weld overlays in as welded	171

	condition	
4.54	Electrochemical Parameters of Potentiodynamic studies on Base Metal in 0.1N HNO <sub>3</sub> solution	173
4.55	Electrochemical Parameters of Potentio-dynamic studies of 309 L cladded weld overlay in 0.1N HNO <sub>3</sub> Solution	174
4.56	Table No- 4.54(B) : Electrochemical Parameters of Potentio-dynamic studies interface of 309 L cladded weld overlay in 0.1N HNO <sub>3</sub> Solution	175
4.57	Electrochemical Parameters of Potentiodynamic studies of 309 LNb cladded weld overlays in 0.1N HNO <sub>3</sub> Solution	176
4.58	Electrochemical Parameters of Potentio-dynamic studies interface of 309 L Nb cladded weld overlay in 0.1N HNO <sub>3</sub> Solution	177
4.59	Electrochemical Parameters of Potentiodynamic study of Base Metal in 0.1N HCl	178
4.60	Electrochemical Parameters of Potentiodynamic study of 309 L cladded weld overlay in 0.1N HCl Solution	179
4.61	Electrochemical Parameters of Potentio-dynamic studies interface of 309 L cladded weld overlay in 0.1N HCl Solution	180
4.62	Electrochemical Parameters of Potentio-dynamic study of 309 LNb cladded weld overlay in 0.1N HCl Solution	181
4.63	Electrochemical Parameters of Potentio-dynamic studies interface of 309 LNb cladded weld overlay in 0.1N HCl Solution	182
4.64	Electrochemical Parameters of Potentiodynamic studies on Base Metal in 0.1N H <sub>2</sub> S0 <sub>4</sub> solution	183
4.65	Electrochemical Parameters of Potentio-dynamic studies of 309 L cladded weld overlay in 0.1N HNO <sub>3</sub> Solution	184
4.66	Electrochemical Parameters of Potentio-dynamic studies interface of 309 L cladded weld overlay in 0.1N H <sub>2</sub> S0 <sub>4</sub> Solution	185

4.67	Electrochemical Parameters of Potentiodynamic studies of 309 LNb cladded weld overlays in 0.1N H <sub>2</sub> SO <sub>4</sub> Solution	186
4.68	Electrochemical Parameters of Potentio-dynamic studies interface of 309 L Nb cladded weld overlay in 0.1N H <sub>2</sub> SO <sub>4</sub> Solution	187
4.69	Electrochemical Parameters of Potentiodynamic studies on Base Metal in 3.5 % NaCl solution	188
4.70	Electrochemical Parameters of Potentio-dynamic studies of 309 L cladded weld overlay in 3.5 % NaCl Solution	189
4.71	Electrochemical Parameters of Potentio-dynamic studies interface of 309 L cladded weld overlay in 3.5 % NaCl Solution	190
4.72	Electrochemical Parameters of Potentiodynamic studies of 309 LNb cladded weld overlays in 3.5 % NaCl Solution	191
4.73	Electrochemical Parameters of Potentio-dynamic studies interface of 309 L Nb cladded weld overlay in 3.5 % NaCl Solution	192
4.74	Electrochemical Parameters of cyclic polarization Scan in 6% FeCl <sub>3</sub> Solution	193
4.75	Electrochemical Parameters of cyclic polarization Scan of 309L cladded weld overlays in 6% FeCl <sub>3</sub> Solution	194
4.76	Electrochemical Parameters of cyclic polarization Scan in 6% FeCl <sub>3</sub> Solution	195
4.77	Electrochemical Parameters of cyclic polarization Scan in 6% FeCl <sub>3</sub> Solution	196
4.78	Electrochemical Parameters of cyclic polarization Scan in 6% FeCl <sub>3</sub> Solution	197
4.79	Peak Current density of EPR scans of cladded region of 309L cladded weld overlays at as welded condition	198
4.80	Peak Current density of EPR scans of interface region of 309L cladded weld overlays at as welded condition	199
4.81	Peak Current density of EPR scans of cladded region of 309L Nb cladded weld overlays at as welded condition	200

4.82	Peak Current density of EPR scans of interfce region of 309L Nb cladded weld overlays at as welded condition	201
4.83	Effect of Nb addition on the amount of ferrite content	207
4.84	Effect of Nb addition on the Micro hardness value	207
4.85	Electrochemical Parameters of Potentiodynamic scans of cladded region of 309 L & 309 L Nb cladded weld overlay develop with 160 mm / min. welding speed in 0.1 N HHO <sub>3</sub> Solution	208
4.86	Electrochemical Parameters of Potentiodynamic scans of cladded region of 309 L & 309 L Nb cladded weld overlay develop with 180 mm / min. welding speed in 0.1 N HHO <sub>3</sub> Solution	209
4.87	Electrochemical Parameters of Potentiodynamic scans of cladded region of 309 L & 309 L Nb cladded weld overlay develop with 200 mm / min. welding speed in 0.1 N HHO <sub>3</sub> Solution	210
4.88	Electrochemical Parameters of Potentiodynamic scans of Interface region of 309 L & 309 L Nb cladded weld overlay develop with 160 mm / min. welding speed in 0.1 N HHO <sub>3</sub> Solution	211
4.89	Electrochemical Parameters of Potentiodynamic scans of Interface region of 309 L & 309 L Nb cladded weld overlay develop with 180 mm / min. welding speed in 0.1 N HHO <sub>3</sub> Solution	212
4.90	Electrochemical Parameters of Potentiodynamic scans of Interface region of 309 L & 309 L Nb cladded weld overlay develop with 200 mm / min. welding speed in 0.1 N HHO <sub>3</sub> Solution	213
4.91	Effect of Nb addition on corrosion resistance of weld overlay at clad as well as at interface clad as well as at interface in 0.1 N HNO <sub>3</sub> solution	214
4.92	Electrochemical Parameters of Potentiodynamic scans of cladded region of 309 L & 309 L Nb cladded weld overlay develop with 160 mm / min. welding speed in 0.1 N H <sub>2</sub> SO <sub>4</sub> Solution	215

