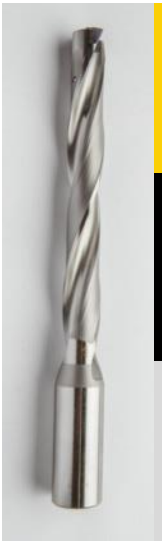
Kennametal Stellite™720 Solutions for Delayed Coker Fired Heater Return Bends

Benjamin Goodly
Sr. Business Development Engineer, Petrochemical & Refinery, N America

One of the world's leaders in tooling & wear resistant solutions



Founded in 1938
in Latrobe, Pennsylvania by Philip McKenna

Revenue $2.4B+
in Fiscal Year 2019

Employs 10,000+
team members throughout the world.

Kennametal delivers productivity to customers seeking peak performance, by providing innovative wear-resistant solutions, enabled through our advanced materials science, application knowledge, and commitment to a sustainable environment.

KENNAMETAL

Our Business Segments

Industrial

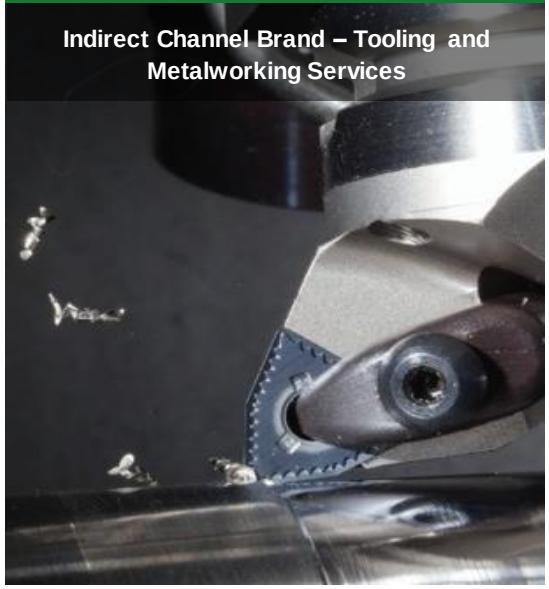
Tooling and Metalworking Services

Infrastructure

Earth Cutting & Construction Tools, Surface Wear Technologies, Engineered Components

WIDIA

Indirect Channel Brand – Tooling and Metalworking Services



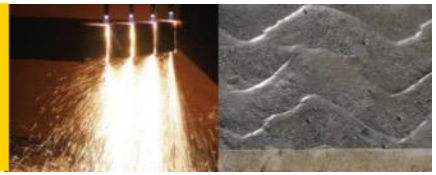
INDUSTRIES SERVED

- Earthworks
- Energy
- General Engineering
- Aerospace
- Transportation

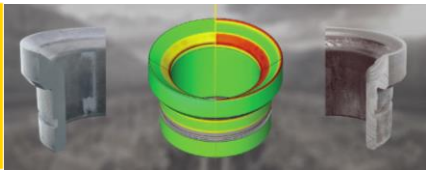
Infrastructure Business

Global market leader of surface wear technologies, engineered components and earth cutting & construction tools.

