THERMAL SPRAY COATINGS IN THE STEEL INDUSTRY

INTRODUCTION AND BACKGROUND

Throughout the steel production process, the production hardware is exposed to a broad range of degradation mechanisms, which ultimately leads to a reduction in product quality, reduced operation efficiency, increased downtime and high maintenance costs. Thermal spraying has been used to address these challenges since the 1970's. As thermal spraying technologies have evolved, the number of thermal spray coating solutions have increased. Product quality begins during raw material production and continues with shape forming and product sizing in a continuous flow processes. This production flow requires tooling to withstand high metal melting temperatures and pressures as well as having excellent erosion and corrosion resistance. To enhance product quality, the steel industry uses various types of surface modification technologies including thermal spraying. Today, high-velocity-oxyfuel (HVOF) and related spray processes are more mainstream in steel manufacturing plants worldwide. Applications from the melting and transfer of steel from furnace to end product use all types of coatings, with WC-Co and Cr_3C_2-NiCr cermets playing a large roll. Figure 1 is a good view of the harsh conditions in which steel are manufactured. To help enhance the life of the equipment used in steel production, a number of thermal spray coatings are applied. Figure 1 shows a hot coil being wound from strip steel. Wrapper rolls that force the strip to turn into a coil, use a nickel based self-fluxing alloy that is sprayed and fused. This is one of only a few coatings that has worked in this extreme environment. The temperature is estimated at over 1400°C. This is one of the harshest environments in strip steel manufacturing.

Figure 1: Hot steel coil being wound, showing the harsh conditions of steel manufacturing

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KEY TECHNICAL REQUIREMENTS FOR THERMAL SPRAY COATINGS IN THE STEEL INDUSTRY

The primary coating technologies used in the steel industry are Plasma and HVOF thermal spraying for steel sheet processing rolls. These technologies provide thermal spray coatings, characterized by:

- excellent wear resistance
- non-adhesion or build-up resistance
- corrosion resistance
- gripping properties
- thermal shock resistance

The relevance of the factors above depends on the type of application and the level of temperature and chemical exposure to which the coatings are exposed.

EXAMPLES OF APPLICATIONS IN THE STEEL INDUSTRY

Additionally the above example there are specific areas of steel production where coatings are used which include:

Continuous casting moulds. The main purpose of a casting mould is to control the rate of solidification and the shape of the resulting slab or billet. Mould life is limited by the ability of the coating to withstand wear that could transfer marks onto the billet or slab. Coatings used for this application are carbides, cermets, and ceramics.

Coiling Manderels are shown in figure 2a and 2b. In steel applications, hot mill strip products require further processing. The transfer of the coils to the other continuous process lines requires that the coil be unwound and then rewound, holding the core of the coil tightly wrapped. The coating requirements for this type of application include the correct amount of friction, grip, and wear resistance to allow proper strip tension from the initial weld joining to final trimming and wrapping. Detonation gun and HVOF-applied carbide coatings result in surfaces that is harder than the strip materials. In addition, optimized surface profiles and high friction coefficients support the gripping of strip to rolls without causing any detrimental effects to the surface finish properties of the steel strip.

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Figure 2a: Segments for coiling manderel before coating

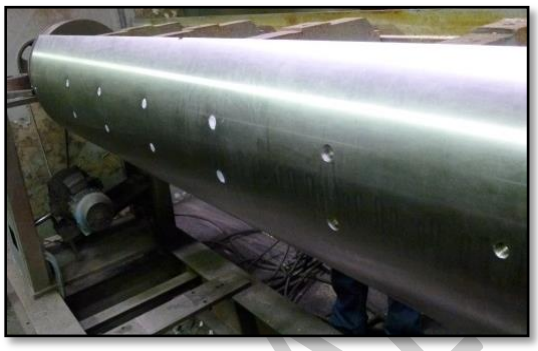

Figure 2b: Segments of coiling manderel after coating

Annealing line rolls. The type of coatings used in annealing line rolls are either, as shown in figure 3, HVOF or Detonation Gun coatings. Proprietary coatings using oxidation resistant MCrAlY cermets, by Thermaspray, are used for extremely high furnace temperatures. For lower temperature heat treatment of low manganese steels, NiCr-Cr_3C_2 coatings are used. High manganese steels presents more severe problems for rolls. Corrosion and oxidation products of the MCrAlY coatings (typically CrO and Al_2O_3) react with the manganese from the steel, reducing the service life of the coatings and the quality of the steel sheets. Today there are many proprietary coatings of the MCrAlY chemistries, applied by Thermaspray, that provide a solution for the high manganese steel roll applications.

