Beyond limits: Titanium nitride’s game-changing role in hydrometallurgical production

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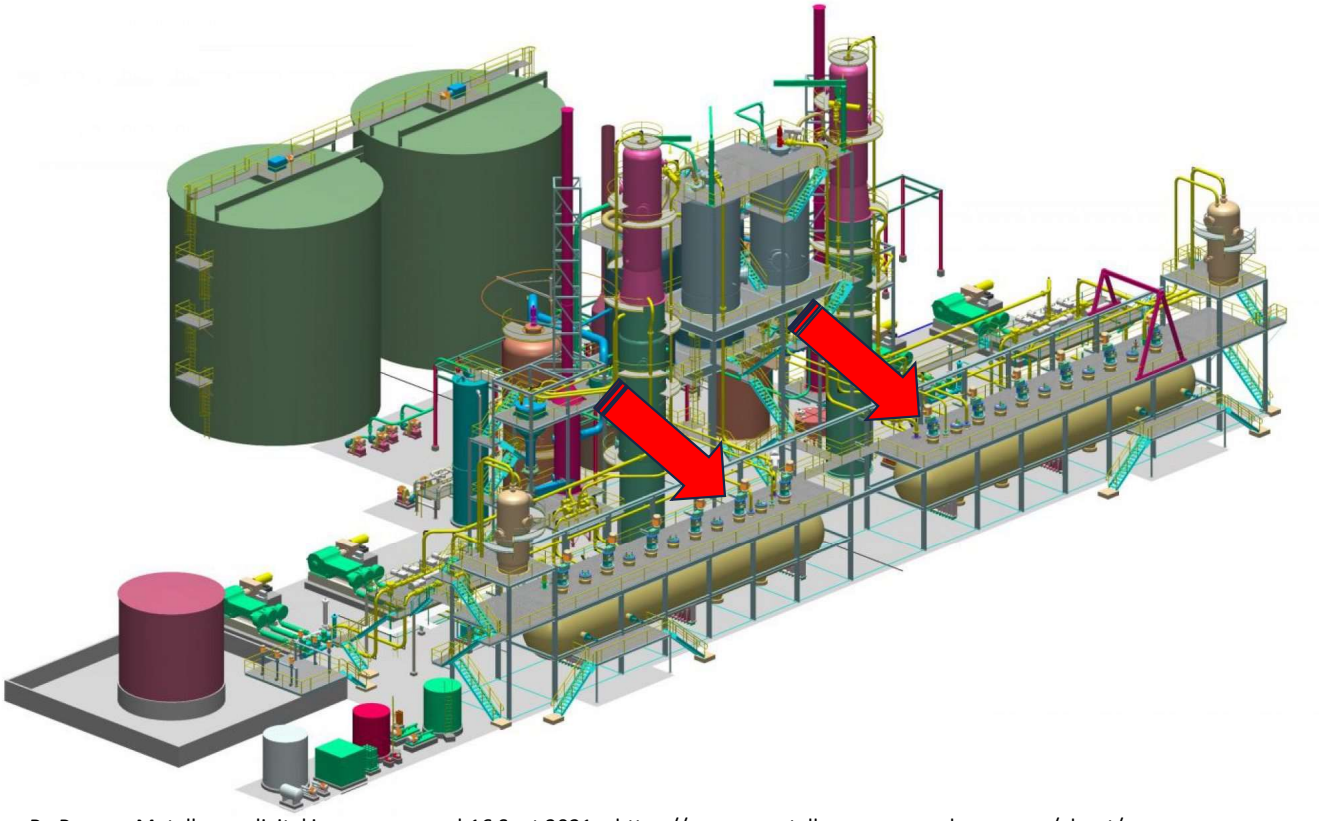
Titanium use in HPAL is extensive

Titanium is the material of choice in HPAL for its corrosion resistance and strength-to-weight ratio.