SURFACE TECHNOLOGIES

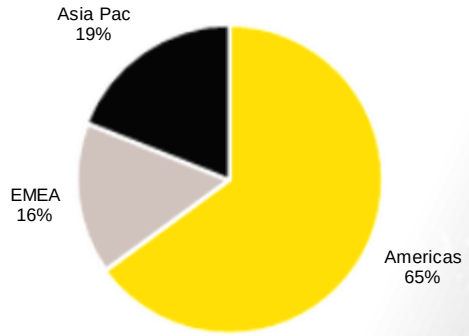


ENGINEERED COMPONENTS

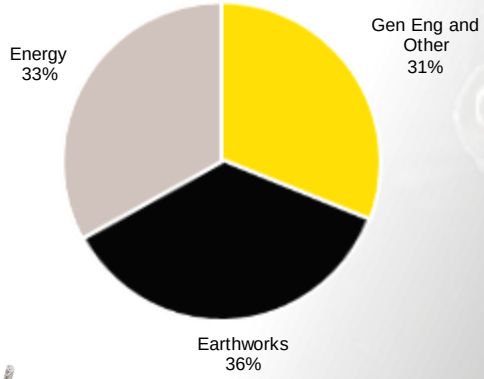


EARTH CUTTING & CONSTRUCTION TOOLS

2019 SALES BY GEOGRAPHY



2019 SALES BY END MARKET



PRODUCT LINE

Conicals

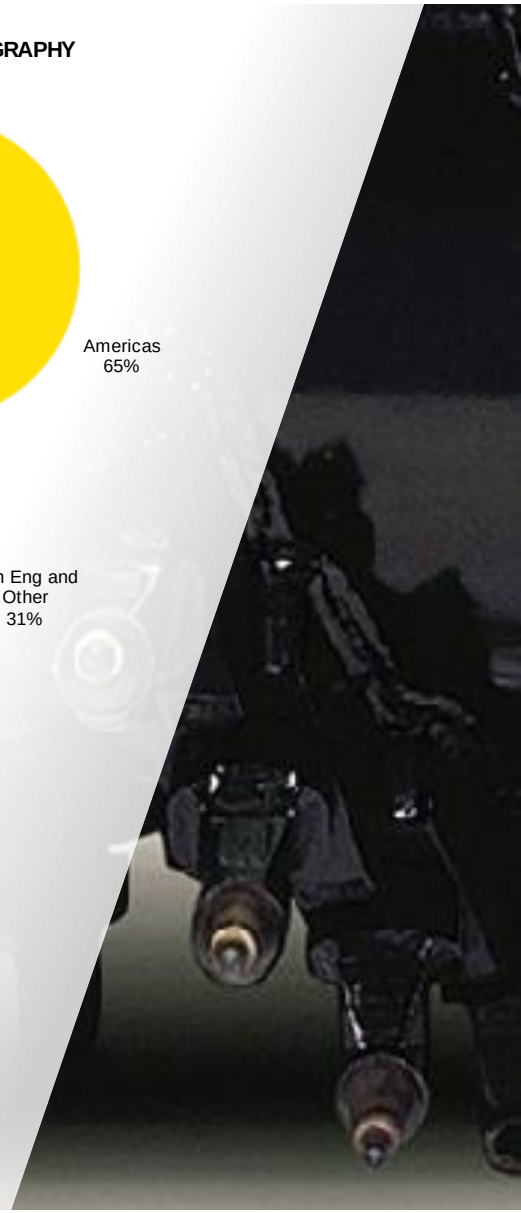
Block systems

Stellite™

Cladding

Rods & Blanks

…AND MORE



Application: Delayed Coker Fired Heaters

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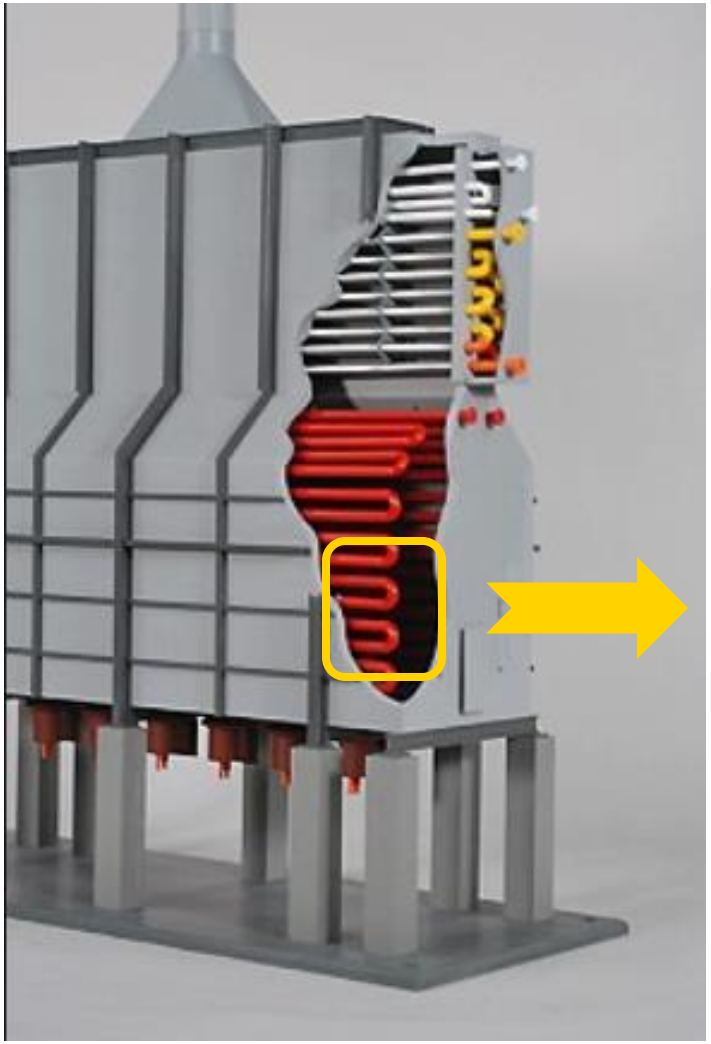


- Radiant section 180-degree return bends –Lowest sections – Substrate - 347H (CF8C), 9Cr (C12)

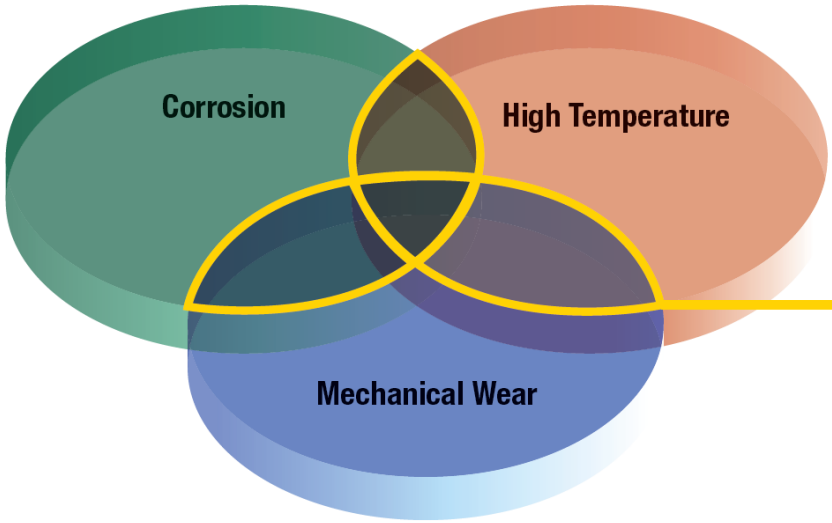
- Outlet elbows – 4” x 6”

- Thermowells – 347H, 9Cr

Stellite™ Cladding

Stellite™

Where does Stellite fit within the range of Wear Solutions?



Stellite materials are candidates for a wear solution when multiple modes of wear are present.

- **High Operating Temperatures**
- **Mechanical Wear**
- **Corrosion**

Our experienced metallurgists and applications engineers are here to help.

Our Stellite division traces its origins to the town of Deloro, Canada where our first Cobalt alloys were produced in 1907.

We are the original Stellite™.

UltraFlex™ Stellite™ 720

Stellite 720 is a cobalt-base alloy with properties well suited to combat high temperature, corrosive and erosive wear. It is often the UltraFlex material of choice for Refinery applications.

A Comparison of Stellite Materials

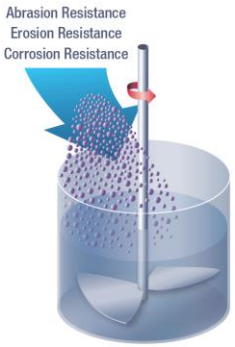
	Nominal Composition (mass %)					Hardness
	Co	Cr	W	Mo	C	HRC
Stellite 6	Base	29	5	-	1.2	39-43
Stellite 12	Base	29	8	-	1.8	47-51
Stellite 1	Base	30	12	-	2.5	51-58
Stellite 720	Base	33	-	18	2.5	55-60

By replacing W with Mo, Stellite 720 achieves…

- ✓ **Higher bulk hardness**
- ✓ **Higher corrosion resistance to Chorine & Sulphur attack**

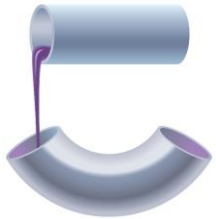
UltraFlex™ Cladding

A proprietary coating process that delivers tungsten carbide or Stellite ™ materials to substrates with complex geometries and non-line-of-sight applications.