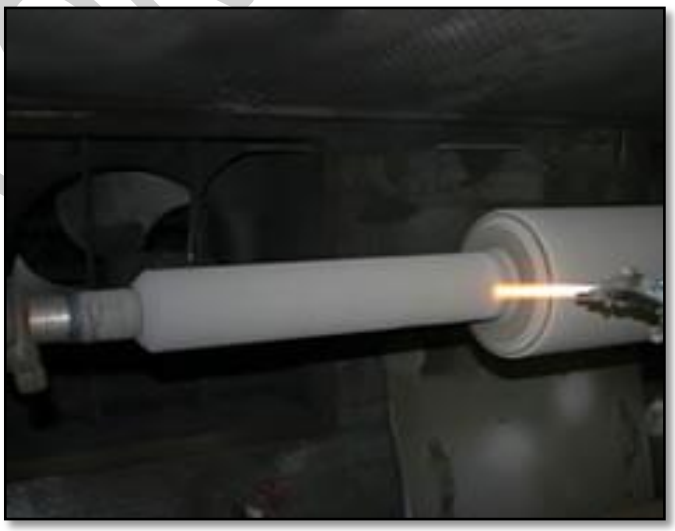

Figure 3: Furnace rolls coated with NiCr-Cr_3C_2

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Continuous galvanising line. Degradation associated with continuous galvanising lines involve the reaction of the zinc/aluminium with the iron from the steel rolls. These reaction products degrade the steel rolls and the surface quality of the steel products. The coating currently used, by Thermaspray, for this application is tungsten carbide/cobalt applied via HVOF or detonation gun technology.

CONCLUSION

Today carbide cermets of tungsten carbide/cobalt (chromium) or nickel chromium/chromium carbide, oxidation resistant MCrAlYs with ceramics such as alumina, self-fusing/fluxing alloys with or without blends of carbides, and thermal insulation materials of zirconium oxide with Thermaspray proprietary sealants are used in many types of applications in the steel industry. As thermal spray technology continues to evolve, coatings are becoming more robust and reliable, allowing steel manufacturers to predict more accurately the life of critical components used in the steel industry resulting in improved and more consistent high quality steel products.

Thermaspray, in a joint venture with Cape Town-based Surcotec, offers an extensive portfolio of engineering and thermal spray coating solutions that extend component life cycles to assist OEM and end-user clients across southern Africa in reducing costs and increasing production.

The companies' world-class quality wear- and corrosion-resistant thermal spray coatings, Plasma Transferred Arc (PTA) cladding and Polymer coatings (in partnership with Plasma Coatings USA and Diamant Metallplastic Germany) are augmented by a host of specialised allied services.

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About Thermaspray

Thermaspray, headquartered in Olifantsfontein, Johannesburg, has close to 20 years' experience in wear- and corrosion-resistant thermal spray coatings. In addition to providing a comprehensive range of support coating finishing technologies in the bespoke finishing shop, Thermaspray also refurbishes industrial components damaged by wear and corrosion. The company's in-house, metallurgical laboratory is the only dedicated facility of its kind in Africa's thermal spray industry and is equipped to undertake world-class developments and quality control. Thermaspray is a DQS ISO 9001 Quality Management and Eskom level 1 certified company.

About Surcotec

Surcotec is the oldest established thermal spray coating company in the Western Cape. The company has a wealth of experience in thermal spray coatings and mechanical component refurbishing. Surcotec's coating services are supported by a fully equipped engineering workshop and an on-site machining division. A level 1 B-BBEE company, Surcotec is TNV ISO 9001 Quality Management certified and is certified as a level 2 nuclear supplier to Eskom.