www.integratedglobal.com

JUBCOR 2024

CONFERENCE & EXHIBITION

INNOVATIVE SOLUTIONS FOR CORROSION CHALLENGES

Field Applied Solutions for Corrosion Challenges in Amine Systems

IGS - The Global Source for Reliable Surface Protection

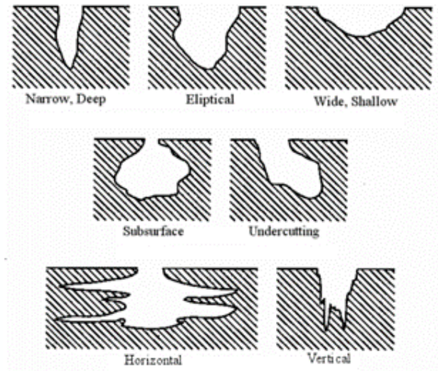
Presented By:
Rohit Kardile

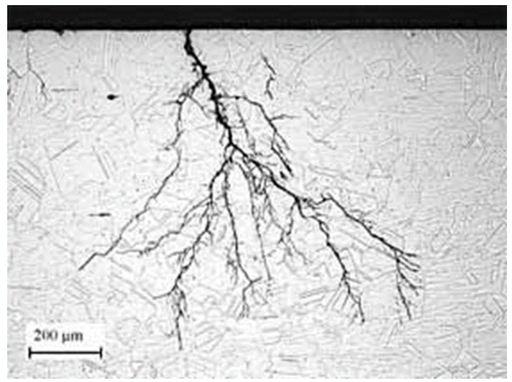
AGENDA:

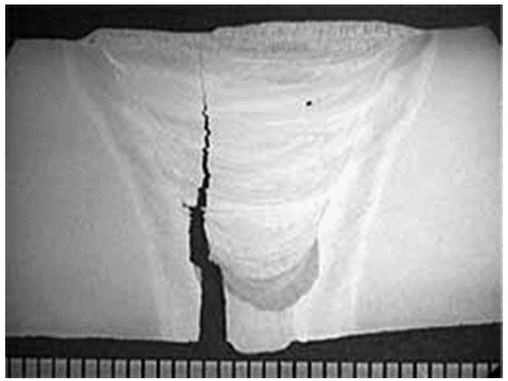
- Introduction
- Corrosion Resistant Alloy Selection for Sour Service
- CRA Brownfield Application
- Amine and Sour Service Case Studies
- Conclusion

INTRODUCTION:

- The amine unit plays a vital role in the petroleum refining, gas processing, coal gasification and ammonia manufacturing industries.
- Revenue losses from an unplanned amine plant shutdown are significant, in both gas plants, refineries and agrochemical plants, an amine unit shutdown directly reduces output and capacity, with accumulated production losses running into a few to many hundreds of thousands of US dollars per day depending on the facility.
- Corrosion is widely acknowledged as one of the main causes of amine system failure and unplanned shutdowns.
- Effective corrosion management is an important aspect of amine system management.
- To address these challenges in an operating plant, a robust, fit for purpose, field applied solution is required.







INTRODUCTION:

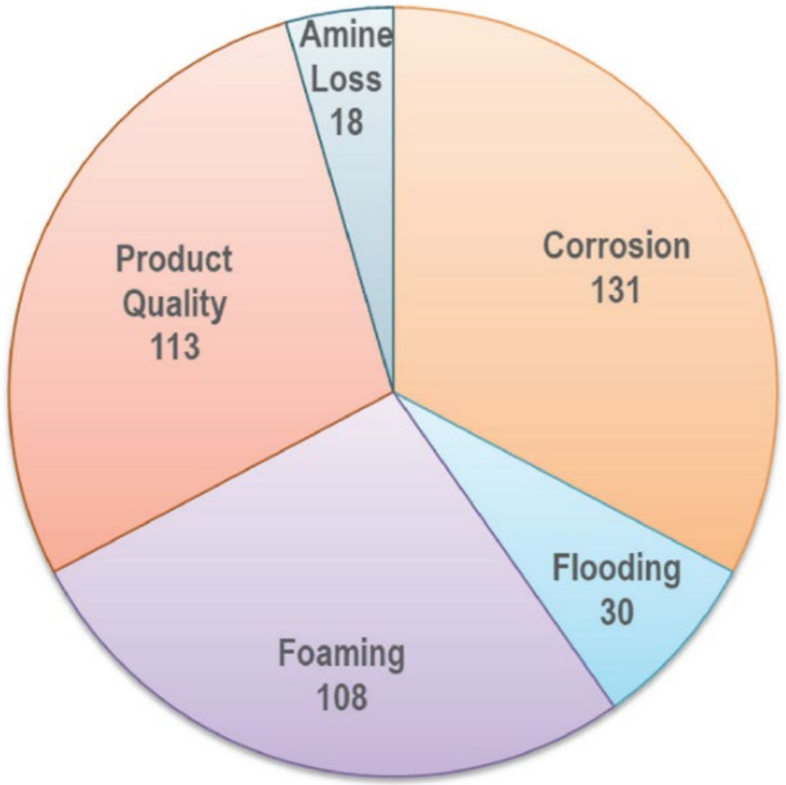
Source: ***Trends in tragedy – An in-depth study of amine system failures***