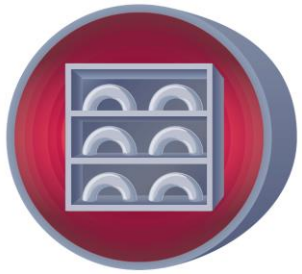
Slurry Preparation

Powders and binders are mixed into a slurry.



Coating

Flow coating methods are used to apply an even "green" coating.



Vacuum Furnace

Coating is fused to the substrate in a vacuum furnace.

UltraFlex coatings are…

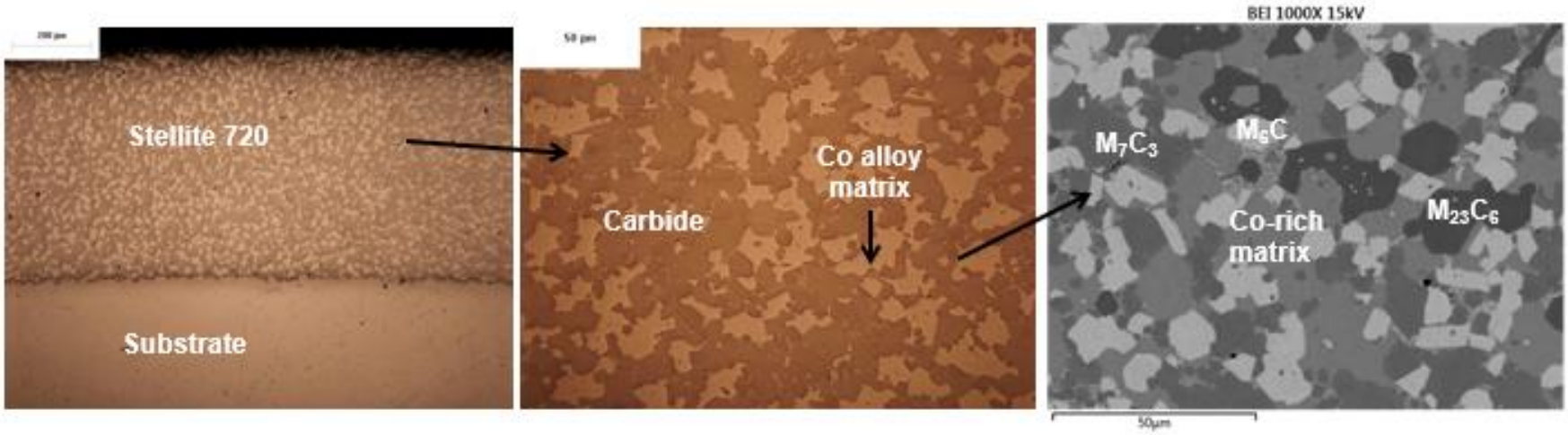
- Metallurgically bonded
- Fully dense and uniform
- Typically .020-.030" thick, but can vary with requirements

Best for:

- Conveyance applications
- Very complex geometries
- Small inner diameters
- Non-Line-of-Sight applications

UltraFlex™ Stellite™ 720 Cladding

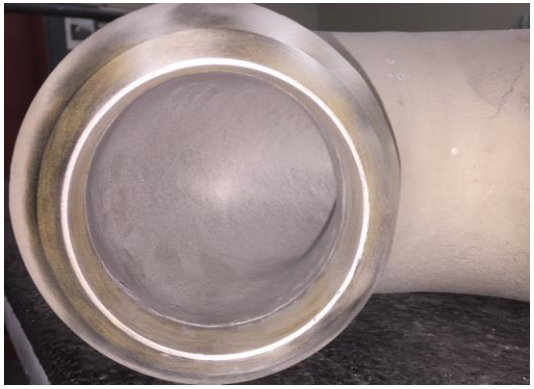
- Co-Cr-Mo based alloy coating
- High hardness: 59-63 in HRC
- High corrosion, erosion & high-temperature resistances
- True metallurgical bonding
- Smooth surface finish
- Flexible cladding process: Capable of complex geometry, none line-of-sight, ID surface of small and long pipes
- Patented technology

