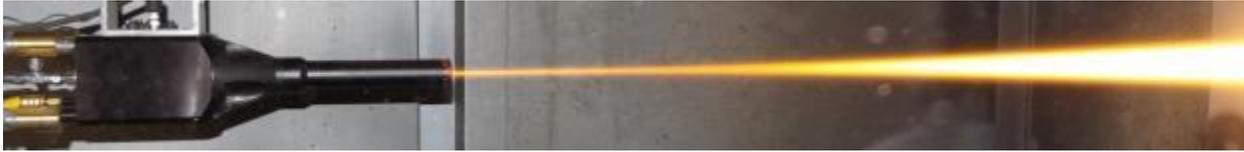


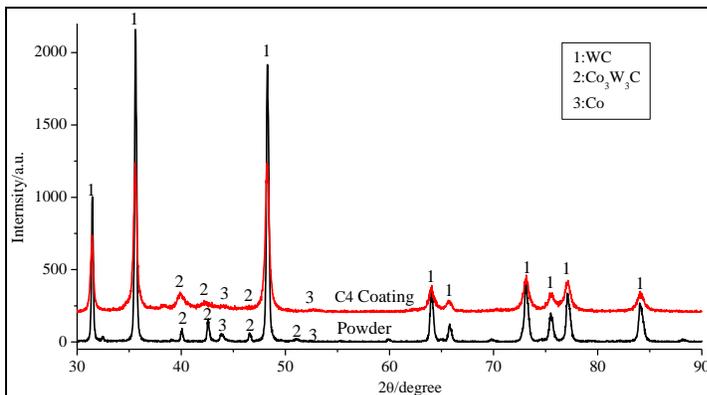
Kermetico HVAF protective coatings for Internal Diameters of Pipe Lines, Vessels and Industrial Equipment



The Kermetico AK- HVAF Gun is “a small jet engine”, combusting compressed air and LPG fuel and generating a jet of metal particles with a velocity from 800 to over 1200 m/sec. Such particles form extremely dense and tough coatings. Our “signature” coatings are tungsten carbide coatings (WC-12Co, WC-10Co-4Cr, etc.) which are non-permeable to gas and have hardness 1400-1700 HV₃₀₀. In spite of high hardness, these coatings are not brittle since decarburization or oxidation does not occur in comparably low-temperature HVAF process.

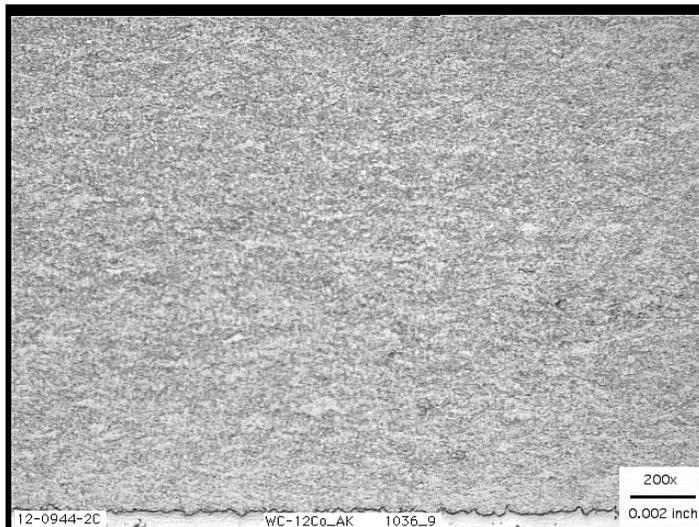
Specific features of the Kermetico HVAF process

Accurate Heating: The combustion temperature of air-fuel mixtures (1800-1900°C) is ideal for gradual and precise heating of the spray particles of metals and cemented carbides to or slightly above the metal melting temperature. This prevents material oxidation, carbides decomposition and formation of other coating defects. Many alloys can be applied without particle melting.



X-ray diffraction data for the WC-12Co HVAF coating and initial spray powder

No change of phase composition occurred during HVAF spraying



Micrograph of the same

WC-12Co HVAF coating

Coating hardness:
1540 +/- 56 HV₃₀₀

Coating bond strength to carbon steel per ASTM C633

(Machined substrate, no grit blasting):

@0.25 mm thickness: >75 MPa

@1.00 mm thickness: >75 MPa

(100% adhesive failure)

Heating efficiency: Spray particles are fed through combustion chamber. Thus, their heating occurs at high pressure, where heat transfer is the most efficient. The size of the chamber provides long residence time for spray particles to heat. Thus the energy transfer efficiency increases noticeably compared to other high-velocity spraying methods, resulting in much higher spray rates with HVOF guns, over 33 kg/hour for large guns and up to 5 kg/hour for the smallest, 30 kW power guns.