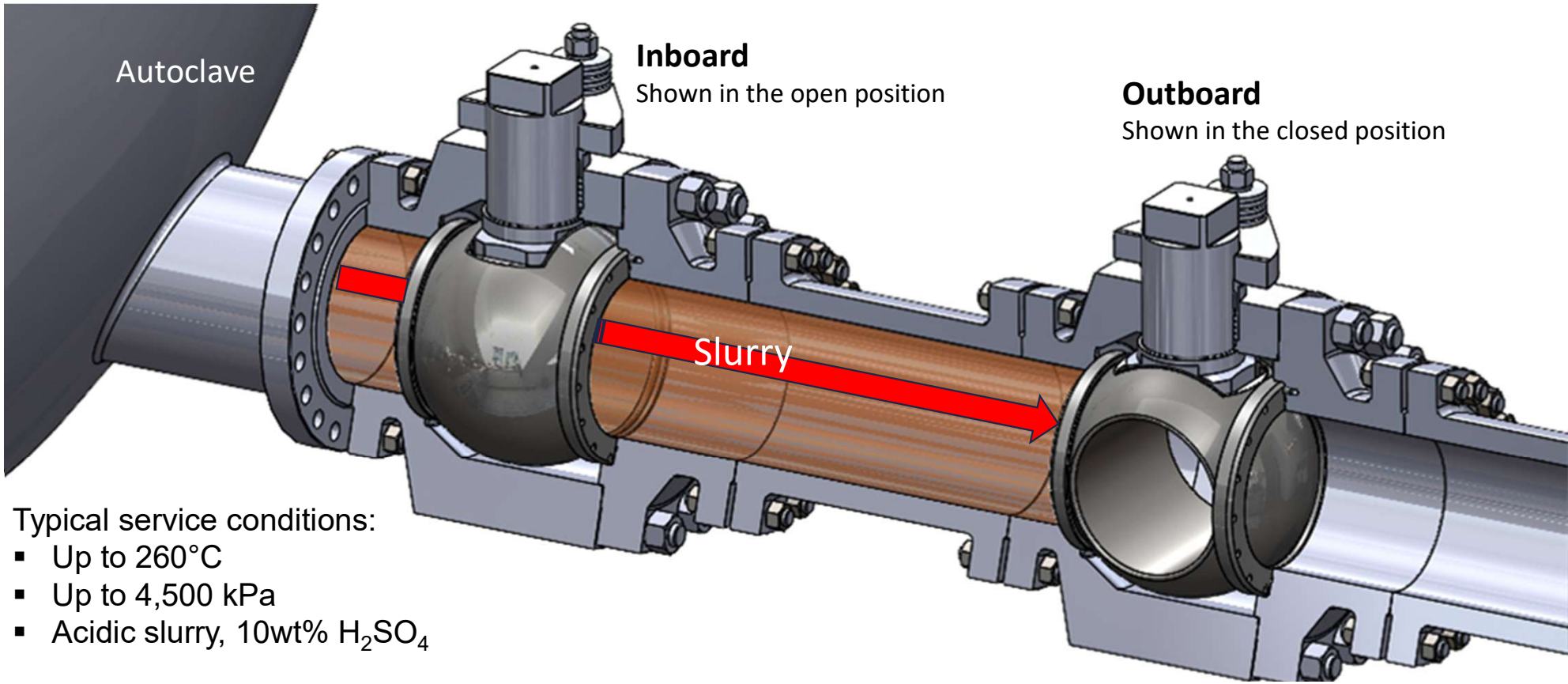
Clary, R., Process Metallurgy, digital image, accessed 16 Sept 2021, <https://processmetallurgycom.wordpress.com/about/>.

Equipment that is predominantly fabricated from Ti or Ti alloy:

- Pre-heater vessels
- Pre-heater towers
- Autoclave lining
- Discharge valves
- Let down valves
- Feed valves
- Vent valves
- All piping

HPAL discharge ball valves are critical equipment

The discharge valves are subject to the most severe conditions.

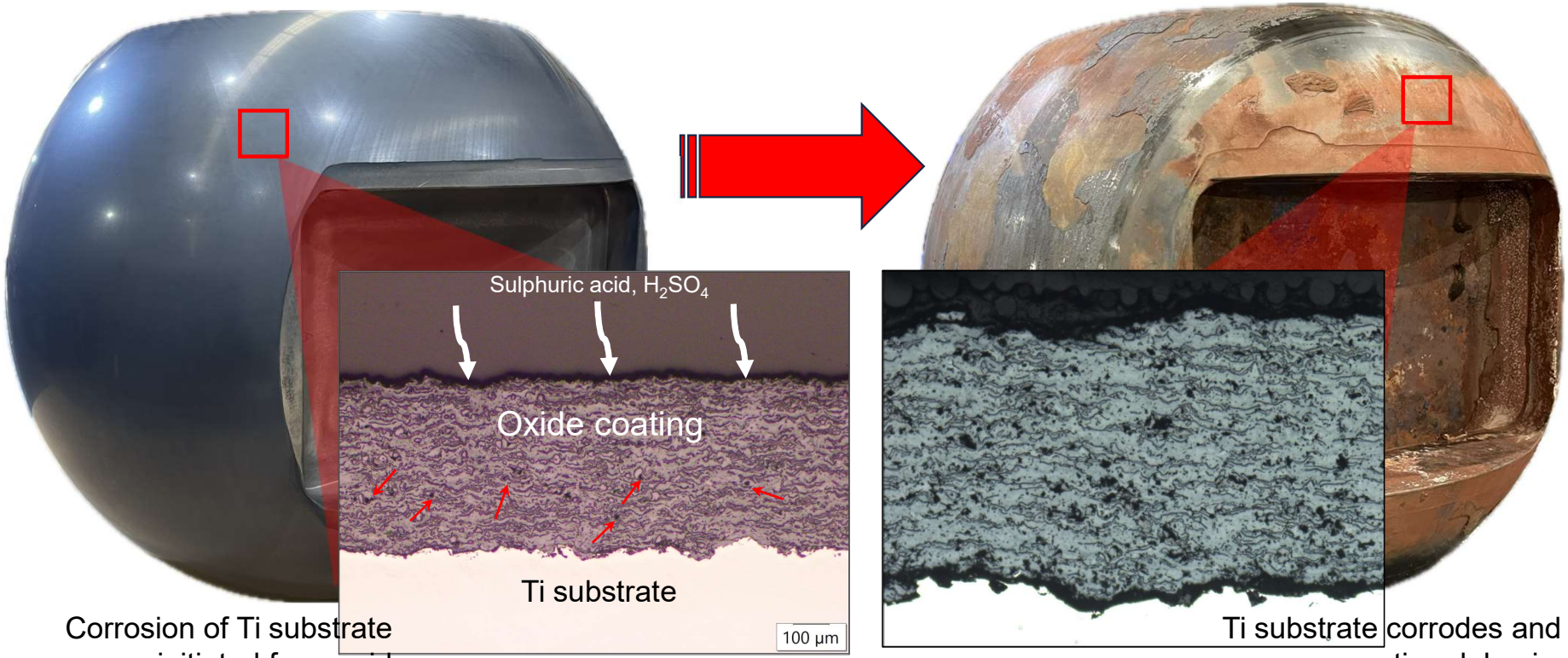


Typical service conditions:

- Up to 260°C
- Up to 4,500 kPa
- Acidic slurry, 10wt% H_2SO_4

Ceramic coatings are applied on the valve trim

The typical failure mechanism is coating delamination, with a 6- to 12-month lifespan.