4.93	Electrochemical Parameters of Potentiodynamic scans of cladded region of 309 L & 309 L Nb cladded weld overlay develop with 180 mm / min. welding speed in 0.1 N H <sub>2</sub> SO <sub>4</sub> Solution	216
4.94	Electrochemical Parameters of Potentiodynamic scans of cladded region of 309 L & 309 L Nb cladded weld overlay develop with 200 mm / min. welding speed in 0.1 N H <sub>2</sub> SO <sub>4</sub> Solution	217
4.95	Electrochemical Parameters of Potentiodynamic scans of Interface region of 309 L & 309 L Nb cladded weld overlay develop with 160 mm / min. welding speed in 0.1 N H <sub>2</sub> SO <sub>4</sub> Solution	218
4.96	Electrochemical Parameters of Potentiodynamic scans of Interface region of 309 L & 309 L Nb cladded weld overlay develop with 180 mm / min. welding speed in 0.1 N H <sub>2</sub> SO <sub>4</sub> Solution	219
4.97	Electrochemical Parameters of Potentiodynamic scans of Interface region of 309 L & 309 L Nb cladded weld overlay develop with 200 mm / min. welding speed in 0.1 N H <sub>2</sub> SO <sub>4</sub> Solution	220
4.98	Effect of Nb addition on corrosion resistance of weld overlay at clad as well as at interface clad as well as at interface in 0.1 N H <sub>2</sub> SO <sub>4</sub> solution	221
4.99	Electrochemical Parameters of Potentiodynamic scans of cladded region of 309 L & 309 L Nb cladded weld overlay develop with 160 mm / min. welding speed in 0.1 N HCl Solution	222
4.100	Electrochemical Parameters of Potentiodynamic scans of cladded region of 309 L & 309 L Nb cladded weld overlay develop with 180 mm / min. welding speed in 0.1 N HCl Solution	223
4.101	Electrochemical Parameters of Potentiodynamic scans of cladded region of 309 L & 309 L Nb cladded weld overlay develop with 200 mm / min. welding speed in 0.1 N HCl Solution	224
4.102	Electrochemical Parameters of Potentiodynamic scans of Interface region of 309 L & 309 L Nb cladded weld overlay develop with 160 mm / min. welding speed in 0.1 N HCl Solution	225

4.103	Electrochemical Parameters of Potentiodynamic scans of Interface region of 309 L & 309 L Nb cladded weld overlay develop with 180 mm / min. welding speed in 0.1 N HCl Solution	226
4.104	Electrochemical Parameters of Potentiodynamic scans of Interface region of 309 L & 309 L Nb cladded weld overlay develop with 200 mm / min. welding speed in 0.1 N HCl Solution	227
4.105	Effect of Nb addition on corrosion resistance of weld overlay at clad as well as at interface clad as well as at interface in 0.1 N HCl solution	228
4.106	Electrochemical Parameters of Potentiodynamic scans of cladded region of 309 L & 309 L Nb cladded weld overlay develop with 160 mm / min. welding speed in 3.5 % NaCl Solution	229
4.107	Electrochemical Parameters of Potentiodynamic scans of cladded region of 309 L & 309 L Nb cladded weld overlay develop with 180 mm / min. welding speed in 3.5 % NaCl Solution	230
4.108	Electrochemical Parameters of Potentiodynamic scans of cladded region of 309 L & 309 L Nb cladded weld overlay develop with 200 mm / min. welding speed in 3.5 % NaCl Solution	231
4.109	Electrochemical Parameters of Potentiodynamic scans of Interface region of 309 L & 309 L Nb cladded weld overlay develop with 160 mm / min. welding speed in 3.5 % NaCl Solution	232
4.110	Electrochemical Parameters of Potentiodynamic scans of Interface region of 309 L & 309 L Nb cladded weld overlay develop with 180 mm / min. welding speed in 3.5 % NaCl Solution	233
4.111	Electrochemical Parameters of Potentiodynamic scans of Interface region of 309 L & 309 L Nb cladded weld overlay develop with 200 mm / min. welding speed in 3.5 % NaCl Solution	234
4.112	Effect of Nb addition on corrosion resistance of weld overlay at clad as well as at interface clad as well as at interface in 3.5 % NaCl solution	235