By Philip Le Grange, Mike Sheilan and Ben Spooner of:

Amine Experts International

‘analyzing **400 cases** of major amine system failure’

‘it is clear that the most frequent failure areas facing both sweet and sour amine treating systems are foaming, product quality and **corrosion.**’



Cases of critical failure by type for all amine systems (sweet and sour)

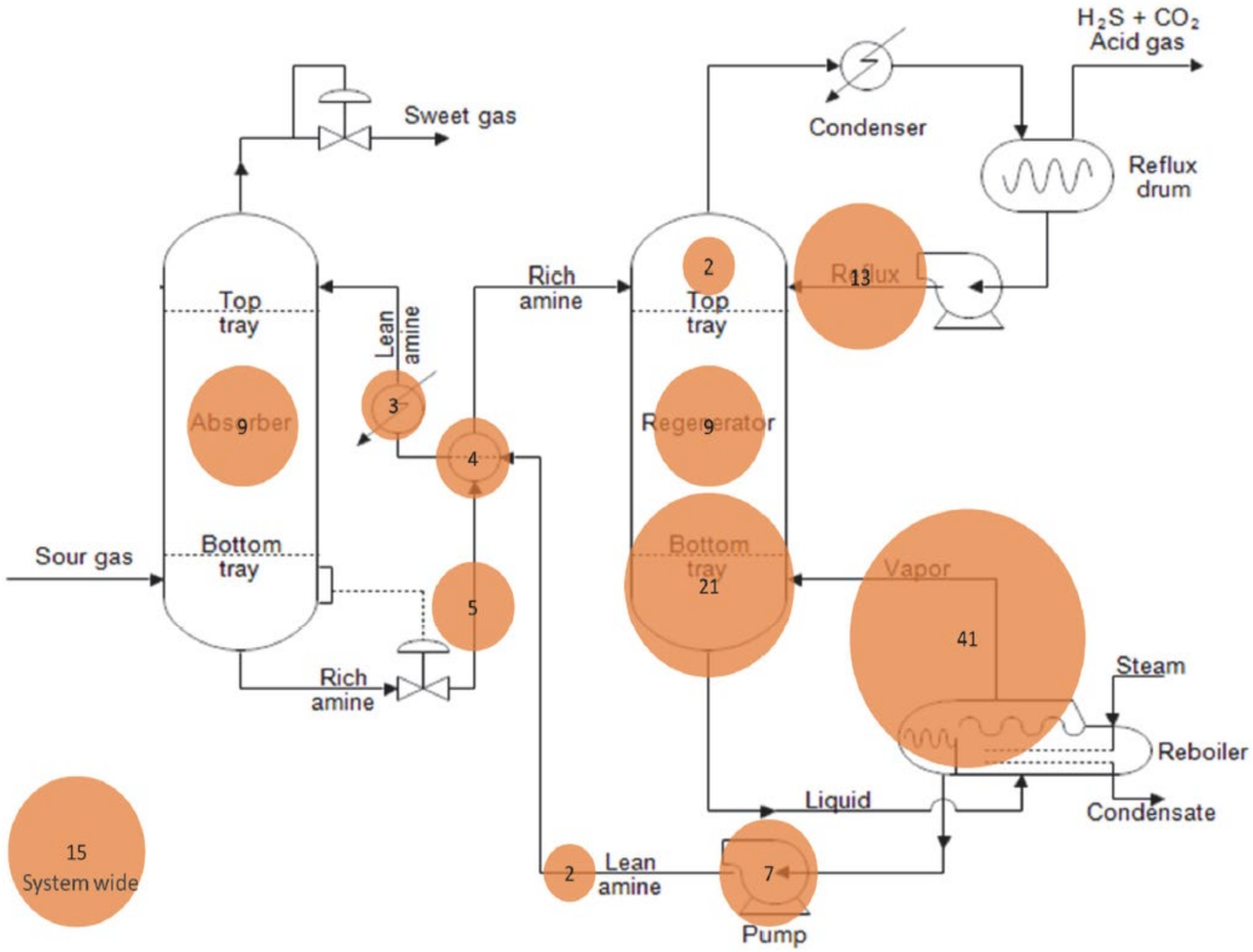
INTRODUCTION:

Source: ***Trends in tragedy – An in-depth study of amine system failures***

By Philip Le Grange, Mike Sheilan and Ben Spooner of:

Amine Experts International

‘In amine units, the environment includes a number of serious **corrosion promoters**, such as **acid gases** (H_2S and CO_2), **heat stable salts** and their acid precursors, **chelants** (that can remove any protective films that may be formed), **velocity** and **high temperature**.



Locations of the corrosion (131 cases – all systems)

CORROSION RESISTANT ALLOY SELECTION FOR SOUR SERVICE:

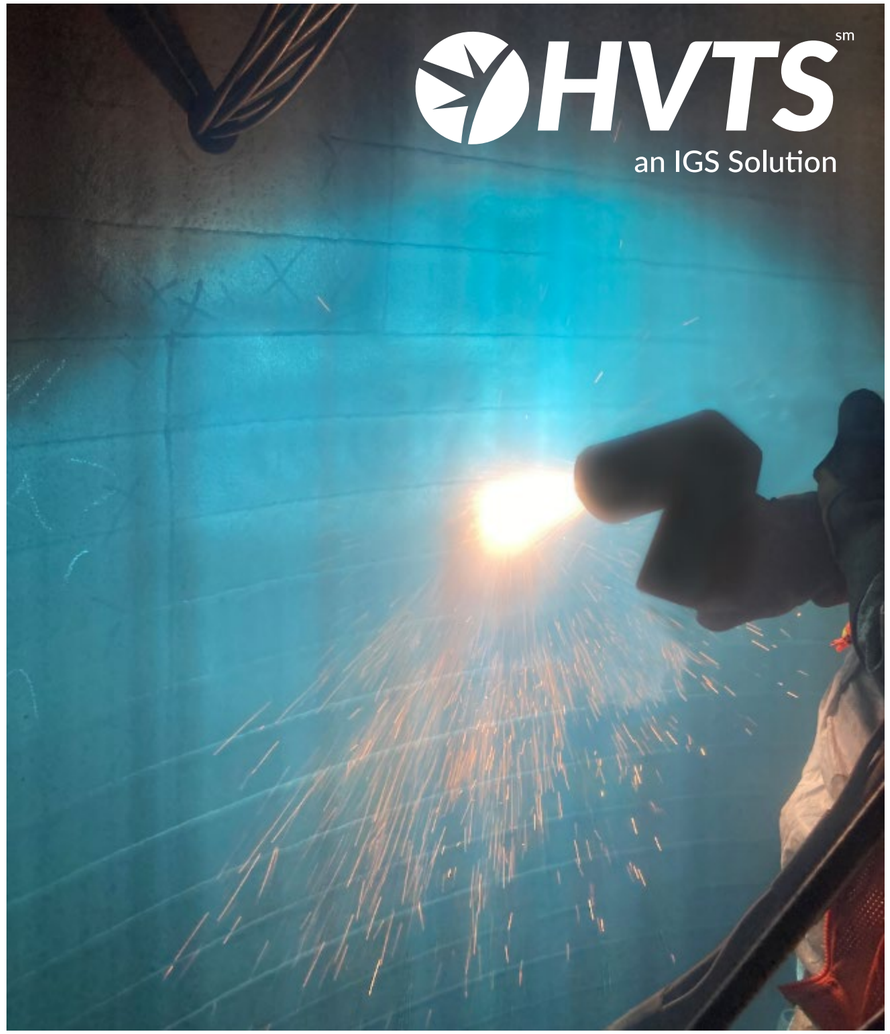
Alloy	Ni	Cr	Mo	W	Nb	Other(<10%)	PREN
Inconel 690	Bal	29	0	0	0	Fe	29
65/35NiCr	Bal	35	0	0	0	none	35
Inconel 625	Bal	21.5	9	0	3.5	Fe	51.2
Hastelloy C276	Bal	16	16	4	0	Fe	75.4
IGS HVTS	Bal	17	17	>2	X	De-oxid/stress red.	79.5