Corrosion of Ti substrate initiated from acid

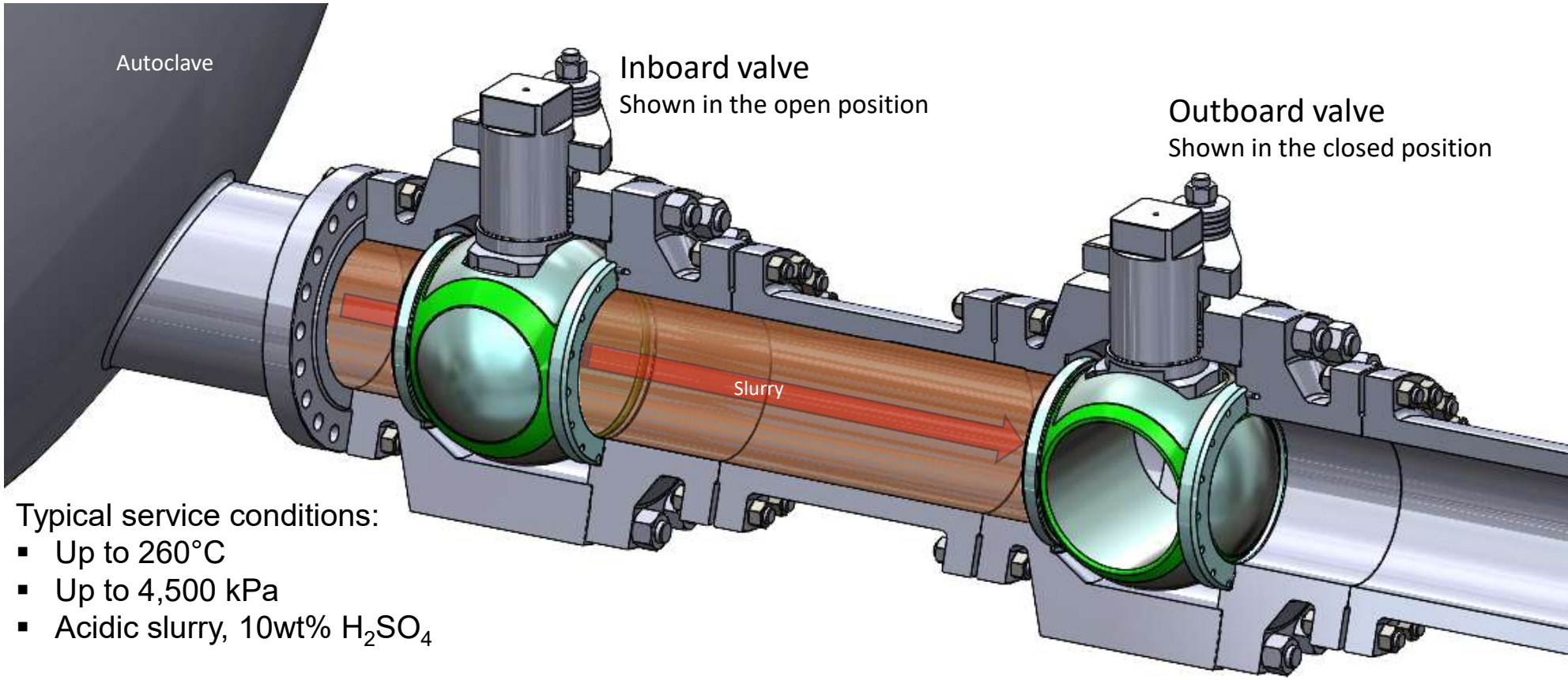
Ti substrate corrodes and the coating delaminates

Innovation in surface modification at Callidus

Patented FM-1500™ applied on discharge titanium valve trim

FM-1500™ designed for severe service trim

FM-1500™ installed as a retrofit or repair to a client's OEM valve.



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A closer look at FM-1500™

Innovating with Titanium Nitride. Patented material and design.

Experimenting with Titanium Nitride (TiN)

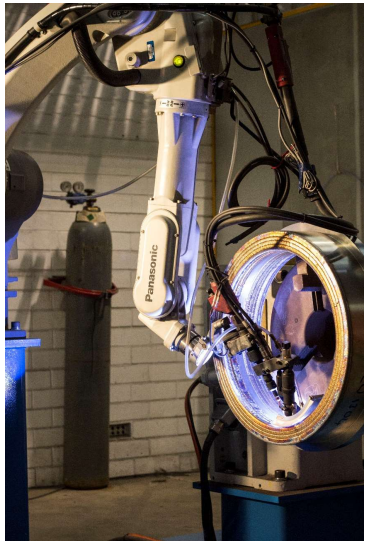
Evolution of innovation at Callidus

Titanium nitride (TiN) surface modification

Turning an unfortunate event into something purposeful.