Acceleration efficiency: Large diameter of the nozzle eliminates the nozzle length limitations, known to other guns. The spray particles can be accelerated up to the gas velocity (well over 1000 m/s). Herewith, the spray particle velocity is often purposely limited to reach needed deposit efficiency (cost) and decrease residual stresses in the coating.

Uniform coating quality: The diameter of the spray particle jet is several times smaller than the nozzle diameter. The influence of the nozzle wall on the spray particle velocity is negligible, providing even acceleration of the particles and improved consistency of the coating structure and properties.

AK-HVOF guns

Kermetico Inc. has been developing and manufacturing AK-HVOF guns and HVOF spray equipment since 2006. The company is actively involved in the coating services business, spraying the parts as small as a fraction of an inch and as large as 20,000 lbs.(9 ton) hydro-turbine rotors and 6-feet diameter x 25-ft long (1800 x 7500 mm) oil refinery vessels in its spray shops, located in the Benicia Industrial Park, California.

To provide needed flexibility and efficiency of coating applications to different size parts, Kermetico Inc. developed the range of AK-HVOF gun of different power:



AK7

200 kW guns for deposition of coating to massive parts (rollers, plates) and vessels with internal diameter 6 feet (1,8 m) and over



AK6

130 kW gun for deposition of coating to shafts and rollers 0.5-8 inch diameter, elongated parts (external surfaces of pipes and rotors) and vessels with internal diameter over 4 feet (1,2 m)



AK5

80 kW gun for deposition of coating on small diameter or thin-wall parts, as well as for spraying interior of pipes and vessels of 10-60 inch (250-1500 mm) diameter



AK-ID

35 kW gun for spraying internal diameters starting at 3.15 inch (80mm). Standard reach from 3 to 5 feet (0.9-1.5 m)

Rotating AK-HVAF guns

Rotating guns, recent development of Kermetico Inc., are ideal tools for application of coatings inside sophisticated shapes, such as elbows, square-to-round shape transition nozzles, as well as for internal spraying of the parts, rotation of which is difficult or impossible: stationary heavy vessels, vessels with long protruding nozzles, heavy blocks of cylinders, pump housings, etc. High-torque air motors are used in Kermetico rotators, while the rotator itself is set on the robot or linear movement device.



AK-IDR

Internal diameter 4" (100 mm) or more spraying gun set on the rotator RPT-A; the arm allows 1 or 2 feet reach (300 or 600 mm)

Coating applications for internal surfaces of the vessels and pipe lines

Hastelloy C corrosion resistant coatings for vessels of oil refineries



Application of Hastelloy C coating inside the sulfur removal plant vessel

The vessel was 6-feet diameter, 25-feet long, only one 2-feet (600 mm) manhole was available for internal access. The rotating AK5 gun was used for coating deposition. The cart with rotating gun traversed inside the steady vessel. Robot was used for the cart traversing. Additional moving arm was used to position the gun and its angle to spray heads of the vessel. This way the entire inner surface was coated.



Tungsten carbide WC-10Co-4Cr erosion resistant coatings inside the cyclones



The WC-10Co-4Cr coating applied in the refinery coke transport line cyclone with rotating AK-5 gun. The cyclone was 33-inch diameter, 5-feet long. The 4-foot protruding transition nozzle did not allow the cyclone rotation. The rotating shaft supported the further end of the gun, making available liner movement up to 6 feet.

The nozzle of 12-inch diameter and its transition to rectangular 16 x 9 inch area were sprayed with AK-5-ID gun, set on 3-feet reach rotating device (below).



Application of WC-10Co-4Cr coating with rotating AK-5 gun inside the double-elbow of a coke transport line. The elbow internal diameter 12 inches, total length 6 feet.