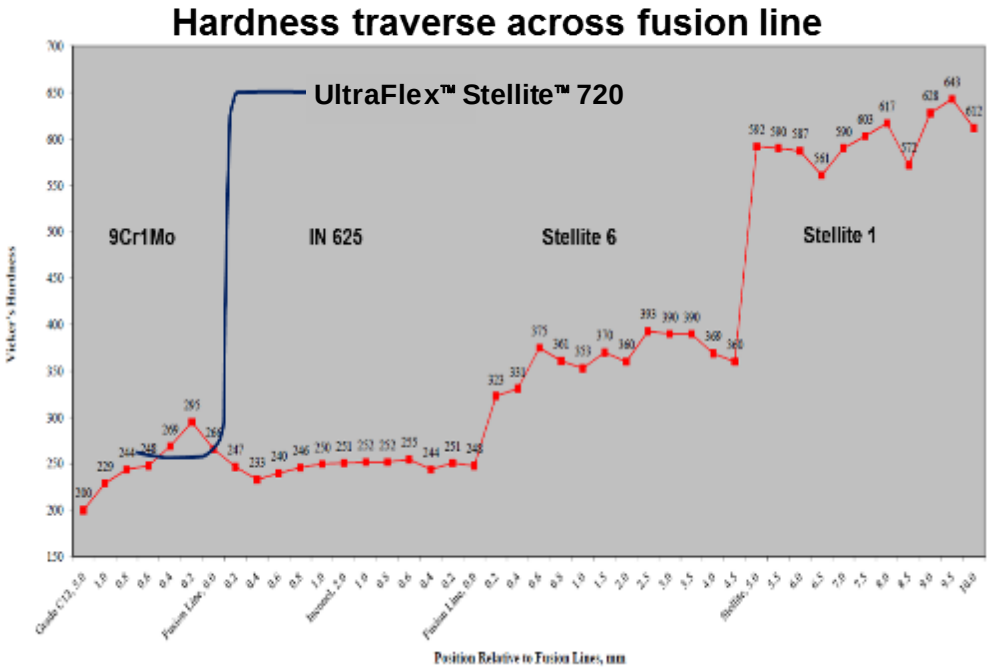


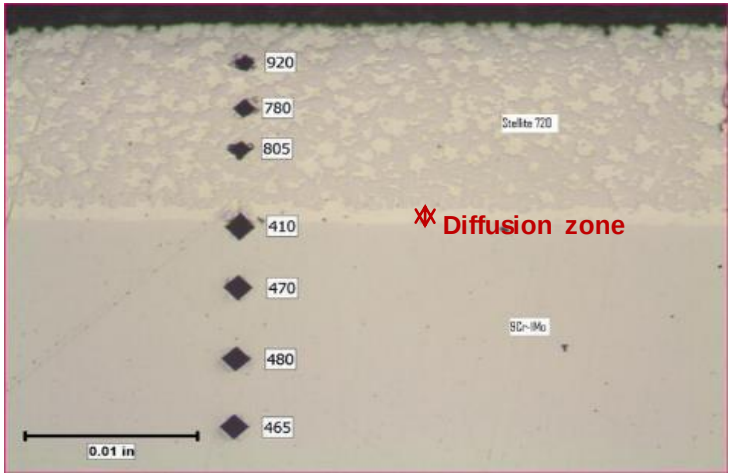
Stellite™ Cladding

- The UltraFlex™ process produce a ‘pure’ Stellite coating
- Dilution only in diffusion zone ensuring a metallurgical bond
- Diffusion zone is typically 0.001” - 0.002” thick

- Traditional weld overlay solutions require multiple-passes of less wear resistant materials
- **UltraFlex™ Stellite 720 gives full wear properties across entire coating thickness**