4.113	Electrochemical Parameters of cyclic polarization Scan in 6% FeCl <sub>3</sub> Solution	236
4.114	Electrochemical Parameters of cyclic polarization Scan in 6% FeCl <sub>3</sub> Solution	237
4.115	Electrochemical Parameters of cyclic polarization Scan in 6% FeCl <sub>3</sub> Solution	238
4.116	Electrochemical Parameters of cyclic polarization Scan in 6% FeCl <sub>3</sub> Solution	239
4.117	Electrochemical Parameters of cyclic polarization Scan in 6% FeCl <sub>3</sub> Solution	240
4.118	Electrochemical Parameters of cyclic polarization Scan in 6% FeCl <sub>3</sub> Solution	241
4.119	Electrochemical Parameters of cyclic polarization Scan in 6% FeCl <sub>3</sub> Solution	242
4.120	Electrochemical Parameters of cyclic polarization Scan in 6% FeCl <sub>3</sub> Solution	243
4.121	Electrochemical Parameters of cyclic polarization Scan in 6% FeCl <sub>3</sub> Solution	245
4.122	Electrochemical Parameters of cyclic polarization Scan in 6% FeCl <sub>3</sub> Solution	246
4.123	Electrochemical Parameters of cyclic polarization Scan in 6% FeCl <sub>3</sub> Solution	247
4.124	Electrochemical Parameters of cyclic polarization Scan in 6% FeCl <sub>3</sub> Solution	248
4.125	Peak Current density of EPR scans of cladded region of 309 L & 309 L Nb cladded weld overlay developed with 160 mm / min. welding speed	249
4.126	Peak Current density of EPR scans of cladded region of 309 L & 309 L Nb cladded weld overlay developed with 180 mm / min. welding speed	250

4.127	Peak Current density of EPR scans of cladded region of 309 L & 309 L Nb cladded weld overlay developed with 200 mm / min. welding speed	251
4.128	Peak Current density of EPR scans of interface region of 309 L & 309 L Nb cladded weld overlay developed with 160 mm / min. welding speed	252
4.129	Peak Current density of EPR scans of interface region of 309 L & 309 L Nb cladded weld overlay developed with 180 mm / min. welding speed	253
4.130	Peak Current density of EPR scans of interface region of 309 L & 309 L Nb cladded weld overlays with developed with 200 mm / min. welding	254
4.131	Peak Current density of EPR scans of cladded region og 309 L & 309 L Nb cladded weld overlays developed with 160 mm / min, welding speed after PWHT	255
4.132	Peak Current density of EPR scans of cladded region og 309 L & 309 L Nb cladded weld overlays developed with 180 mm / min. welding speed after PWHT	256
4.133	Peak Current density of EPR scans of cladded region og 309 L & 309 L Nb cladded weld overlays developed with 200 mm / min. welding speed after PWHT	257
4.134	Peak Current density of EPR scans of interface region og 309 L & 309 L Nb cladded weld overlays developed with 160 mm / min. welding speed after PWHT	258
4.135	Peak Current density of EPR scans of interface region og 309 L & 309 L Nb cladded weld overlays developed with 180 mm / min, welding speed after PWHT	259
4.136	Peak Current density of EPR scans of interface region og 309 L & 309 L Nb cladded weld overlays developed with 200 mm / min. welding speed after PWHT	260
4.137	Effect of PWHT on of ferrite content in 309 L & 309 L Nb cladded region	269
4.138	Effect of PWHT on hardness value at clad region	269

4.139	Effect of PWHT on hardness value interface region	270
4.140	Effect of PWHT on Hardness value at base Metal	270
4.141	Electrochemical Parameters of cyclic polarization Scan base metal after PWHT in 6% FeCl <sub>3</sub> Solution	271
4.142	Electrochemical Parameters of cyclic polarization Scan of cladded region 309L cladded weld overlays after PWHT in 6% FeCl <sub>3</sub> Solution	272
4.143	Electrochemical Parameters of cyclic polarization scan clad region of 309LNb Cladded weld overlays after PWHT in 6% FeCl <sub>3</sub> Solution	273
4.144	Electrochemical Parameters of cyclic polarization Scan of interface region309L cladded weld overlays after PWHT in 6% FeCl <sub>3</sub> Solution	274
4.145	Electrochemical Parameters of cyclic polarization Scan interface region of 309LNb Cladded weld overlays in 6% FeCl <sub>3</sub> Solution	275
4.146	Comparisons of pitting behaviour of both weld overlay before & after PWHT	276
4.147	Peak Current density of EPR scans ofcladded region of 309L cladded weld overlays after PWHT	277
4.148	Peak Current density of EPR scans ofcladded region of 309LNb cladded weld overlays after PWHT	278
4.149	Peak Current density of EPR scans of intefcae region of 309L cladded weld overlays after PWHT	279
4.150	Peak Current density of EPR scans of intefcae region of 309 LN <sub>b</sub> cladded weld overlays after PWHT	280
4.151	Comparisons of sensitization behaviour of weld overlays before and PWHT	281