WokaStar-610 put through its paces

Oerlikon Metco's advanced liquid-fuel HVOF spray gun proves its worth

The Oil and Gas industry uses valves in critical applications for both subsea and surface applications. Very often, valves are designed to operate in extremely severe environments, with gas-tight, metal-to-metal sealing that must maintain very high pressures. Failure of a valve can result in catastrophic harm to workers and the environment as well as lost production and potentially expensive repair and clean up operations. As part of their engineered design, BEL Valves (United Kingdom) routinely utilizes thermal sprayed tungsten carbide coatings to ensure proper sealing.

Operating conditions are becoming ever more challenging within oil and gas production. As such, BEL Valves employs best practice solutions and engineers their valves to very exacting standards so the valves are safe, reliable and fit for purpose. Their designs are developed to provide solutions to their customers' demands for current and future surface and subsea applications.

To fulfill this promise to their customers, BEL Valves reviews and tests technologies that could improve their products and the reliability of their production processes. While the company has long applied tungsten carbide coatings using liquid-fuel HVOF (High Velocity Oxy Fuel) to their valves, they tested Oerlikon Metco's WokaStar-610 spray gun and compared the coating results to the TAFA JP5220 spray gun that BEL Valves currently uses. BEL Valves tested each gun with a 4-inch and 6-inch barrel. The spray runs and parameters are summarized in Table 1.

Run	Spray Gun	Barrel Length (in)	Oxygen Flow (scfh)	Nitrogen Flow * (slpm)	Kerosene Flow (gal/hr)	Comb. Pressure (psi)	O_2 Pressure (psi)	Kerosene Pressure (psi)
1A	WokaStar-610	4	2000	22	6	103	160	150
1B	JP-5220	4	2000	22	6	103	142	112
2A	WokaStar-610	6	2000	22	6	104	162	150
2B	JP-5220	6	2000	22	6	103	143	113

* carrier gas

Table 1. Spray parameters used for the BEL Valves comparison of the WokaStar-610 to the TAFA 5220 spray gun. All coatings sprayed onto Inconel 718 coupons (solution annealed / precipitation hardened). The material used was WOKA 3652 WC 10Co 4Cr (Oerlikon Metco).

WokaStar-610 is clearly better

The resulting coatings were tested and analyzed by the BEL Valves Metallurgy Laboratory. Table 2 compares the coating hardness and porosity values for each of the spray runs. Coating hardness (higher is better) is important to ensure proper metal-to-metal contact for valve sealing and proper valve actuation. Porosity (lower is better) is important to ensure the coatings are gas-tight. In each case, the coatings sprayed with WokaStar-610 exhibit better results.

The coating structure is equally important. Coating porosity should not only be as low as possible, but should also be well-distributed without any large, interconnected pores. The WokaStar-610 coatings compared favorably, as shown in Figure 1. In addition, the coating microstructure should also be as low as possible in undesirable metastable phases (Figure 2). For both the WokaStar-610 and the JP-5220 spray guns the coatings applied using the 6-inch barrel (Run 2) were better than the coatings applied using the 4-inch barrel (Run 1).

Run	Spray Gun	Microhardness (HV0.3)	Porosity (vol. %)
1A	WokaStar-610	1075.1	0.41
1B	JP-5220	1041.9	0.68
2A	WokaStar-610	1224.9	0.47
2B	JP-5220	988.2	0.66

Table 2. Microhardness and porosity results.

The BEL Valves Metallurgy Laboratory also analyzed the coatings for

Factbox

All the important information about this interesting project at a glimpse:

Company
BEL Valves
www.belvalves.com

Challenge
Tungsten carbide coatings with improved coating properties and reliability for critical valve sealing applications

Objectives
- Improve coating hardness
- Reduce coating porosity
- Improve metallographic properties

Solution
WokaStar-610 liquid-fuel HVOF spray gun

Location
Newcastle Upon Tyne, UK

Date of Project
2015

additional metastable tungsten carbide phases in the coatings. The undesirable phases can embrittle the coatings which may result in the cracking of the coating during service. Here, too, the WokaStar-610 produced favorable results.