Optimal weld colour

Inferior weld colour



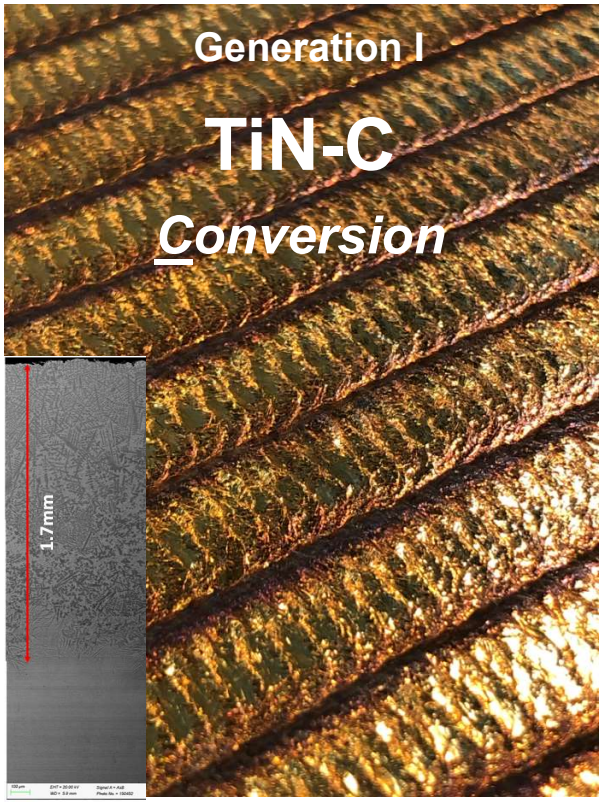
Ti weld quality, optimal vs inferior

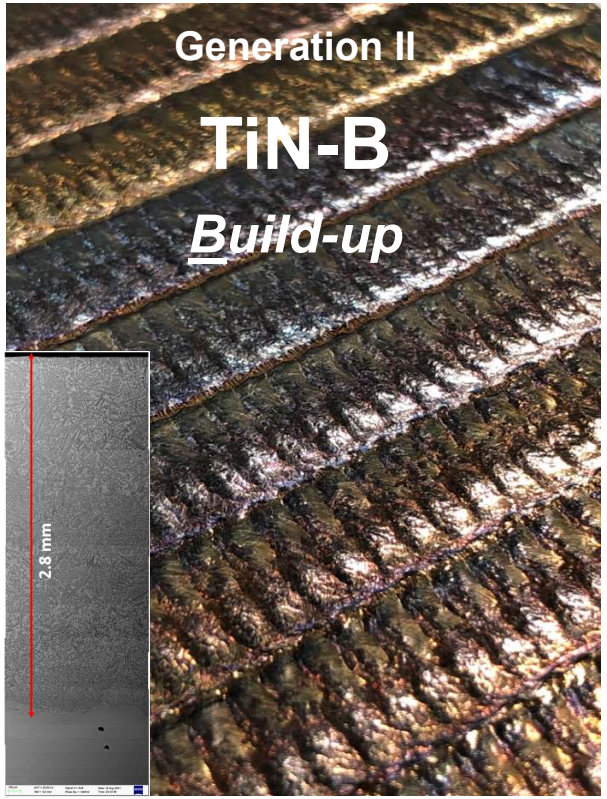
Purposefully hardening the surface

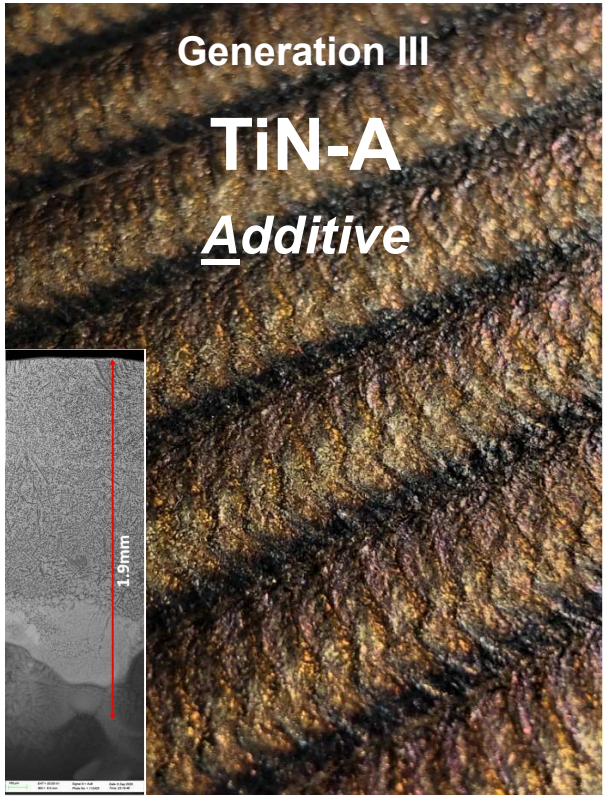
Use of robotic welding for consistent quality

Callidus' suite of titanium surface modifications

Over a decade committed to innovating surfaces for erosion- and corrosion-resistance.

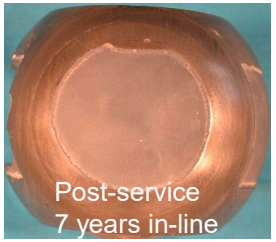




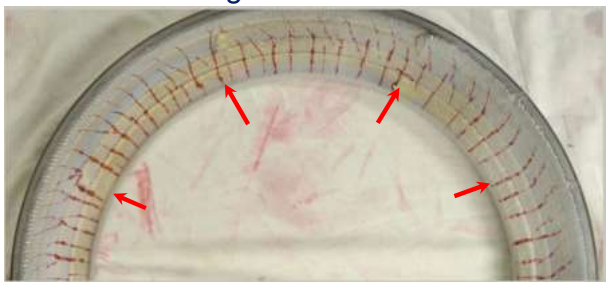


TiN-C material properties

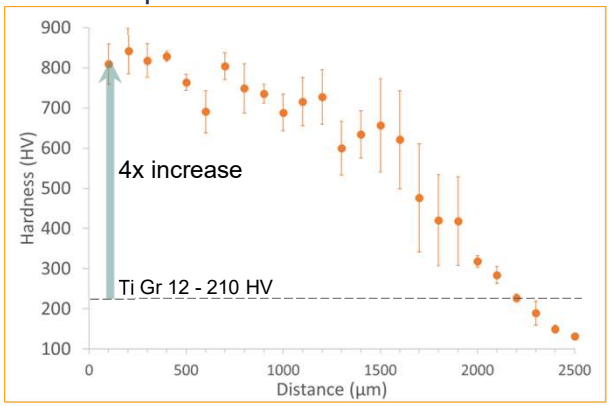
Painful to manufacture as valve trim but still highly applicable.