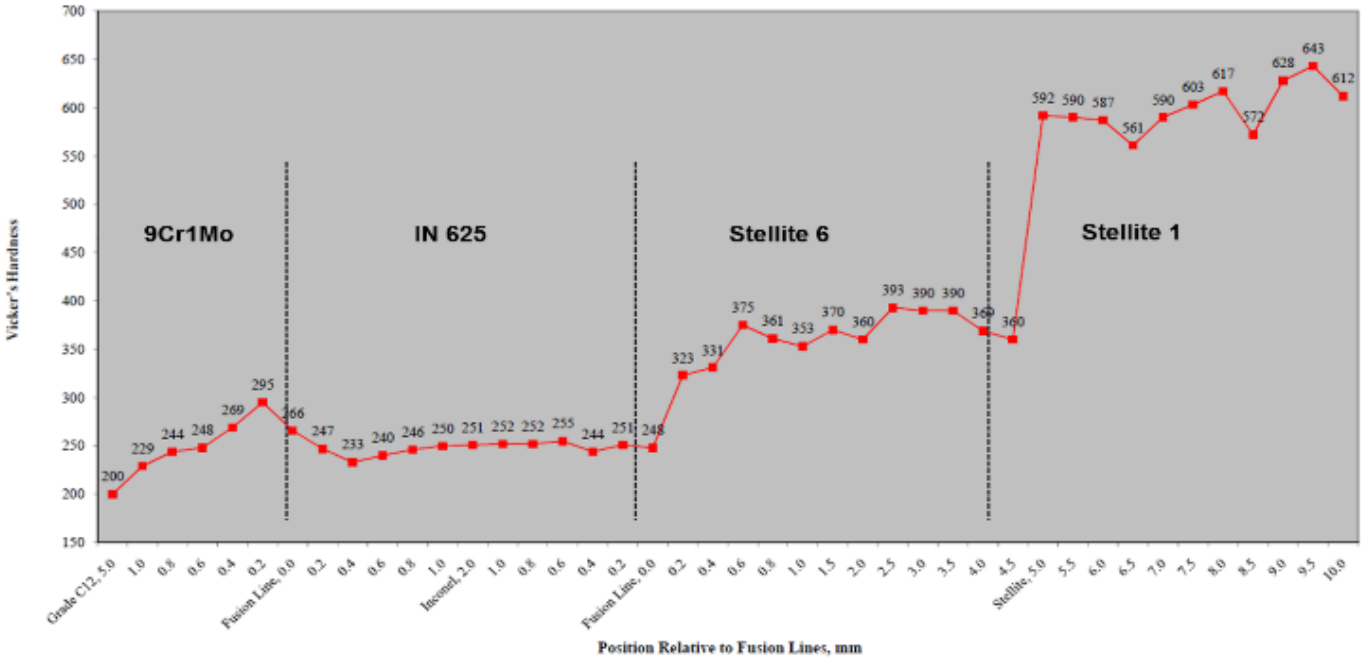




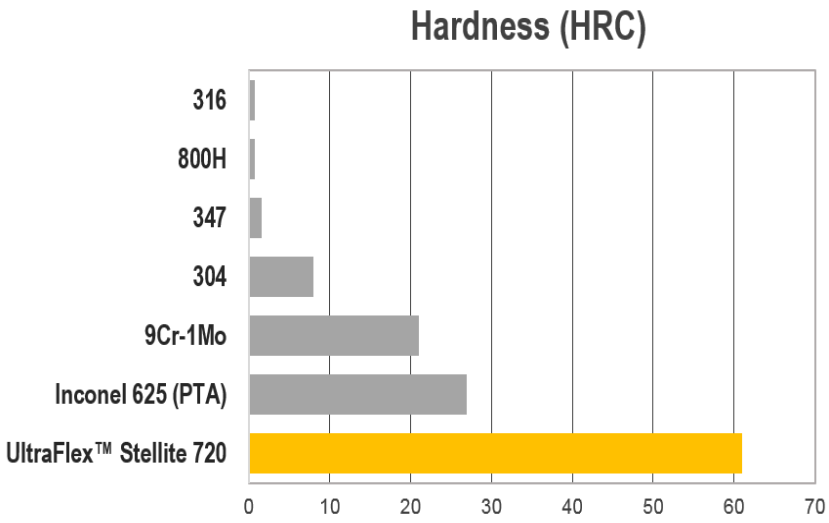


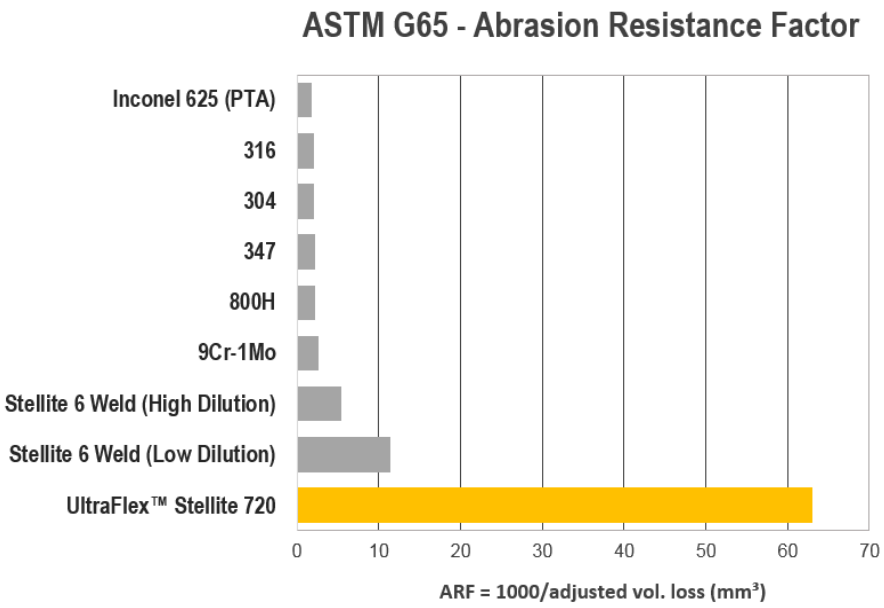
The hardness values of the 9Cr1Mo substrate are higher than normal as this sample did not receive full HT cycle

Stellite Weld-Overlay



Hardness and Abrasion Resistance





Stellite 720 gives high cladding hardness, HRc 60

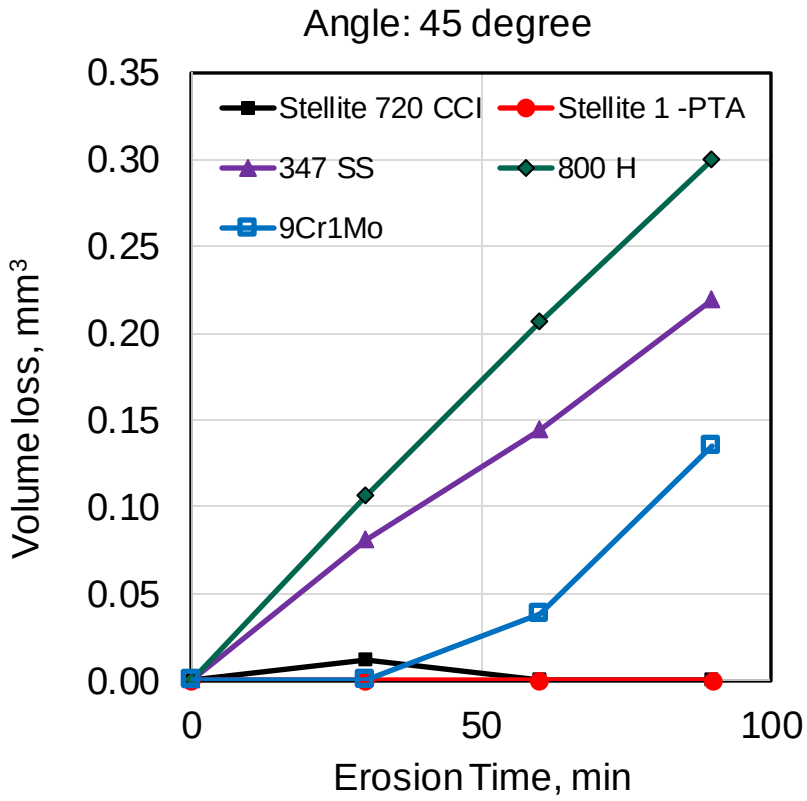
Stellite 720 gives abrasion resistance

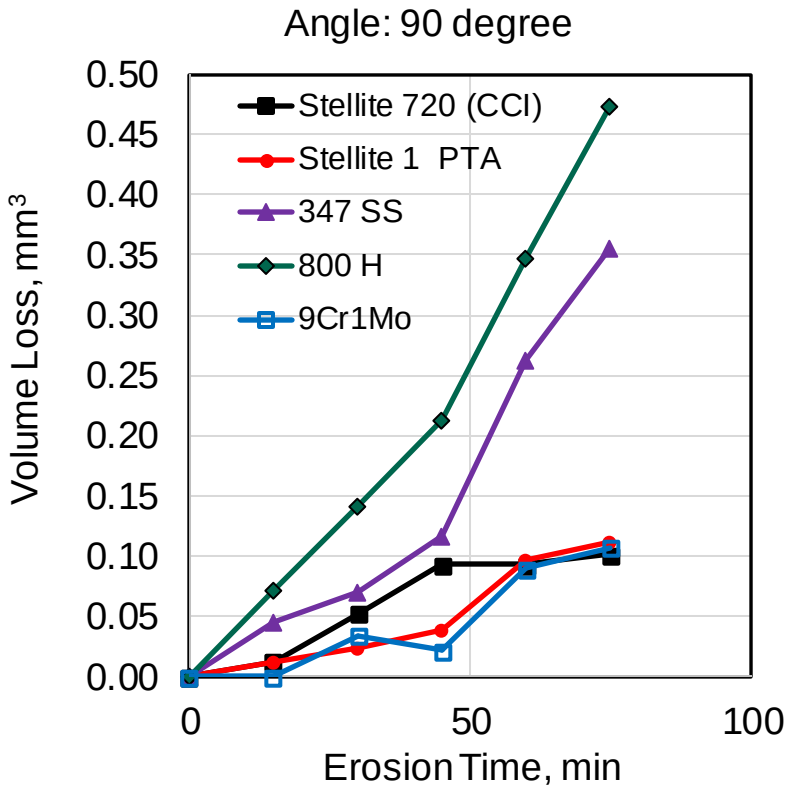
- **6x-10x of Stellite 6 weld overlay**
- **25x-35x of uncoated steel substrates**

ASTM G65:

- Test Media: AFS 50/70 test sand
- Sand flow: 200-300 g/min
- Weight applied: 12 lb.
- 6000 rev. in total