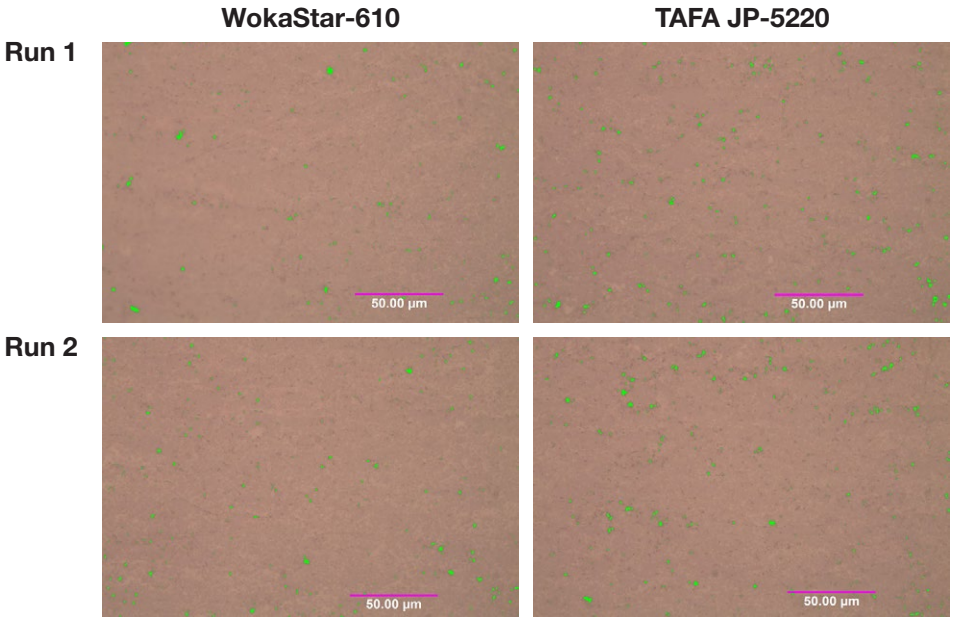

Figure 1. Coating porosity is highlighted in green. The WokaStar-610 spray gun exhibited consistently lower porosity compared to the TAFA JP-5220 gun.

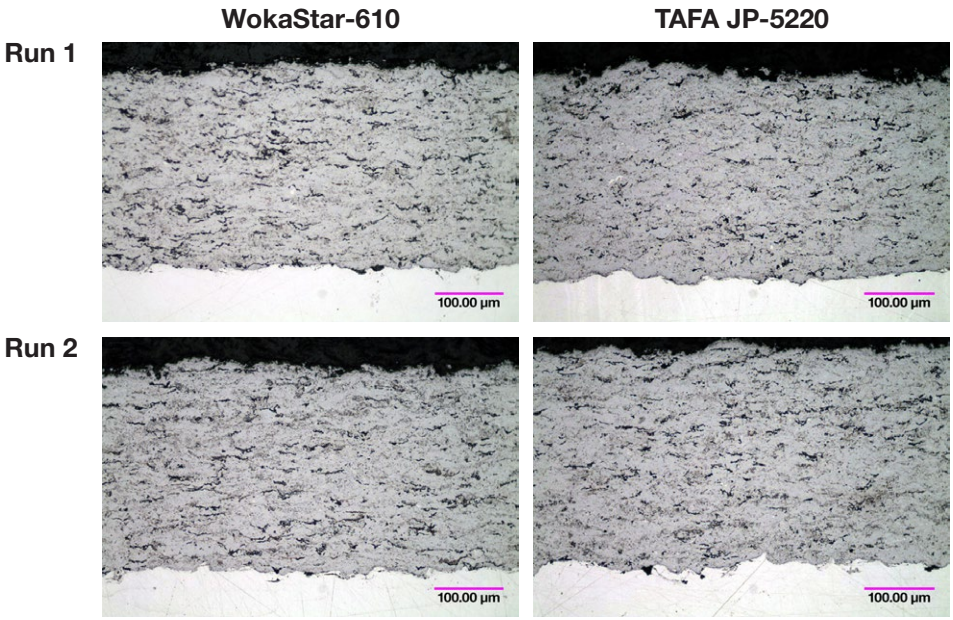

Figure 2. Coating photomicrographs etched to bring out detail and metastable phases. The WokaStar-610 spray gun exhibited consistently lower porosity compared to the TAFA JP-5220 gun.

Using a 6-inch barrel the WokaStar-610 produced a superior coating to that of the JP-5220.

The benefits of using the WokaStar-610 include reduced consumable usage and potentially increased gun component life due to the lower parameters while still achieving a comparable coating quality.

BEL Valves' conclusions
Overall, the samples sprayed using the Oerlikon Metco WokaStar-610 gun resulted in slightly better properties than those achieved using the TAFA JP-5220 gun with regards to microstructure, percent porosity and hardness at comparable spray parameters.

Using a 6-inch barrel, the WokaStar-610 produced a superior coating to that of the JP-5220. As a comparison, the coating produced was similar to that produced when using BEL Valves standard values[1] with the JP-5220, suggesting a reduced oxygen and fuel flow rate can be used with the WokaStar-610 gun. The presence of additional metastable phases were also reduced using the lower flow rates.

The benefits of using the WokaStar-610 include reduced consumable usage and potentially increased gun component life due to the lower parameters while still achieving a comparable quality coating.

As a direct consequence of these promising test results, BEL Valves intends to continue to evaluate the suitability of the WokaStar-610 spray gun for their processing requirements, with further trials currently under discussion.

[1] The spray parameter flow rates for oxygen, kerosene and nitrogen carrier gas used for this test, as shown in Table 1, are lower than the standard coating parameters normally used by BEL Valves. The actual production parameters used by BEL Valves remain undisclosed.

About Oerlikon Surface Solutions Division
Oerlikon is a leading global provider of surface and additive manufacturing solutions and services. The division offers an extensive portfolio of market-leading thin-film, thermal spray and additive manufacturing technologies, equipment, components and materials. Emission reduction in transportation, maximized longevity and performance of tools and components, increased efficiency and intelligent materials are hallmarks of its leadership. Pioneering technology for decades, the division serves customers with standardized and customized solutions across a worldwide network of more than 170 sites in 37 countries. With its technology brands – Oerlikon Balzers, Oerlikon Metco and Oerlikon AM – Oerlikon's Surface Solutions division focuses on technologies and services that improve and maximize performance, function, design, reliability and sustainability, which are innovative, game-changing advantages for customers in the automotive, aviation, tooling, general industries, luxury, medical, semiconductors, power generation and oil & gas markets. The division is part of the publicly listed Oerlikon Group, headquartered in Switzerland, which has 12 000 employees and generated CHF 2.65 billion in revenue in 2021.

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