

Production Asset Integrity and Corrosion Management: Best Practices and Innovations

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Production Asset Integrity and Corrosion Management: Best Practices and Innovations



High Velocity Thermal Spray Application on Internal surface of Offshore Asset Separator Vessels

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Corrosion issue faced in Process Vessels

High Velocity Thermal Spray HVTS

3

Project planning and scope

Execution

Quality control and post Job evaluation

Video Conclusion

Overview of the Vessels and Critical Workshop

- From the internal inspection conducted in 2017, pitting corrosion was identified sporadically along the bottom of process separator.
- Corrosion was notably concentrated in areas where water and sludge buildup occurred, primarily between the *five and seven o'clock directions*.
- The mechanism of under deposit microbial corrosion (UDMC) in the water phase explains the root cause.
- In 2019, major repairs involving in-kind weld buildup were conducted on three separators .





Corrosion Mitigation



Existing corrosion mitigation method

- Corrosion mapping by PAUT inspection (every 6 months)
- Continuous corrosion inhibitor injection
- Intermittent biocide batching (every 2 weeks)
- Cleaning and weld buildup to restore the base metal thickness (every 5 years)

Corrosion Mitigation



Implementation of new technology

Decision process to gain acceptance for changing to HVTS Pre-qualification processes

• Client consider the technical evaluation with life cycle cost analysis (IRR/ROI) for three options. Also, get the endorsement from Medco's technical authority team.

Op1: Weld buildup to restore the base metal thickness Op2: Weld buildup to restore the base metal thickness + Internal coating Op3: Weld buildup to restore the base metal thickness + HVTS

IGS Thermal Spray Technologies





- Atomized molten particles propelled by a carrier gas
- Used to apply a wide range of materials onto a surface quickly and cost effectively.

KS 100

- Also allows for adoption of established industry corrosionresistant materials (45ct, 625/622, C276 etc.)
- Mechanical bond, no heat affected zone (HAZ)

IGS Thermal Spray Technologies Critical Success Factors of Thermal Spray: <u>Alloy modification: Oxides</u>

Bal

Bal

Bal

Bal

Bal

Bal

29

35

36

21.5

16

17

0

0

0

0

4

>2

0

0

3.5

0

Х

0

0

9

16

17

Other(<10%)

Fe

none

B.C

Fe

Fe

De-oxid/stress red.

PREN

29

35

36

51.2

75.4

79.5

Alloy

Inconel 690

65/35NiCr

Alloy 888

IGS 5470

Inconel 625

Hastelloy C276

C276 – NiCrMoW, is a good alloy selection. It is suitable for wide pH ranges in sour and chloride environments. It has a high Pitting **Resistance Equivalent Number (PREN):**

PREN = Cr + 3.3(Mo + 0.5W) + 16N

In Flight Oxidation of Thermal Spray splats:

- Un-modified alloy oxidizes in flight, depleting key alloys (Cr...) weakening the microstructure as oxides are fractured & permeable.
- Even in High Velocity Cladding, oxides form part of the applied TS structure and are permeable, creating a pathway for corrosive media to penetrate through the cladding leading to subsequent substrate corrosion, and premature TS failure.
- IGS alloys are modified to minimize in flight oxidation to acceptable levels during spraying.
- Modified alloy reduces total oxide content and maintains Cr content





Scope Verification

- Apply HVTS cladding to a nominal thickness of 500 microns (20 mils) in 5 7 O'clock position using IGS specially designed and performance proven IGS 5470 + 6315 cladding system
- Apply HVTS cladding to a nominal thickness of 250 microns (10 mils) from the edge of HVTS to 150 mm above the LAHH

Equipmont no	Application area (m ²)									
Equipment no.	HVTS@20 Mils	HVTS@10 Mils	Total scope							
Produced Water Surge Drum	22	84	106							
2 nd Stage Separator	17	61	78							
1 st Stage Separator	28	119	146							

Project Planning and Scope Scope Verification, Cladding areas

1st Stage Separator



<u>HVTS 500micron 5-7 O-Clock =</u> <u>1.92m (0.96 M Measured from</u> <u>Center Point Outwards)</u> (Marked – Red)

SPE Workshop

<u>HVTS 250micron Upper Limit =</u> <u>LAHHH + 50mm = 3.33 m (</u>Marked – <u>Blue</u>)



2nd Stage Separator



HVTS 500micron 5-7 O-Clock = 1.60m (0.80 m Measured from Center Point Outwards) (Marked – Red)

workshop

<u>HVTS 250micron Upper Limit =</u> <u>LAHH + 150mm = 2.45 m (Marked –</u> <u>Blue</u>)

Project Planning and Scope Scope Verification, Cladding areas

Produced Water Surge Drum



HVTS 500micron 5-7 O-Clock = 1.67m (0.84 m Measured from Center Point Outwards) (Marked – Red) HVTS 250micron Upper Limit = LAHH + 150mm = 2.67m

SPE Workshop

(Marked – Blue)





Project Planning and Scope

Manpower safety requirement

- Medical checkup BOSIET training
- Confined space training Working at height training
- Emergency drill scenario PPE

Equipment test

- CCU lifting gear

- Equipment check and approval



vorkshop







Execution



Site execution

- Daily toolbox talk
- Permit to work
- Confined space rescue team
- Ventilation
- Working shift change meeting







Execution





Equipment layout and plot plan Upper deck

- Oil free Air compressors
- Blasting pots
- Garnet and Aluminum oxide loading area
- 2 equipment storage containers
- HVTS wires







Equipment setup

- Blasting pots, nozzles and hoses
- Light
- HVTS guns
- Ventilation system, coppus fan
- Oil free air compressor, manifold
- Dust collector, dust bag
- Scaffolding
- Breath box







Blasting and HVTS Equipment setup







Clean blast with Garnet, Profiling with AlOx





Execution



HVTS application, Spraying

HVTS application 5-7 O'clock @20 mils and MRP @ 10 mils,

Produced Water Surge Drum vessel





Quality control



HVTS Thickness of Produced Water Surge Drum



Specified Average Thickness	20	mils	Thickness Tolerance								
Minor Tolerance (90% of Readings)	52%	mils	-20%	+100%	16	4					
Major Tolerance (100% of Readings)	52%	mils	-20%	+200%	16	6					

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Post Job Evaluation



Bond strength ASTM D4541:

Table 1 - Bond strength testing results

Location	Bond Strength (MPa)	Failure Mode
Left	46.49	Adhesion
Center	42.35	Adhesion
Right	36.14	Adhesion
Average	41.66	



SEM Analysis:



· SEM cross-section image of IGS 5470 on production plate (100x magnification)



EDS spectra of IGS 5470 applied on production plates









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