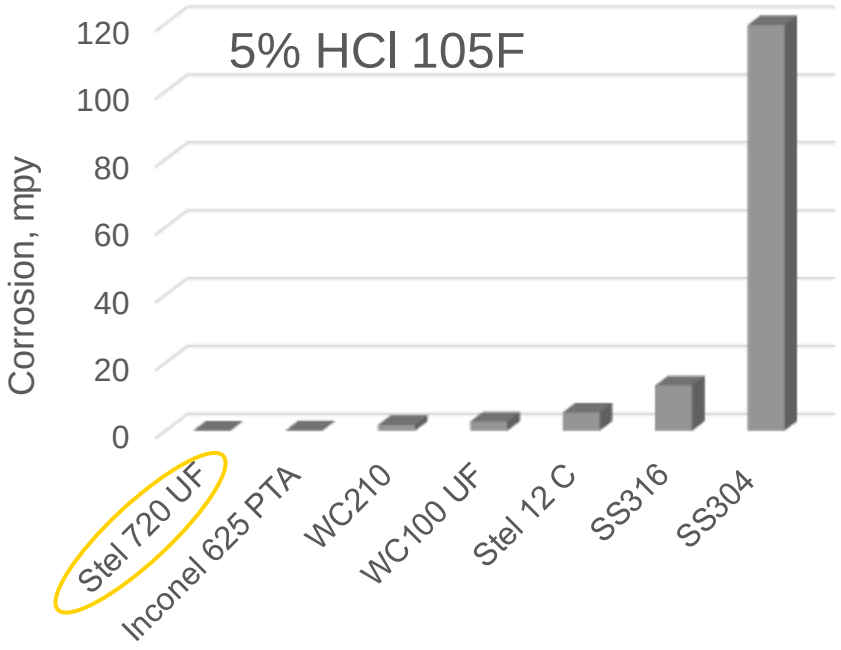
Resistance to Coke Erosion: Stellite 720 >= Stellite 1 > 9Cr1Mo > 347SS > 800H

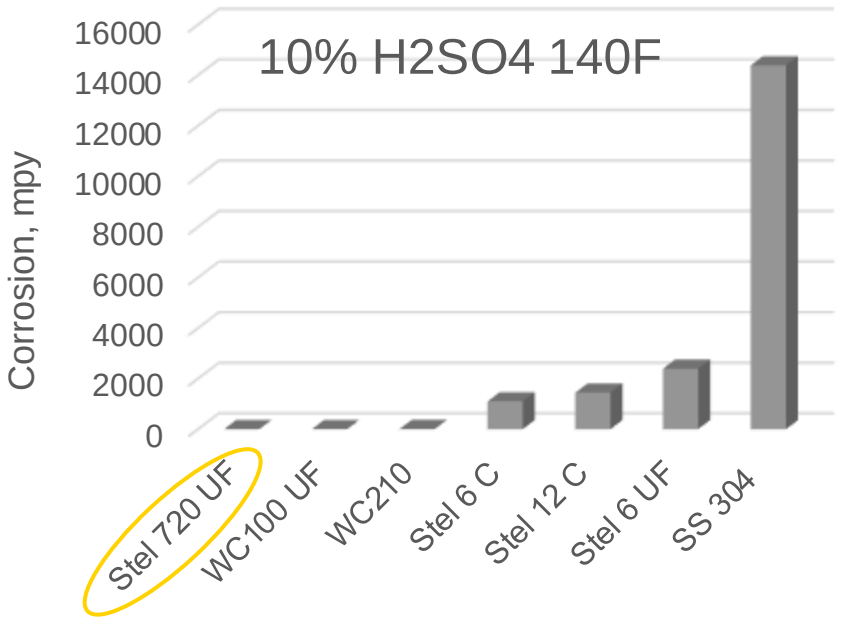




- **A lab test to** understand the relative resistance to the coke erosion during on-line spalling
- Conditions:
  - Coke particle size <40 mesh
  - Flow rate: 1.5 g/min at 60 PSI
  - Nozzle- Sample distance => 0.4 Inch

