

Laser Cladding for Continuous Caster Rolls

Application Data Sheet LC-01-15

Issue: LC-01-15 March 2015



Introduction

Continuous caster rolls are used in the steel industry to cast continuous solid forms from liquid steel. The rolls are exposed to thermal fatigue, high temperatures, bending stresses, corrosion oxidation and abrasion. The standard method of protecting caster rolls is by submerged arc welding with a 400 series stainless steel, which can suffer heat affected zone cracking between weld runs.

Laser cladding the caster rolls is a cost effective method of applying a thin layer of a high performance alloy, in this case nickel based super alloys, to improve wear and corrosion resistance.

Laser cladding is a process that falls into the range of hard-facing solutions, which can be used to increase corrosion resistance, wear resistance or impact performance of metallic components, using a method of applying a fully dense, metallurgically bonded and virtually pure coating. Rolls that have been laser clad have been proven to last up to five times longer than the standard submerged arc welded rolls.

Materials

Main Deposit

Nickel based super-alloy

Method

Preparation

- a) Old or worn rolls may need to be repaired prior to laser cladding using weld repair.
- b) The rolls are pre-machined to a size about 2mm smaller than the finished diameter.
- c) The surface of the rolls must be clean and unoxidised and can be presented straight from the lathe.
- d) If the rolls need to be cleaned prior to laser cladding, this can be done through degreasing or blasting.

Equipment

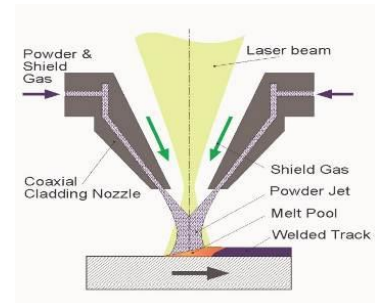
Metallisation MET-CLAD system

Application of Laser Cladding

The surface of the roll is laser clad with a nickel based super-alloy using a fine, accurately controlled laser beam, which results in an extremely strong wear and impact resistant coating.

The rolls are then stress relieved to reduce residual stress and finish machined to the required size.

The laser cladding process utilises a precisely focused high power laser beam to create a tightly controlled weld pool into which a metallic powder is applied. The powder is carried by a stream of inert shielding gas, which is blown coaxially through the laser beam. The highly controllable nature of the laser beam allows fully dense cladding with minimal dilution and a perfect metallurgical bond.



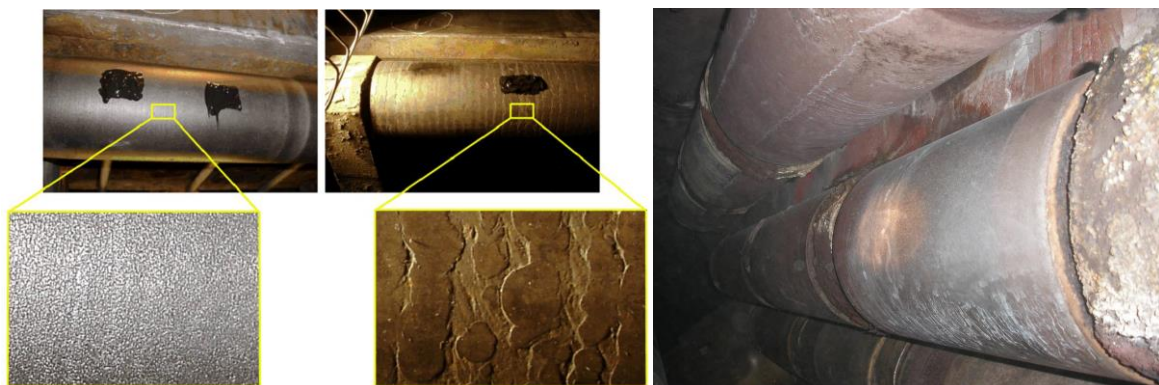
The very low heat input, associated with a laser, minimises distortion and results in a refined microstructure. Due to the high level of accuracy and control, laser cladding enables the cost effective application of high performance alloys to tackle a wide range of engineering issues. Typical deposition rates are between 60 and 100 g/min around 3-6 kilograms per hour, depending on the material being deposited and the geometry of the work piece.

To apply a laser clad coating the cladding head has to be fed the appropriate with four key things; a laser beam, process gasses, the metallic powder and cooling water. The Metallisation MET-CLAD laser cladding control console provides integration and control of the complex component parts. The MET-CLAD system is a simple to use control system with touch screen HMI and is based on the Metallisation HVOF and Plasma control concept.

The control console offers mass-flow control of the laser shielding and powder feed gas for repeatable cladding. The laser can also be housed and controlled within the cladding console up to 3kW or as a separate enclosure for larger laser sizes.

The control interface for production operations is simple, but it can be drilled down to a great level of complexity for coating development. Repeatable operations are easily programmed or they can be linked to a barcode system for even simpler programming. The process gases are mass flow controlled for repeatability of the coating process.

Comparison of Coatings



The image on the left, shows a laser clad surface after 118 ktonnes. The image in the middle, shows a sub arc welded surface after 63 ktonnes.

In the right hand image, the top roll is sub arc welded and the lower roll is laser clad.

Comparison of coating processes

The following table gives a broad comparison of coating processes. The data shown is based on typical applications and parameters. There can be exceptions to this data, dependent on the specific applications and parameters, Metallisation will be happy to offer advice for specific applications.

	HVOF Thermal Spray	PTA	Laser Cladding
Heat Source	Flame (liquid or gas)	Electric arc	Laser beam
Coating thickness (typical)	0.05 – 1mm	0.5 – 5mm	0.2 – 2mm
Typical Deposition rates	≤ 5 kg/hr	≤ 10 kg/hour	≤ 5kg/hr
Dilution	0	5-15%	≤ 5%
Type of bonding	Mechanical	Metallurgical	Metallurgical
Bond strength	≤ 80 MPa	≤ 800 MPa	≤ 800 MPa
Heat input	Low – medium	High	Low - medium
Porosity	≤ 1%	< 0.1%	< 0.1%
Comparative capital cost	Medium	Low	High
Comparative running cost	High	Medium - Low	Low

Conclusion

Laser cladding is a cost effective method of applying a relatively thin layer of an expensive, high performance alloy, which increases wear resistance and provides an effective corrosion resistant barrier. The minimal heat affected zone removes problems associated with weld decay. This means that laser clad continuous caster rolls can last up to five times longer than traditional submerged arc welded rolls.