- An **in-situ** brownfield alloy upgrade of the internal vessel surface can be achieved by the following methods:
  - Cladding (CRA) - HAZ, PWHT required
  - Weld Metal Overlay (CRA) - HAZ, PWHT required
  - IGS HVTS (CRA) - no HAZ, no PWHT

CRA BROWNFIELD APPLICATION:

IGS - HVTS

- An in-situ internal metal cladding technology that provides a robust corrosion/erosion barrier on static equipment.
- IGS HVTS is field-applied, following strict engineering specifications, with respect to surface preparation and cladding application.
- Modified materials and application technologies are qualified for the specific service environments.



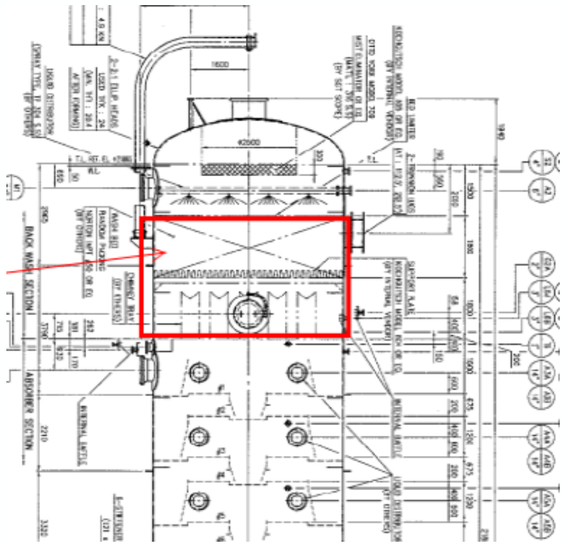
AMINE AND SOUR SERVICE CASE STUDIES:

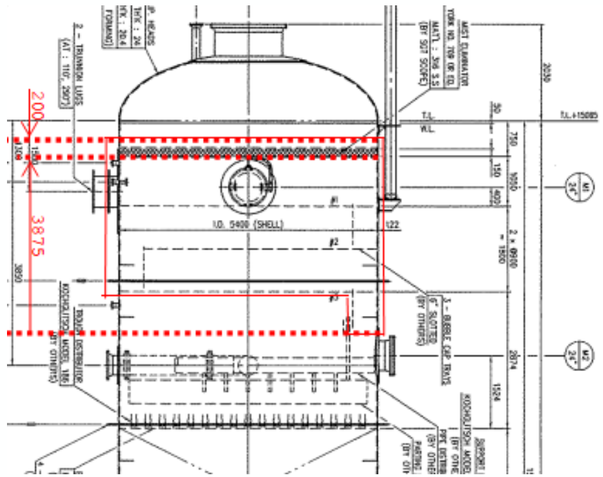
MDEA AMINE COLUMNS

Applications in 2015:

Train 4 outage in March of 2015, metal-wastage problems in Amine Columns 24-C0903 and 24-C0901 were addressed.

The interior surface of the shell was in a bad condition and required extensive grinding. The total area clad was 143m2 in the top sections of both columns.





Process Used:

IGS HVTS cladding was applied to the vessels where the severe pitting corrosion was identified, to protect from further metal wastage and wall loss.

AMINE AND SOUR SERVICE CASE STUDIES:

Inspection, October 2018

Inspection Results:

"The HVTS cladding was found to be in very good condition. The cladding is unaffected after three years of service and has effectively protected the internal metal surface thus freezing the condition of the shell. The cladding condition was the same as the day it was applied in terms of visual appearance and thicknesses."

