

Standard Tungsten Carbide Cladding Formulas — Oil Field

Engineering Formulas

Kennametal Conforma Clad™ has compiled over 30 years of scientific testing to develop three standard tungsten carbide cladding formulas that meet most of your severe wear protection needs. Our standard cladding formulas are designed to protect equipment from multiple modes of wear, including abrasion, erosion, corrosion, or any combination of the three. Kennametal Conforma Clad engineers evaluate individual components and their operating environments in order to recommend a standard cladding formula, or create a custom cladding to meet customer-specific requirements.

Our unique infiltration brazing process combines the hardness of tungsten carbide with the corrosion resistance of nickel chrome boron to create a protective barrier with unmatched wear-resistant properties. With a metallurgical bond strength in excess of 70,000 psi, our cladding is extremely resilient to chipping, cracking, and flaking.

Cladding Specifications

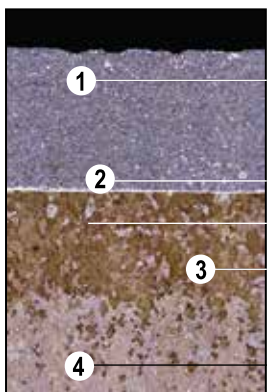
Cladding Composition (Weight Percentage)			
	WC 200	WC 210	WC 219
Tungsten Carbide*	62%	55%	48%
Nickel	30%	34%	39%
Chromium	6%	7%	8%
Other	2%	4%	5%
Total carbide loading from other carbide formation	68%	66%	62%

*Tungsten Carbide (WC) includes cobalt-bonded WC.

Cladding Properties			
	WC 200	WC 210	WC 219
Density (lb/in ³)	0.44	0.42	0.40
Thermal Conductivity (BTU in/h•ft ² •°F)	230	200	170
Metallurgical Bond Strength (psi)	>70,000	>70,000	>70,000
Porosity	<3%	<3%	<3%
Rockwell Hardness (HRC)**	64–70	60–66	56–62

**Cladding is a composite of tungsten carbide particles dispersed in a nickel-based alloy matrix. The extremely hard carbide particles, with a Vickers Diamond Pyramid Hardness of about 2000 DPH_{50g} [1865 DPH_{50g} is equivalent to 80 Rockwell C Hardness (HRC)], are surrounded by a two-phase matrix (300-800 DPH_{50g} equivalent to 30–64 HRC). Because of the heterogeneous structure of the cladding, direct Rockwell hardness measurements are an average of the hard particles and matrix, and are not representative of the individual components of the composite.

Cladding Photomicrograph



Cladding

Dense tungsten carbide loading with uniform carbide distribution: high wear resistance with predictable wear rates and continuous heat transfer

No interconnected porosity: superior corrosion and impact resistance

Bond Line

True metallurgical bond (>70,000 psi) with high interparticle bond strength: provides unsurpassed strength and prevents chipping, flaking, and check-cracking

Diffusion Zone

Minimal dilution: substrate retains uniform properties in diffusion zone

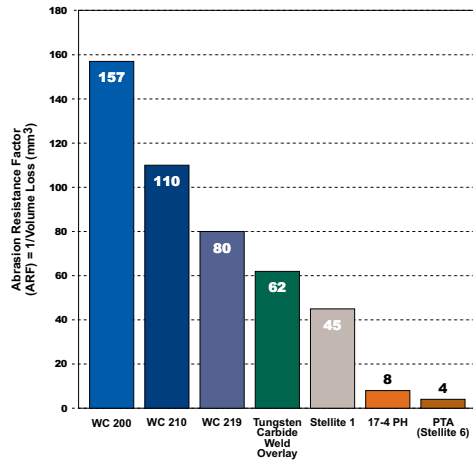
Substrate

Heat treatable: can be heat-treated after cladding process to restore substrate's mechanical properties



Performance Data

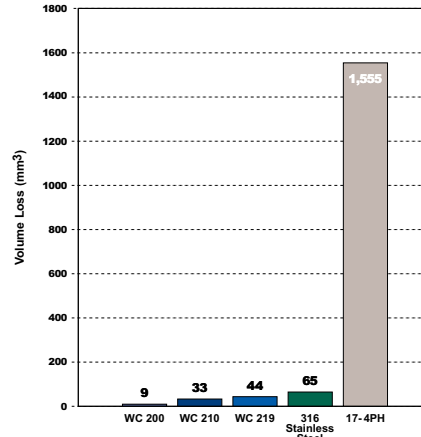
DRY SAND ABRASION TEST (ASTM G65)



2X Better
Abrasion resistance than tungsten carbide weld overlay.

CORROSION TEST (ASTM G31)

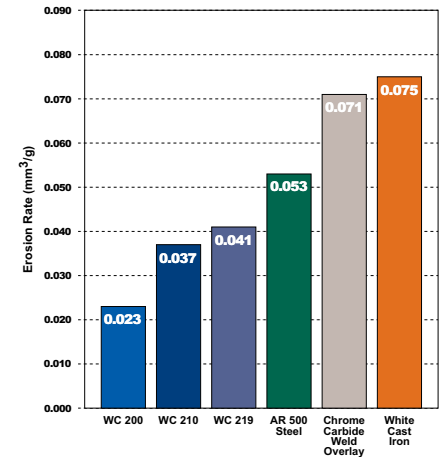
1% Sulfuric Acid at 212° F (100° C)



7.2X Better
Corrosion resistance than stainless steel.

EROSION TEST (ASTM G76)

45° Impingement Angle, 83 m/s, Alumina <63 micron



3X Better
Erosion resistance than chrome carbide weld overlay.

Cladding Properties

Properties	Kennametal Conforma Clad™	Weld Overlay	Wear Tiles	Carbonized/Nitrided Steel
Bond Strength	Very High	High	Low	N/A
Complex Geometries	Yes	Difficult	Difficult	Yes
Abrasion Resistance	Very High	High	Very High	Low
Erosion Resistance	Very High	Low	Low	Low
Corrosion Resistance	High	Low	Low	Low
Impact Resistance	Moderate	Moderate	Very Low	Low
Oxide Level	Low	Low	Low	N/A
Temperature Resistance	High	Low	Very Low	Moderate
Resists Multiple Modes of Wear	Yes	Yes	No	No

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