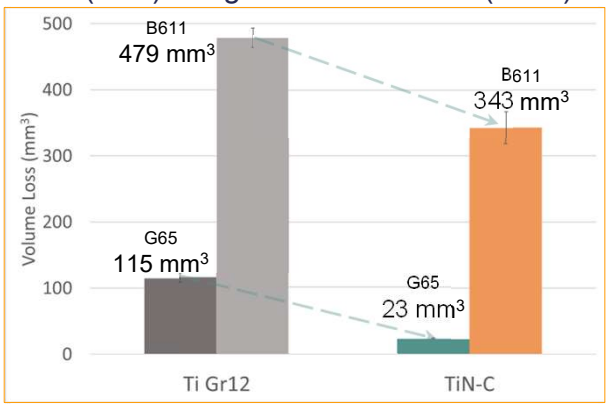
Penetrant testing



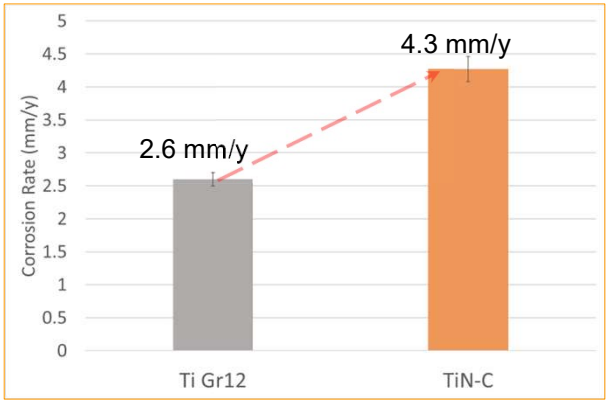
Hardness profile



Wear (G65) & high stress abrasion (B611)



Corrosion rate

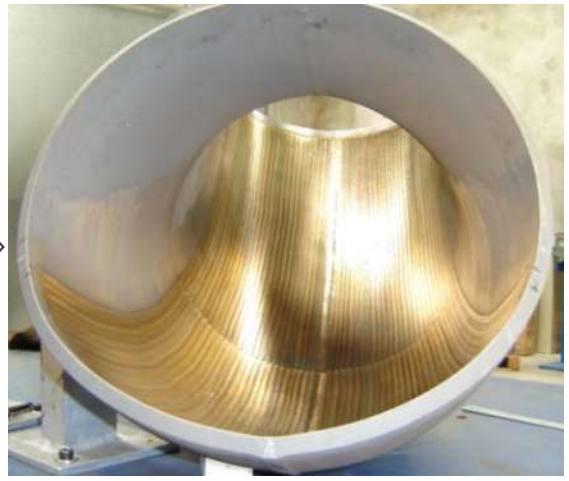


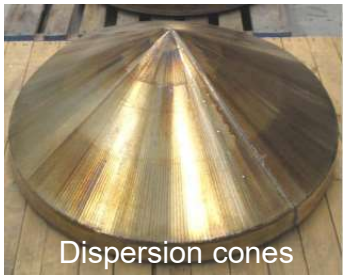
Step change using TiN-C for erosion resistance

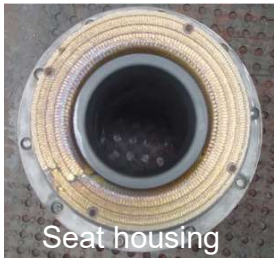
Significantly increasing the service life of mining components.

Without TiN-C

With TiN-C surface modification



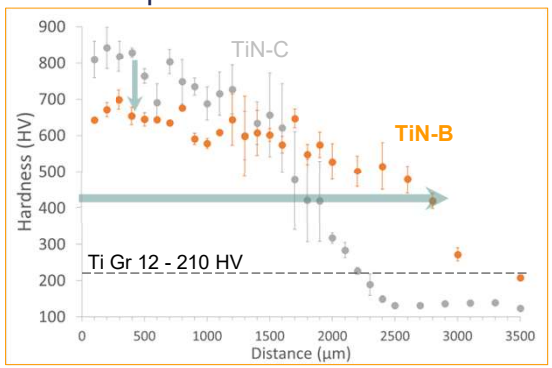




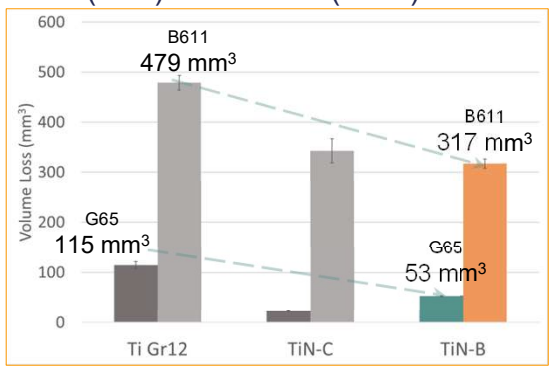
TiN-B material properties

A novel solution to a recurring failure.

