CHAPTER 5

CONCLUSION

5.1 CORROSION PROPERTIES

- With increase in nitrogen content (minimum 2% N_2) in shielding and back purging gas, the corrosion properties are improved because of balanced microstructure. Addition of 5% Nitrogen has insignificant improvement in the pitting corrosion resistance.
- Higher interpass temperatures cause reduction in corrosion resistance due to formation of secondary austenite and intermetallic phases.
- The following parameters are recommended to obtain better corrosion properties for both DSS and SDSS- (a) heat input 0.75-1.1 kJ/mm (b) shielding/purging gas – Ar+2%N_2. (c) stringer bead technique (d) interpass temperature less than 120 ºC.
- The weld root region is susceptible to pitting attack as compared to weld cap region. This is due to the precipitation of hazardous secondary austenite and intermetallic phases in weld root due to multiple heating cycles.
- Lower welding heat input is found to be better for improved corrosion properties than higher heat input. At high heat input, formation of secondary austenite and intermetallic phases are evident. In addition, repetitive heating cycles also promote the formation of sigma phases.

- Potentiodynamic studies reveals that at lower heat input, specimen tends to push the polarization curve to positive values, which confirms improvement of pitting resistance. Critical pitting occurrs between 24 to 27 ºC for DSS and 37 to 41 ºC for SDSS specimen.

5.2 MECHANICAL PROPERTIES

- For DSS, heat input of 1.0-1.1 kJ/mm with interpass temperature less than 120 ºC and shielding/purging gas mixture of $Ar+2\%N_2$ results in improved mechanical properties. Similarly for SDSS, heat input of 0.75-1.05 kJ/mm with interpass temperature less than 120 ºC and shielding/purging gas mixture of $Ar+2\%N_2$ results in better mechanical proeprties.
- Tensile strength of all weldments is 5-10% higher than that of base material. The highest strength values obtained for DSS is 805 MPa and SDSS is 862 MPa. There is a decrease in tesnile strength of weldments than the filler wire with increase in heat input due to grain coarsening and less ferrite formation.
- Hardness values decreases with higher heat input for both DSS and SDSS. At weld root, very high hardness readings are observed due to presence of hard and brittle intermetallic phases and varying weld thermal cycles.
- Impact toughness decreases with increase in heat input because of intermetallic phase formation, secondary austenite formation and increase in grain size. The highest toughness values obtained for DSS is 168 J and and for SDSS is 140 J at - 46 ºC. There is a significant loss of toughness in SDSS samples as they are more sensible to formation of intermetallic/secondary phases.

- High nitrogen contents in shielding and purging gas (i.e. Ar+5%N_2) slightly improve tensile strength and hardness due to strengthening of austenite phase but significantly improve toughness values due to restriction of dislocations. However, 2% N_2 has also given equally improved mechanical properties.

- An increase in interpass temperature from 120 ºC to 160 ºC reduces strength and toughness values due to grain coarsening and sigma phase formation. It is recommended to keep interpass temperature less than 120 ºC.

5.3 FUTURE SCOPE OF WORK

Further studies can be performed as below:

- Studies with higher thickness of DSS and SDSS pipes may be carried out to understand the thickness effect on heating and cooling.
- Other welding processes such as SMAW or SAW can be studied. For higher thickness materials, practically, it is not advisable to complete the welding with GTAW, as this will consume lot of time and welding cost.
- Studies may be carried out with respect to specific application under actual operating temperature, pressure and corrosion rate.

5.4 DETAILS OF PUBLICATIONS

Following papers have been published from the present research work:

- Prabhu Paulraj, Rajnish Garg, "Effect of Intermetallic Phases on Corrosion behaviour and Mechanical properties of Duplex Stainless