View of coated area:



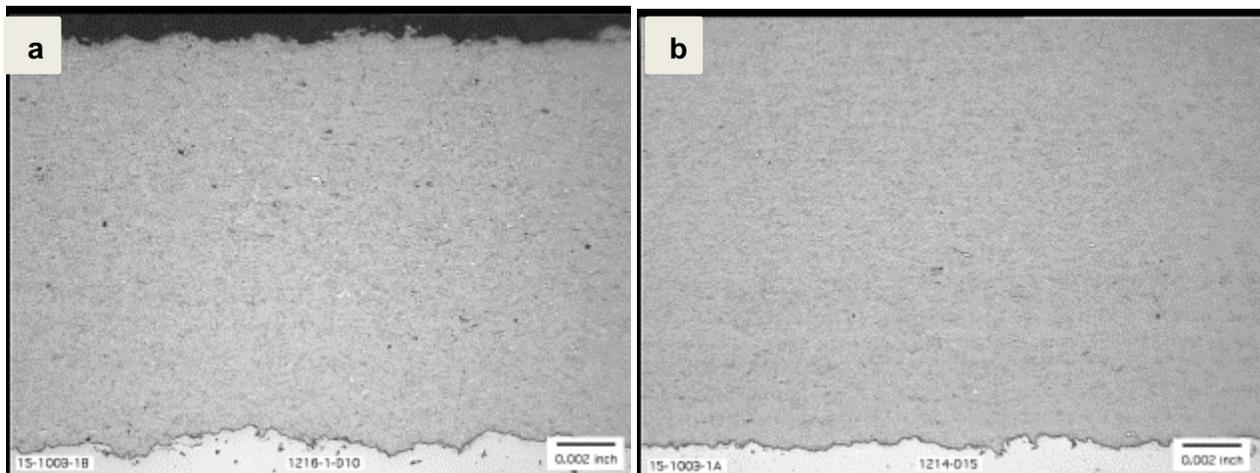
Coating inside small diameters

Extensive development in 2012 resulted in creation of AK-ID HVOF gun, capable for deposition of tungsten carbide coating inside internal diameters as small as 3.15 inches (80 mm). New ideas were successfully implemented in this gun. With only 30 kW equivalent power the gun sprays 5-6 kg of tungsten carbide per hour, reaching hardness of 950 HV₃₀₀ in 3.75-4.0-inch internal diameters and over 1200 HV₃₀₀ hardness in 4.5-5.0 inch internal diameter.

The AK-ID is the smallest high velocity spray gun in the world, capable of depositing quality coatings inside 3.15" (80 mm) internal diameter



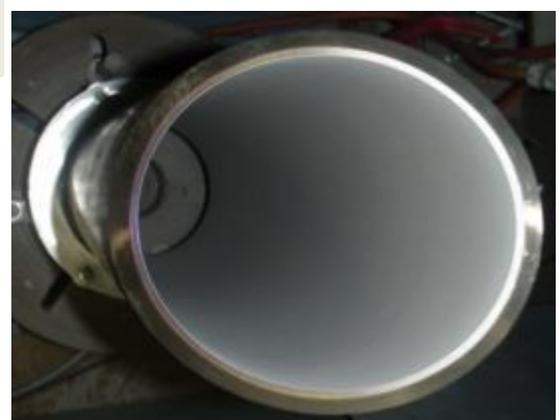
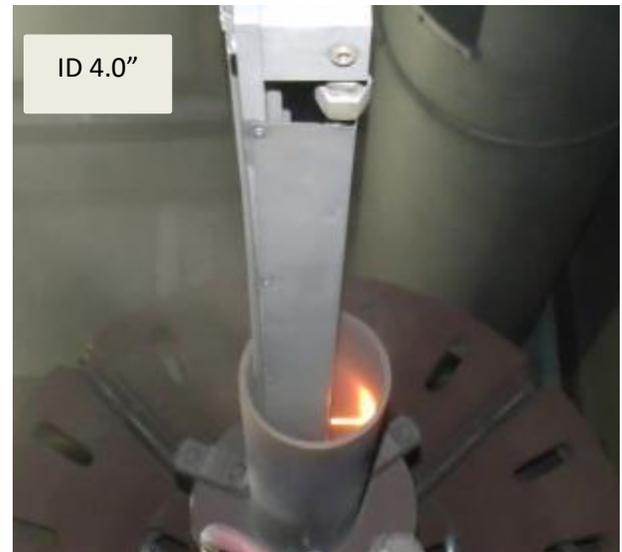
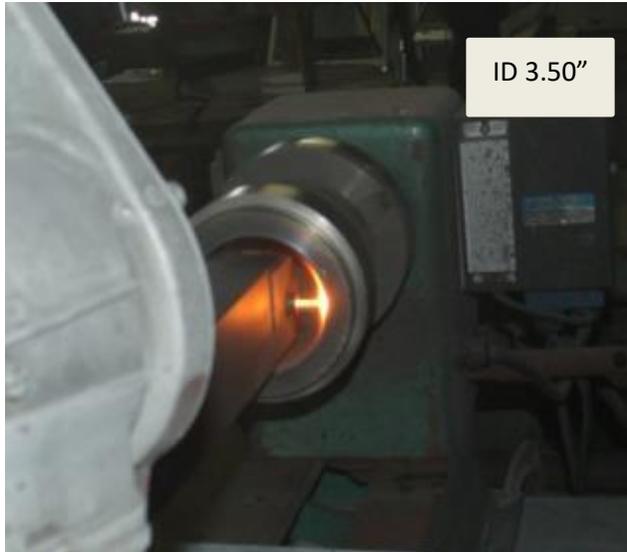
Micrographs of tungsten carbide (WC-10Co-4Cr) coatings sprayed with AK-ID gun in 4.0" (100mm) (a) and 4.5" (125 mm) (b) ID barrels