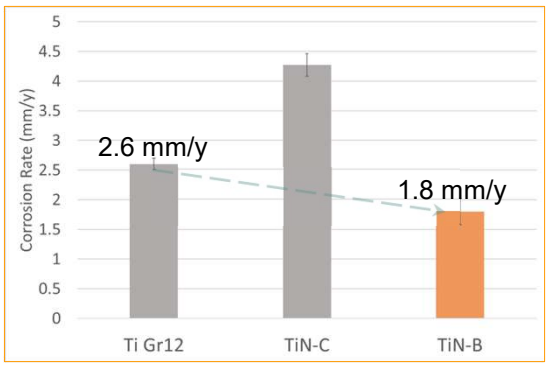
Hardness profile

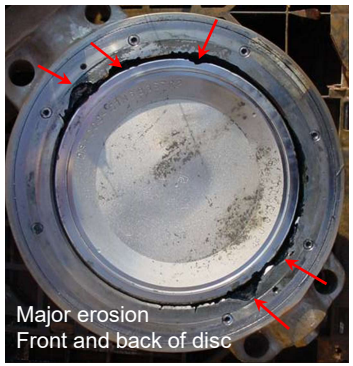


Wear (G65) & Abrasion (B611)



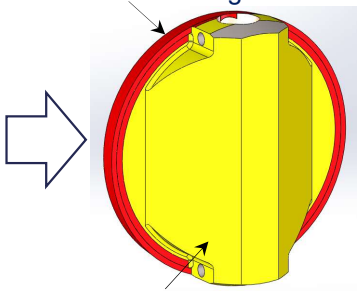
Corrosion rate





As-received butterfly valve, 4 months in-line

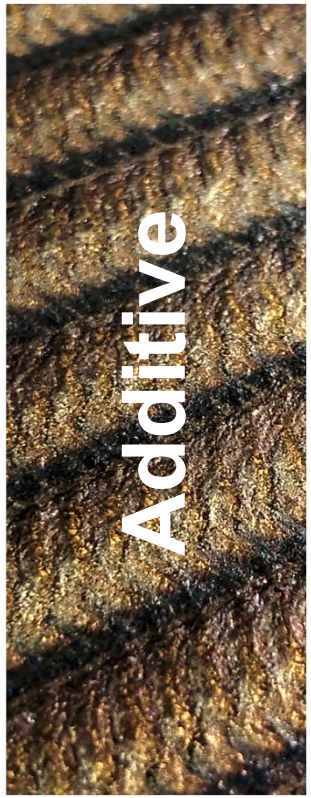
TiN-B on sealing areas

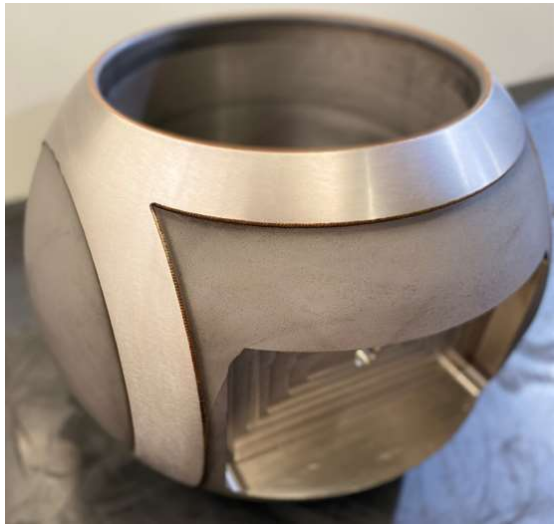


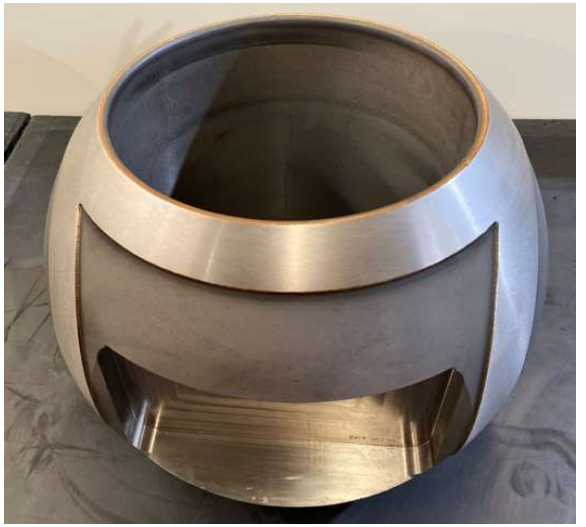
Refurbished disc front & back, 2.5 years in-line

TiN-A on trim is FM-1500™

Designed for discharge valve location. Erosion- and corrosion-resistant.



