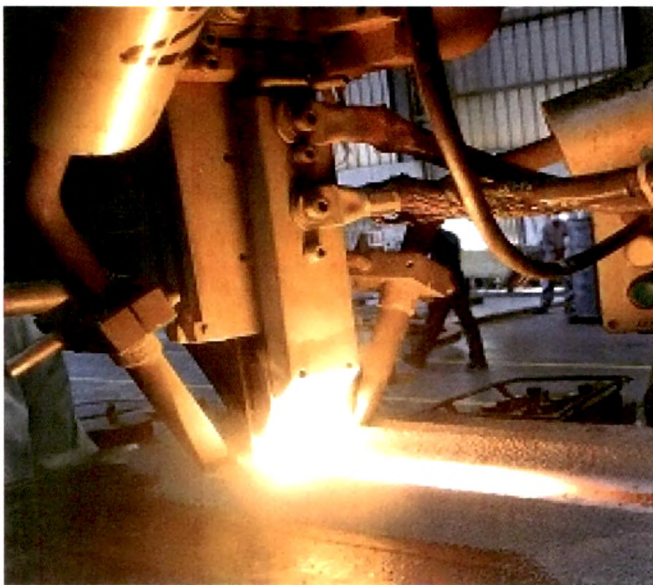


# CHAPTER -5

## CONCLUSIONS



**Conclusions:**

The following conclusions have been drawn based on results & discussions and the effect of various factors such as welding speed, niobium addition & post weld heat-treatment on mechanical properties & corrosion resistance of the weld overlay considering base metal, interface & clad region.

**Alloy Variation at different location:**

- Clad region of the both weld overlay exhibit good corrosion resistance as compared to base metal and interfaces due to higher content of Cr and Ni & tendency to form passive film in different acid solutions.
- Interface region of both welds overlay also having good corrosion resistance as compared to base metal due to presence of some amount of Cr and Ni.
- Corrosion rate was decreased with increasing the alloying elements from base metal to interface to clad region.

**Welding Speed:**

- With increase in the welding speed finer microstructure obtained leading to less ferrite formation which is confirmed by ferrite measurements. The hardness values get increased considerably while ferrite content decreased with increasing welding speed.
- With increase in the welding speed the percentage dilution gets increased but it was well within acceptable limit (8 to 9 %).
- Corrosion rate decreased with increase in welding speed from 160 to 200 mm/min for both weld overlays at clad as well as at interface region in 0.1 N  $\text{H}_2\text{SO}_4$ , 0.1N  $\text{HNO}_3$ , 0.1N  $\text{HCl}$  and 3.5 %  $\text{NaCl}$  solutions.
- With increasing welding speed there was no improvement in pitting susceptibility of clad as well as interface region of 309 L clad weld overlay but in case of 309L Nb clad weld overlay pitting resistance get improved at 180 mm/min

welding speed at clad region while at interface region there was no improvement in pitting susceptibility at all welding speeds.

- With increasing welding speed there has improvement in resistance toward IGC susceptibility of clad as well as interface region of both weld overlays, but at 200 mm/min welding speed the degree of sensitization was increased.

#### **Niobium addition:**

- There were no major micro-structural changes observed at clad region & interface region but in case of 309 L Nb clad weld overlay, little bit higher amount of ferrite phase was observed as compared to 309L clad weld overlay which was confirmed by ferrite measurements at all welding speeds.
- Niobium addition increases the ferrite content that may lead decrease in the hardness value at all welding speeds.
- With addition of Niobium, there is improvements in the corrosion resistance clad region & interface region of weld overlays in 0.1 N H<sub>2</sub>SO<sub>4</sub> & 3.5 % NaCl solutions while there is no improvements in the corrosion resistance in 0.1N HNO<sub>3</sub> & 0.1N HCl solutions at all welding speeds.
- With addition of Niobium, there was improvement in the resistance toward pitting corrosion clad region of weld overlay developed only at 180 mm/min welding speed while there was no improvements in the resistance towards pitting corrosion at interface region of weld overlay developed at all welding speeds.
- With addition of niobium, after PWHT there is improvement in pitting resistance of clad region of weld overlay developed at 160 mm/min & 180 mm/min welding speed while at interface region there was improvement in pitting resistance at all welding speeds.
- With addition of niobium, there is increase in the resistance towards IGC susceptibility at clad as well as interface regions of weld overlay at all welding

speeds at as welded condition. Similar behaviour of weld overlays was observed after PWHT conditions.

#### Post weld heat-treatment (PWHT)

- After PWHT, at clad region of both weld overlays, the island of ferrite become courser and the amount of austenite was increased while the ferrite content was decreases at all welding speeds which were confirmed by ferrite measurements.
- After PWHT, at interface region of both weld overlays, there was diffusion of carbon atom from base metal region near to interface in the form of iron carbide & next to this layer on the clad metal side it formed Type II boundary of austenite phase which is approximately parallel to the dark-etching layer. Further into the weld metal on the left of the Type II boundary austenitic weld metal structure containing ferrite in the substructure boundaries which is referred as type I boundaries.
- The hardness value of clad & base metal region were decreased due to reliving of stresses after PWHT but at interface region, the harness value was increased due to diffusion of carbon atom from base metal region near to interface in the form of iron carbide.
- After PWHT, the amount of ferrite was decreased at all welding speeds for the both weld overlays.
- After PWHT, There was no improvements in pitting resistance at clad as well as at interface region of 309 L cladded weld overlay at all welding speeds. But in case of 309 L Nb cladded weld overlays it exhibits better pitting resistance at cladded region which was developed at all welding speeds while at interface region developed at 160 & 180 mm/min & reveal good pitting resistance.
- after PWHT shows that the degree of sensitization was decreased at clad region as well as at interface region of 309L Nb cladded weld overlay developed at different welding speeds. While in case of 309 L cladded weld overlays, the degree of sensitization was decreased at clad region of weld

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overlay developed at 180 mm/min welding speed & at interface region of weld overlay developed at 200 mm/min welding speed.

- After PWHT, the degree of sensitization was decreases at clad region as well as at interface region of 309L Nb cladded weld overlay developed at different welding speeds while in case of 309 L cladded weld overlays, the degree of sensitization was decreased at clad region of weld overlay developed at 180 mm/min welding speed & at interface region of weld overlay developed at 200 mm/min welding speed.