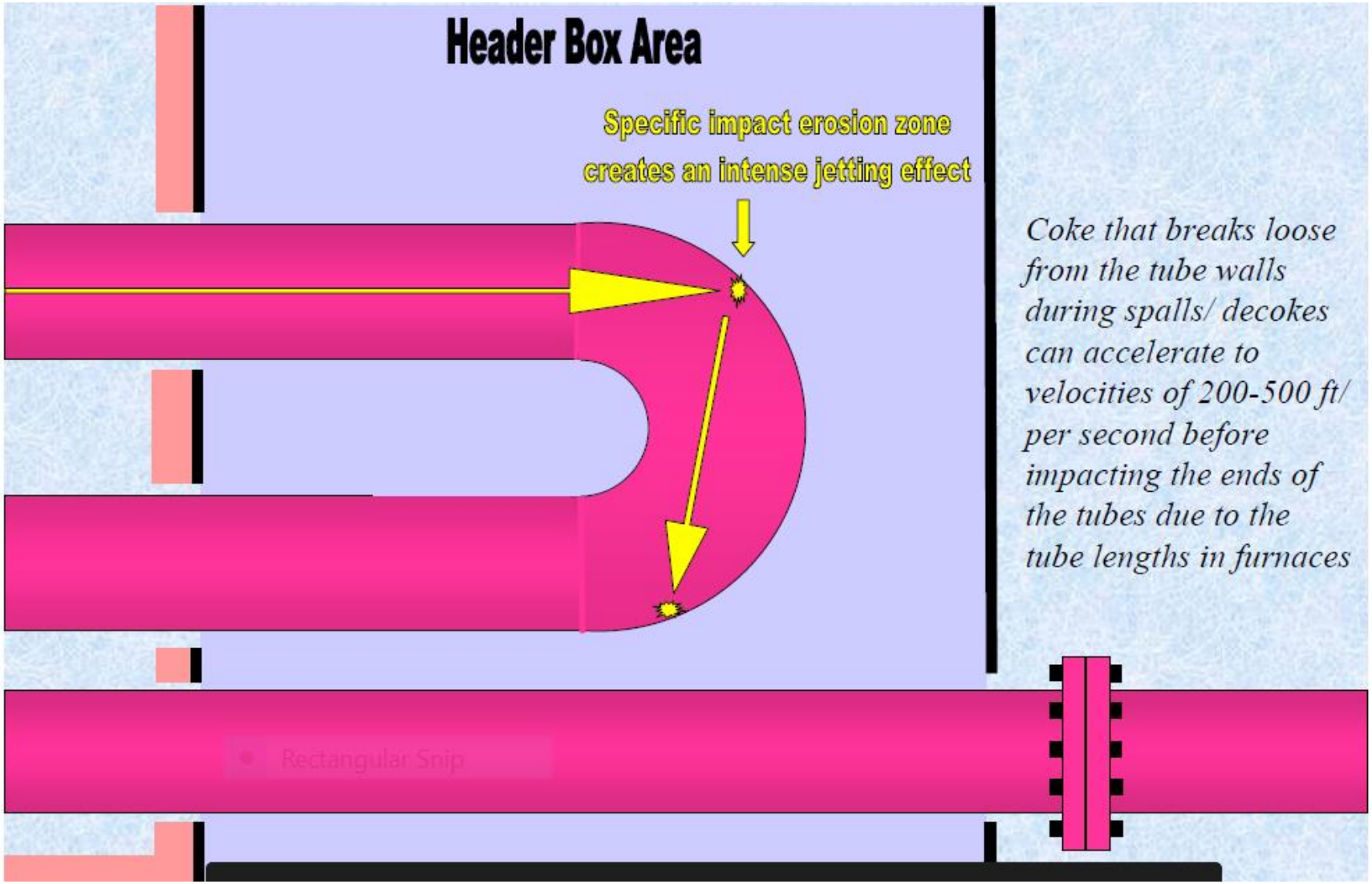
Corrosion Resistance – ASTM G31



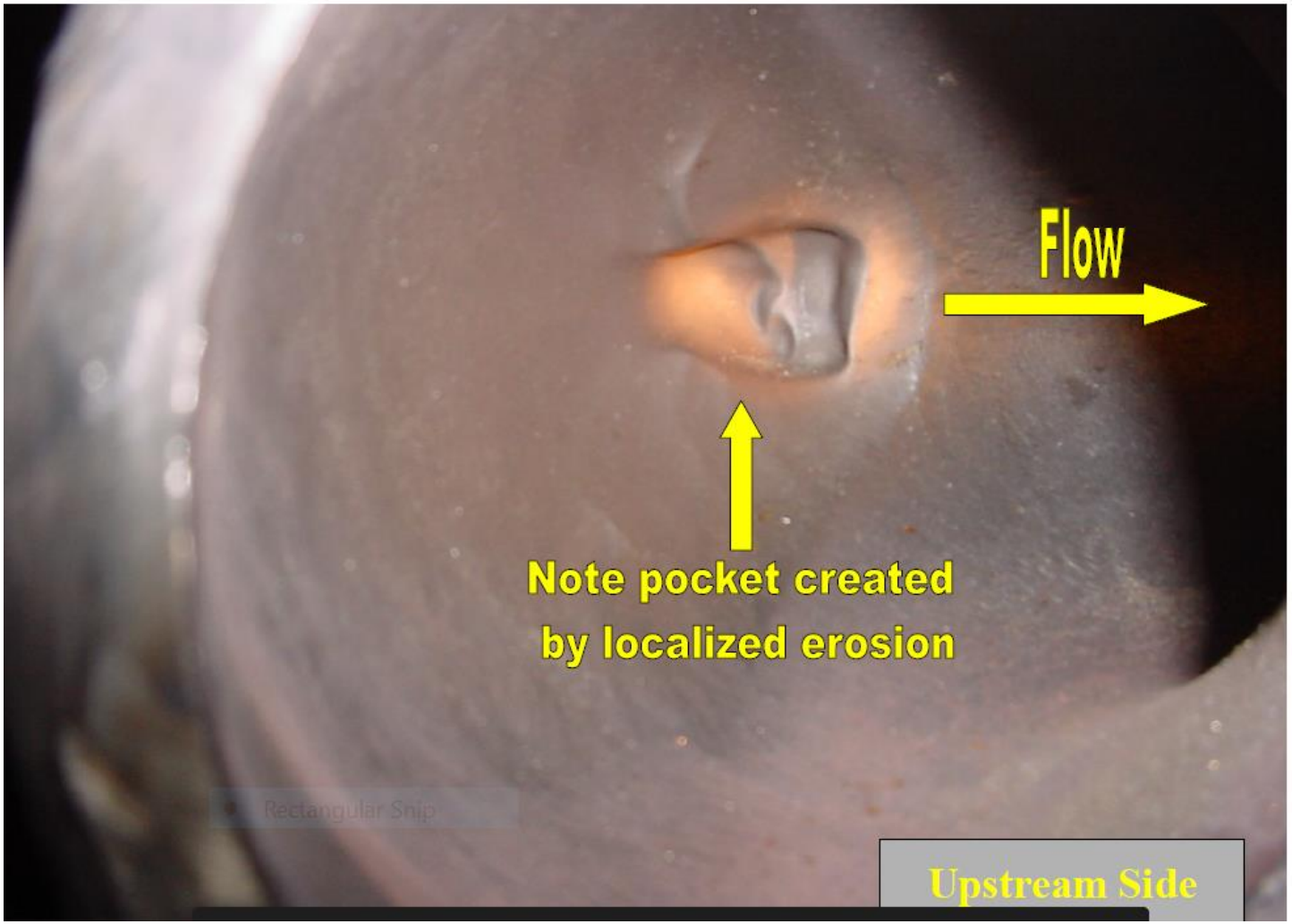


Stellite 720 cladding gives corrosion resistance comparable to Inconel 625 hard facing, >2000x of SS 304H