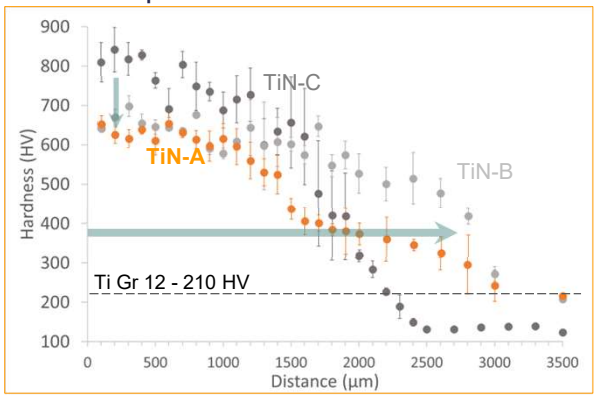




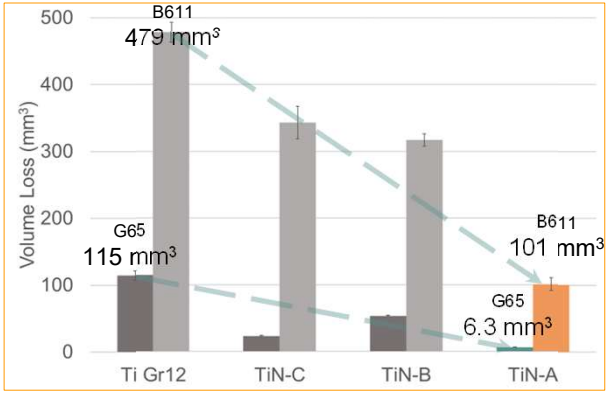
TiN-A material properties

Surpassing previous generations on all counts concerning valve trim.

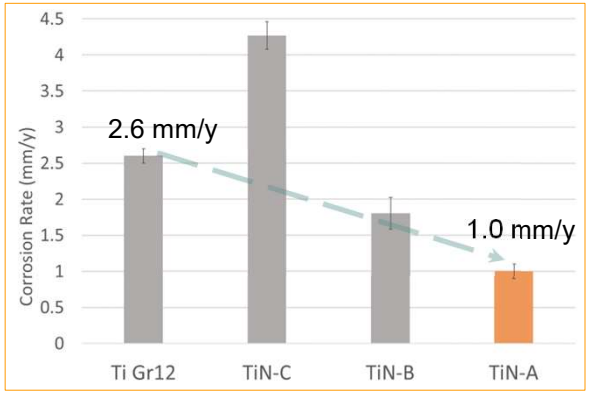
Hardness profile



Wear (G65) & Abrasion (B611)