WC-10Co-4Cr, 4-inch ID
Hardness 1155 HV300, Porosity <0.1%

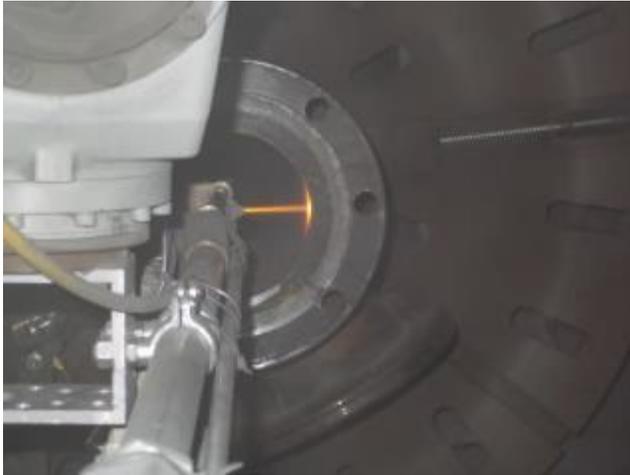
WC-10Co-4Cr, 4.5-inch ID
Hardness 1300 HV300, Porosity <0.1%

Applications of coatings with AK-ID HVAF: Barrels and Sleeves

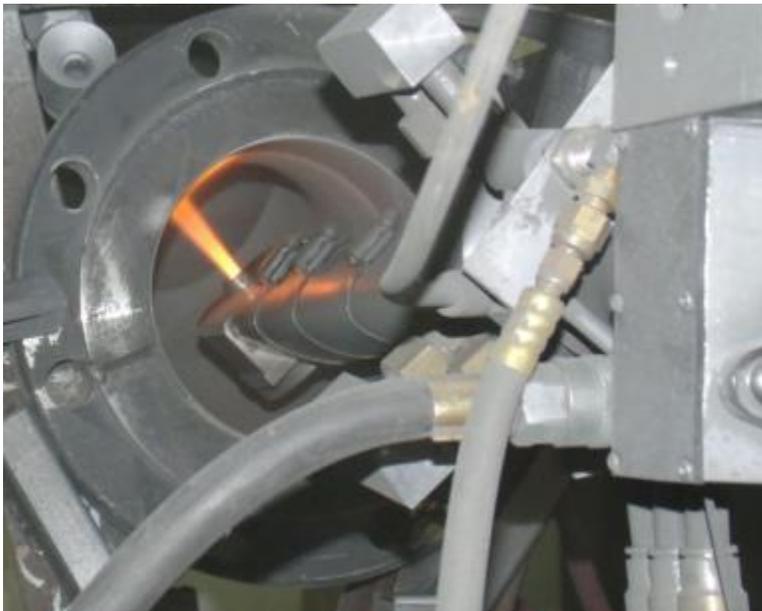


Applications of WC-10Co-4Cr coatings with AK-ID HVOF:

6" (150 mm) ID Coke Transport Pipe



Application of WC-10Co-4Cr coating with rotating AK-ID gun inside the elbows, 6" (150 mm) ID:



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