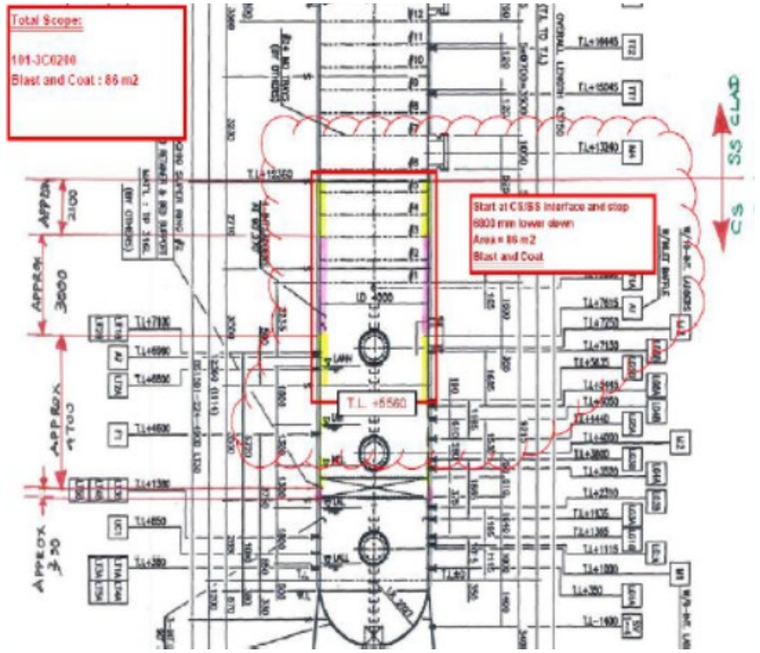
- No repairs required.

AMINE AND SOUR SERVICE CASE STUDIES:

AGR AMINE ABSORBER TOWERS

Applications in 2011 and 2012:

During inspection in 2011 significant pitting corrosion was discovered in various assets e.g. unclad carbon steel sections of AGR Amine Absorbers below the CRA weld overlay and in other discrete locations.

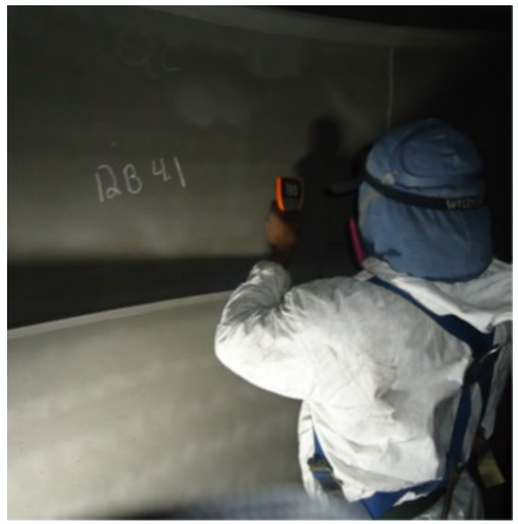


Substrate /Base:

Carbon Steel

Process Used:

IGS HVTS 5420 cladding was applied to the vessels below the CRA weld and in other discrete locations where pitting corrosion was identified.



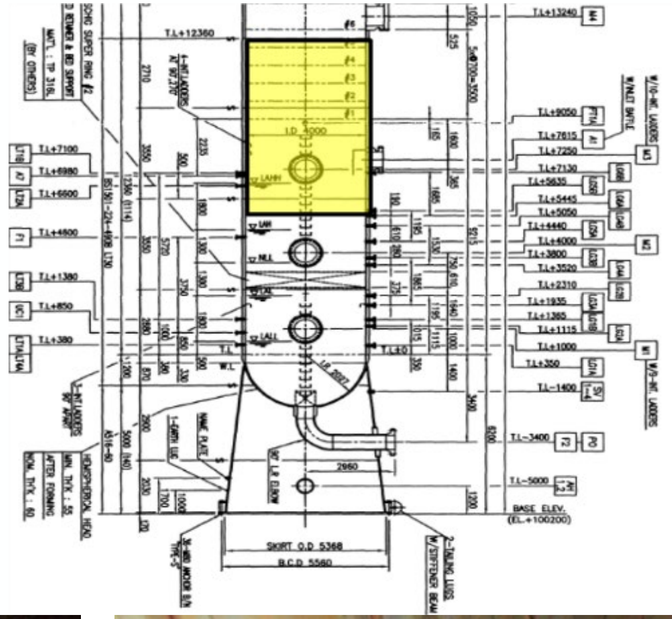
AMINE AND SOUR SERVICE CASE STUDIES:

