Myth 3: Stellite 6 PTA hardfacing will always crack

Introduction

Weld deposition of hardfacing alloys is commonly employed to increase the service life of components subject to abrasive wear and corrosion. A number of alloys are commercially available, based largely on iron, cobalt, or nickel matrices, and offering various properties in the deposit. Generally, greater life is obtained by using deposits of higher hardness, this being obtained by the presence of hard carbides in the matrix. However, due to the higher hardness, tensile ductility is reduced and cracking can occur as a result of welding contraction strain. Such cracking does not significantly reduce the service life of the component and is sometimes seen as advantageous in reducing residual stresses in the material. Nonetheless, in many instances, cracking is undesirable, whether to obtain a sealing surface or to prevent fatigue failure, and a requirement exists for a deposition of a crack free, high hardness deposit.

Cracking can arise either in the solid state or during solidification. Cracking in the solid state is caused by low tensile ductility. The latter mechanism of cracking can usually be overcome by reducing the travel speed, but the former crack type represents a rather more inherent issue in weld hardfacings. Cracking in stellite hardfacing alloys is essentially related to the low tensile ductility of the deposit. If parameters are not controlled or adjusted, cracking will always be present in these hardfacings.

Thermaspray Solutions

Thermaspray has researched and developed parameters to apply stellite hardfacing onto several substrates without cracking using the Plasma Transferred Arc welding process (PTA). By strictly controlling the welding parameters, high quality stellite deposits free from cracks and flaws can be deposited onto a wide variety of substrates.

PTA welding is a hard-facing process that heats metals and merges them by means of arc constriction. The advantages of PTA welding over other weld hardfacing technologies is that PTA weld deposits are characterised by low levels of inclusions, oxides and discontinuities, and the weld hardfacing closely mimics the corrosion resistance of the equivalent alloy. Most critically, the careful control of heat input

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makes it possible to control weld dilution to less than 5%, which is critical for many high-performance alloys. Figure 1 is an overview of the PTA process.

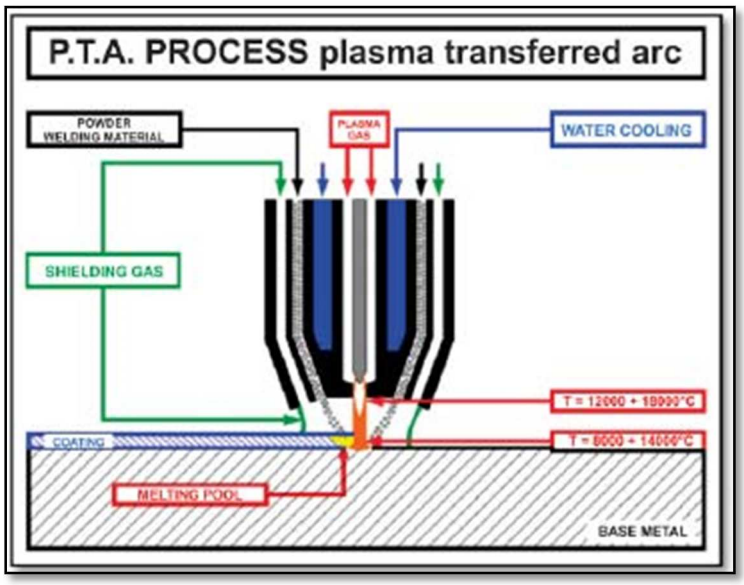

Figure 1: Schematic of the PTA process

Thermaspray Approach

The risk of cracking in the hardfacing is governed by the tensile strength of the deposit and by the applied shrinkage strain. The former is governed by material composition and microstructure, and the latter by composition and the welding conditions, especially the preheat levels. Tests were conducted varying deposit dilution and preheat temperature. Changes to dilution level are achieved by adjusting the current.

Discussion

The very high strength and subsequent low ductility of the weld and its sensitivity to dilution are the main factors affecting the crack susceptibility of the stellite weld deposit. Cracking in the subsequent deposits are as a result of unequal cooling rates within the deposit and the expansion mismatch between the substrate and the weld. In the case of hardfacing, the problem is aggravated by the high material strength

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over a high temperature range that resists the accommodation of shrinkage strains. Dilution of stellite by a steel substrate is important in avoiding cracking because dilution involves the reduction of compositional mismatch, making a more ductile weld deposit by decreasing the carbide content. The situation is made more complex when a second layer is deposited because compositional differences between the new layer and its substrate become much less. In addition, mismatched strains generated in the first layer will, to some extent, be transmitted into the second layer. It was also seen that the effective applied strain and the cracking risk is influenced by preheat level and subsequent cooling rate. Figure 2 shows a cross section of a stellite weld onto a steel substrate free from cracks and flaws.

Figure: Stellite weld onto a steel substrate

Conclusion

Sensitivity to cracking increases as more deposits are made as a result of lower dilution and higher deposit hardness. Cracking in the deposit can be reduced by the application of a correct preheat and current level. Thermaspray has optimized the

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parameters of its PTA process to ensure that weld deposits are made free from cracks and flaws.

Welding certification

Thermaspray is an **ISO 9001** accredited company and an **Eskom level 1 approved supplier** of coatings and PTA welding. Thermaspray has conducted several welding qualification procedures on various material substrates and these welding procedure qualification records (WPQR) are available on request for clients and/or potential clients.

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