

### Case Study

## Alloy 625 Weld Overlaid Carbon Steel Casings for High Pressure Seawater and Produced Water Applications



**A HPcP pump with Alloy 625 weld overlaid Carbon Steel casing for produced water injection**

### The Sulzer Difference

Sulzer Pumps design and development engineers worked towards finding the optimum technical solution for this and similar projects. The resulting overlay process gives designers of large water injection pumps material options that overcome a number of problems associated with traditional barrel manufacture. This capability coupled with Sulzer Pumps considerable experience in water injection supports our ability to design cost efficient, reliable solutions to customers increasingly challenging requirements.

### Project Highlights

To meet the demands of high pressure sea- and produced water applications, Sulzer Pumps offers Pumps with Inconel®625 weld overlaid carbon steel casings. This proven technology brings considerable quality- and reliability improvements compared to pumps made with casings in super duplex materials.

### Customer Benefits

Pumps for seawater or produced water applications are commonly made with super duplex steels which offer good pitting corrosion resistance at normal temperatures. But, it has a few disadvantages for high pressure applications. As an alternative to super duplex steels, Sulzer Pumps has developed a validated production procedure for using a carbon or low-alloy steel as the base material, with wetted surfaces welded with a highly corrosion-resistant Inconel 625 overlay. Carbon steel clad with Inconel is not prone to forming brittle phases and also assures excellent corrosion resistance in elevated temperatures. This technology offers excellent quality- and reliability improvements for customers.

### The Challenge

Casings of high pressure barrel pumps for sea water applications have typically been forged in super duplex steel. This has many disadvantages: The difficulty in forging of thick casings in super duplex, problems in achieving rapid and homogeneous cooling, insufficient corrosion resistance at high temperature, formation of brittle phases during welding, as well as high cost of raw material. Inhomogeneous cooling causes microstructural instability of ferritic austenitic phases and also formation of brittle sigma phases, which lead a sharp drop in impact strength, tensile ductility, and corrosion resistance.

It is also difficult to ensure consistent mechanical properties across the whole thickness; particularly when higher casing wall thicknesses are required for high pressure applications. Depending on the design requirements, the dimensions may exceed the sizes where the related heat treatments and welding procedures can be applied. For certain casing designs, the forged super-duplex design is not an option at all.

Welding of nozzles and other big attachments to the thick super duplex casing is also considerably difficult compared to C-Steel, due to difficulty in post weld heat treatment of big parts.

### The Solution

To avoid forging problems and improve quality, Sulzer Pumps uses carbon steel barrels, with inner parts which come in contact with the liquid protected with Inconel 625 overlay welding. Inconel 625 is a nickel chromium alloy with high strength and an outstanding corrosion resistance in chloride environments.

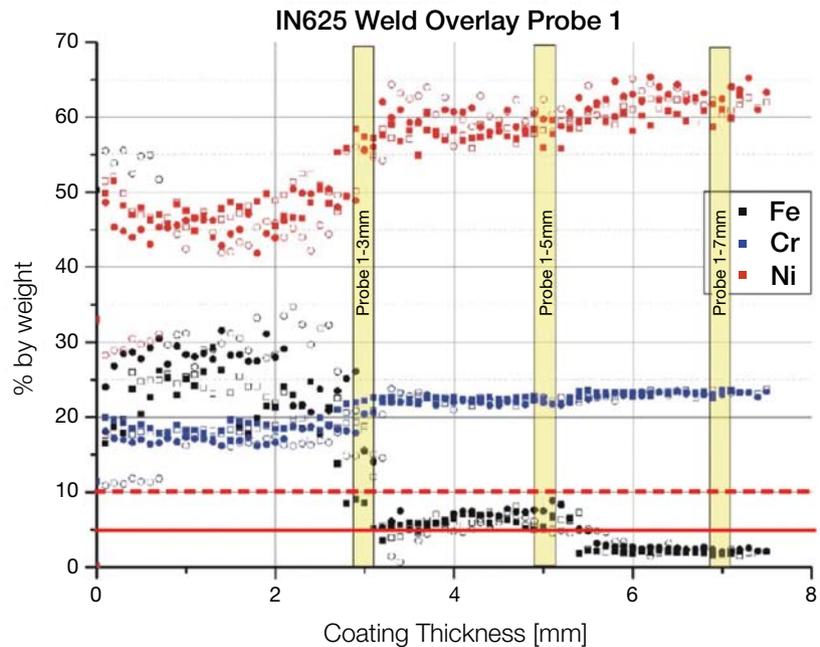
Sulzer has already successfully sold this solution for HPcp water injection pumps. In a joint development project with customer, a qualification procedure of the weld overlays was carried out and the optimum welding procedure specification was selected. Iron (Fe) dilution of the base material to cladding layers, electrochemical corrosion potential and water jet erosion tests were also performed.

The project determined that three 2.5 mm thick layers of Inconel 625 are to be applied (of which 2.5 mm from top will be machined away) on C-Steel in order to keep Fe dilution on the surface layer well below 5%. The maximum surface roughness of the overlay is about Ra25. As pump casing parts have to be provided with bores, threads, O-ring grooves etc, several designs were investigated involving the related suppliers, and optimum solutions were chosen.

Custom made designs for every overlaid casing part were developed and all dimensions were reviewed. Any centering bores that could be eliminated to save machining and welding costs was taken out of the process. Bores and threads were redesigned economically.

### Highlights

- Carbon steel casing cladded with Inconel overlay offers excellent corrosion resistance in high temperature chloride environments.
- Carbon steel casings cladded with Inconel overlay is not prone to forming brittle phases.
- Three layers of Inconel overlay protects against Fe-dilution and offers adequate erosion resistance



WDX scan results for Alloy 625 overlay probe  
(3 x 2.5mm, machined to 7 mm)

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### Applicable Markets

Oil and Gas

### Applicable Products

Barrel Casing Pumps