Delayed Coker Fired Heater Return Bends Erosion Zones

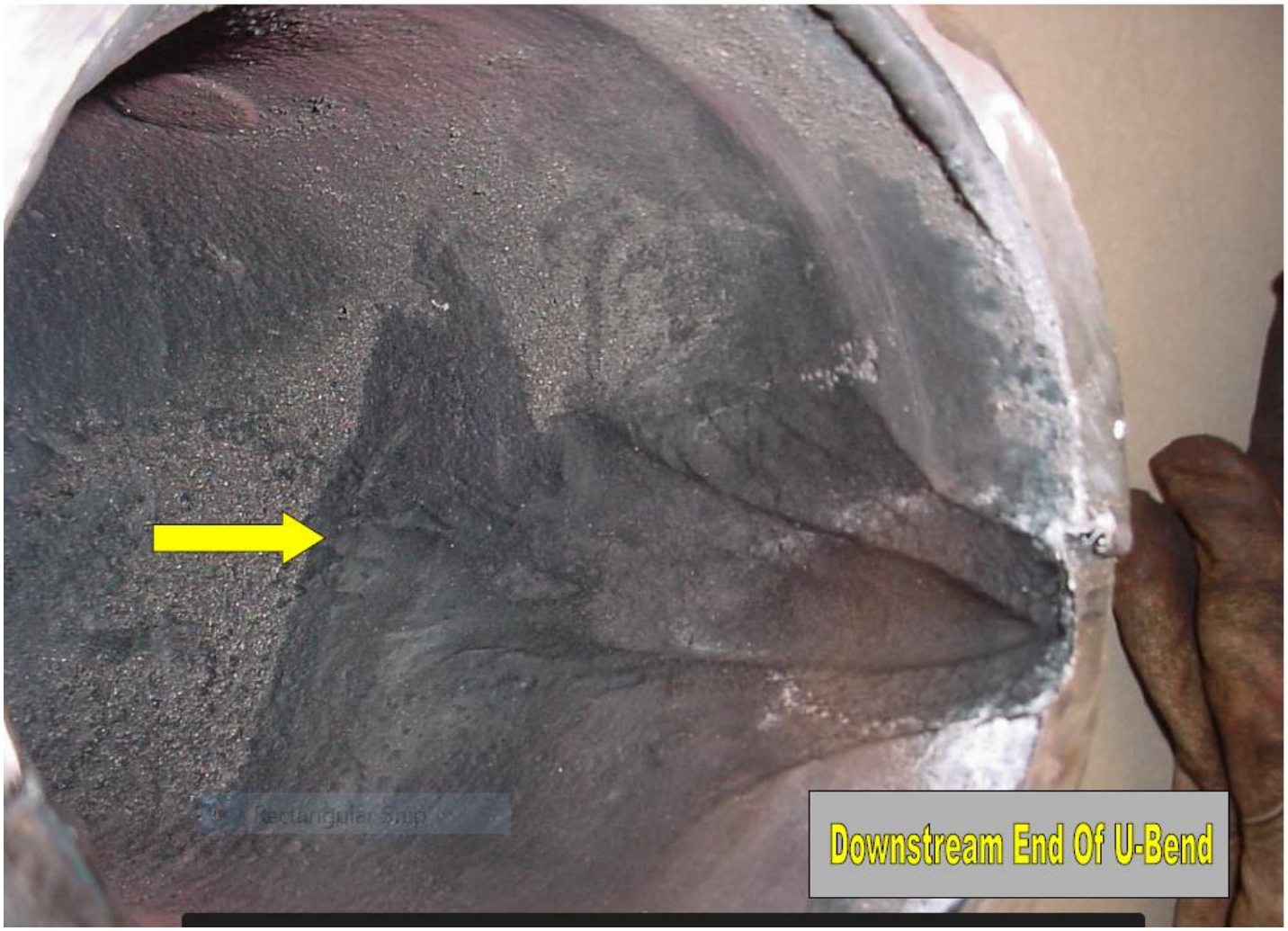


Return Bend Erosion: Upstream



Return Bend Erosion: Upstream

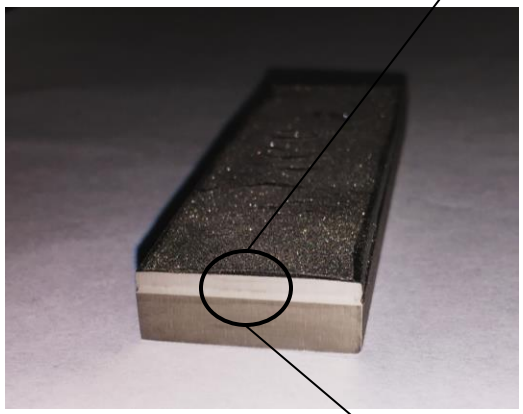
Return Bend Erosion: Downstream

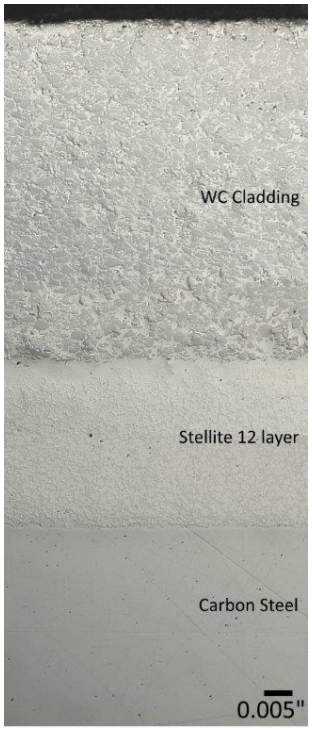


Delayed Coker Fired Heater Application Examples

Capabilities and Limitations

- Parts must be brazed in New Albany; the cladding cannot be applied in-situ
- Furnace Dimensions:
  - –Typical 6’ Long, 48” Wide, and 48” Tall
  - –Largest 12’ Long, 48” Wide, and 48” Tall
- Weight:
  - –In-house: 12,000 lbs.
  - –Contracted: 50,000 lbs.
- Base material property considerations
- Distortion





- Cladding Cracks
  - – Almost all the tungsten carbide claddings will have a network of “spider web” cracks in the cladding
  - – These run perpendicular to the interface and are almost always arrested at the interface

Capabilities and Limitations - Materials

Can Clad	Examples
Carbon steel	1018, A36
Alloy steel	4140, 6150
Stainless steel	
Austenitic	304, 316
Martensitic	410, 440
Precipitation Hardening	17-4, 15-5
Ferritic	430
Tool steels	A2, D2
Cast steel	see above
Cast stainless	CA-15, CA-6NM
Ni-based alloys	IN-625, IN-718
Yes, but….	
ASTM A-514 (plate)	Issues with reform - change to A588, A36 or Cor-Ten
White Iron	Issues with thermal cycles
Nitriding steels	Compatible if not previously nitrided.

Thank you

- Benjamin Goodly
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