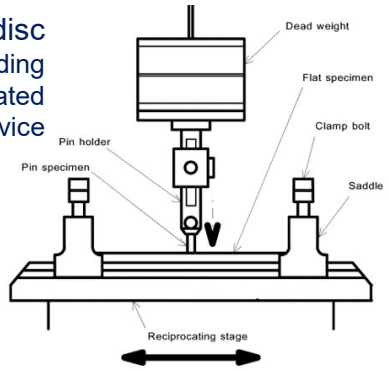


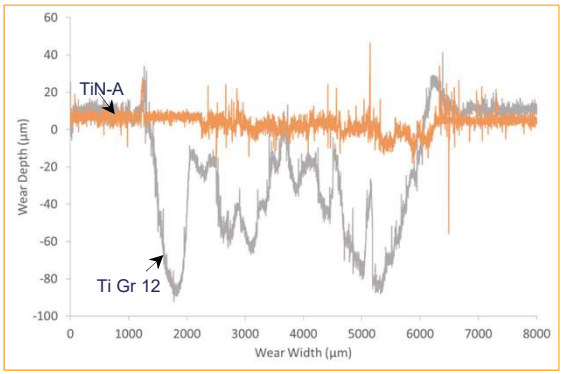
Corrosion rate



Pin-on-disc

Simulation of loading applied on mated surfaces in-service





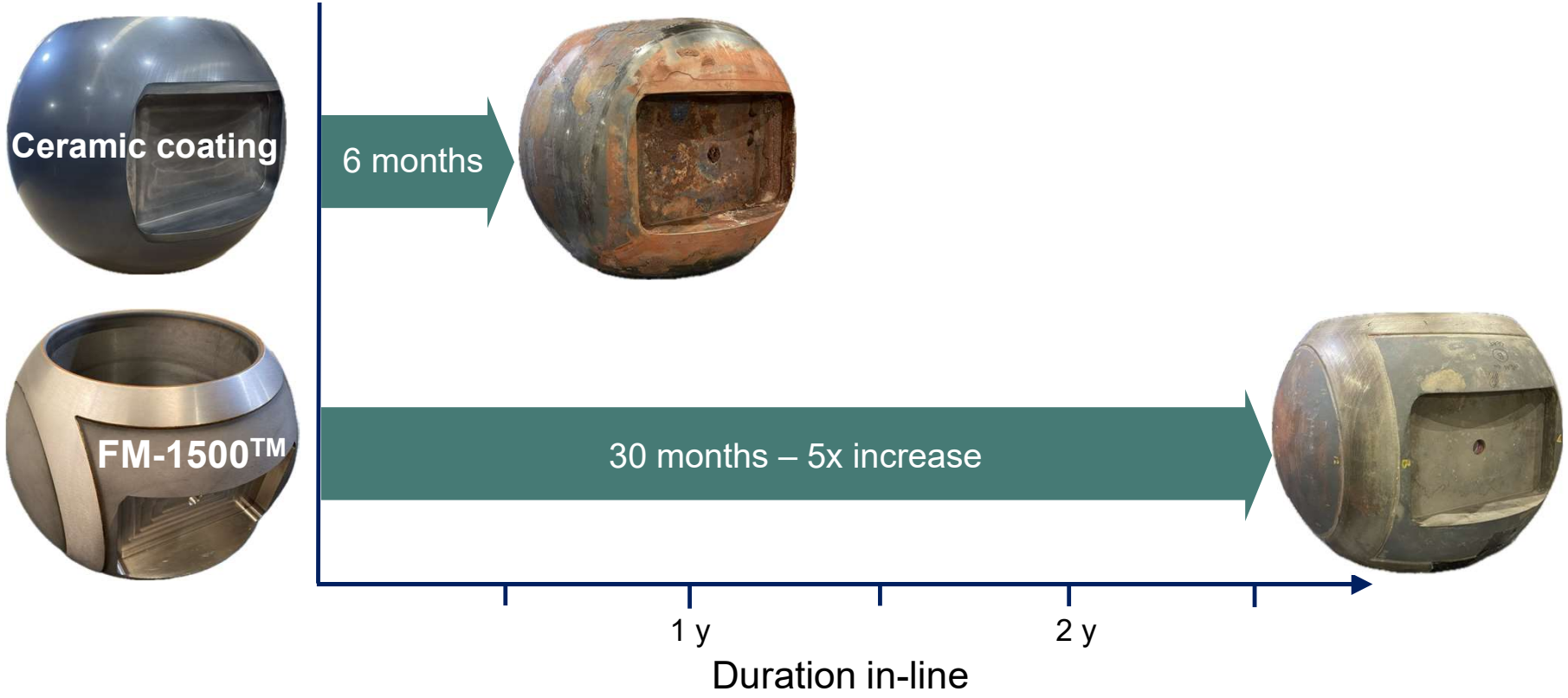
Penetrant testing

Case study

FM-1500™ trial results

Who wins for best performance?

FM-1500™ is a game-changer for the discharge valve location.

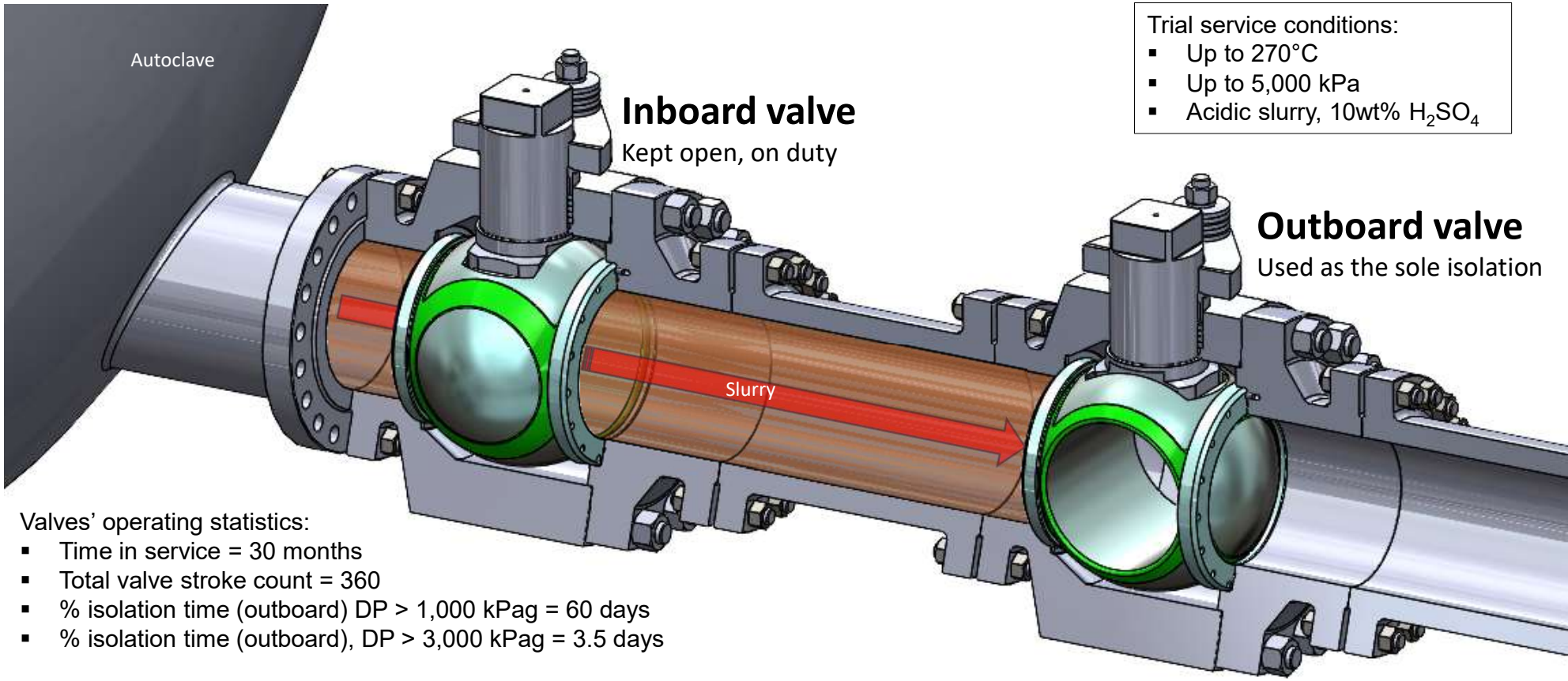


FM-1500™ inspection after 30 months in service

Bands show superficial surface marks and light scoring. No delamination or galling.

How was the valve operated during the trial?

A case study exemplifying severest of severe service.



Trial service conditions:

- Up to 270°C
- Up to 5,000 kPa
- Acidic slurry, 10wt% H_2SO_4

Valves' operating statistics:

- Time in service = 30 months
- Total valve stroke count = 360
- % isolation time (outboard) DP > 1,000 kPag = 60 days
- % isolation time (outboard), DP > 3,000 kPag = 3.5 days

Closing takeaways

- Evolution of TiN surface modifications developed and applied to solve clients' equipment issues. Demonstrative of Callidus' ongoing investment into R&D.
- FM-1500™ for severe service ball valve trim designed for erosion and corrosion resistance.
- Callidus supports the end user to achieve optimum performance through technical, operational, and engineering support to key OEMs to assist with product improvements and development.