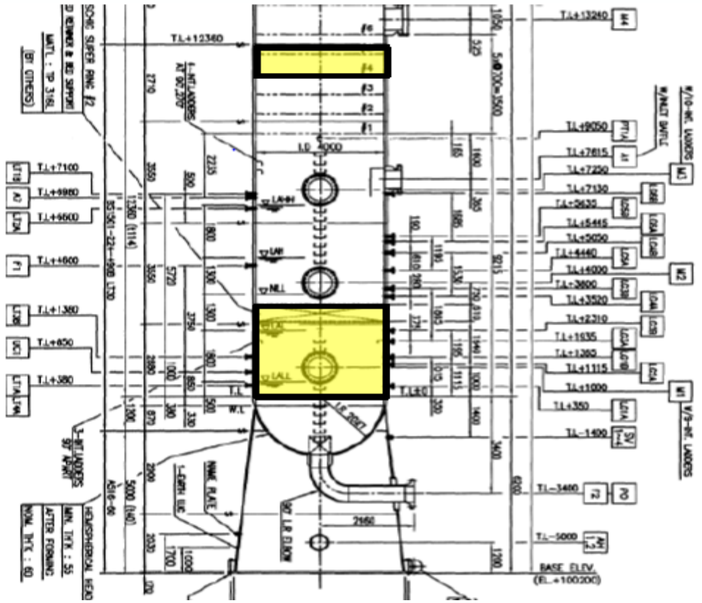
AGR AMINE ABSORBER TOWERS

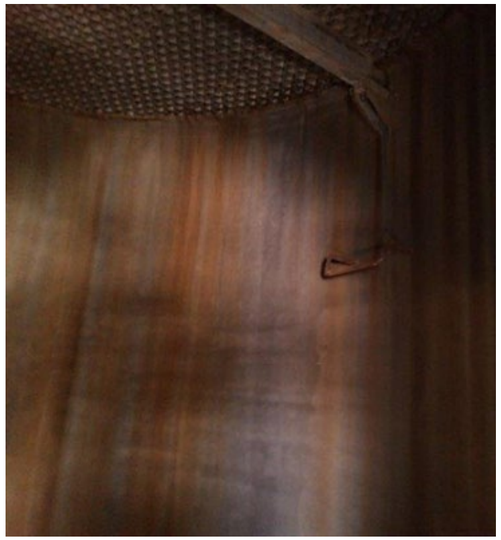
Inspection:
February 2020

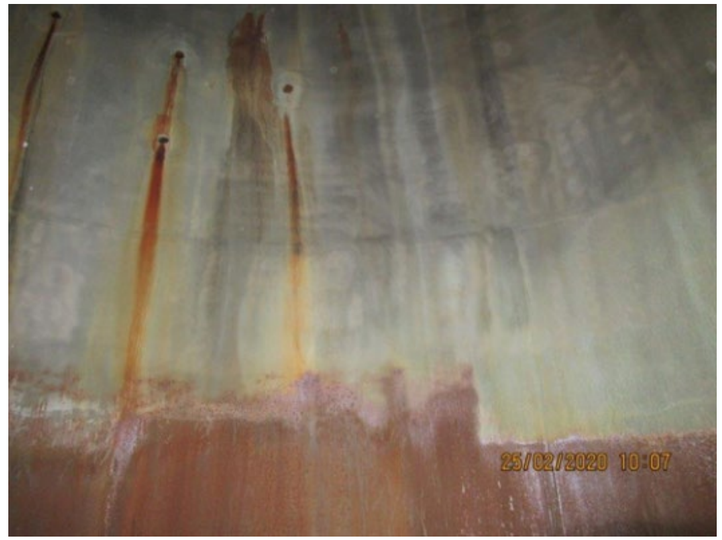
Inspection Results:
IGS HVTS cladding is in excellent condition.

- **No repairs required.**





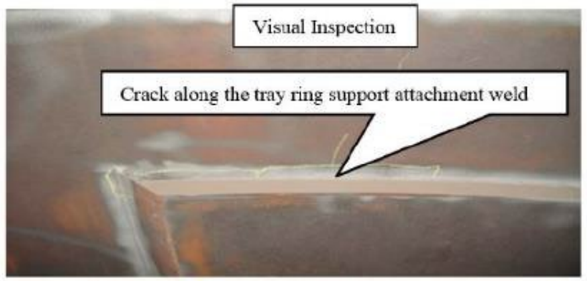


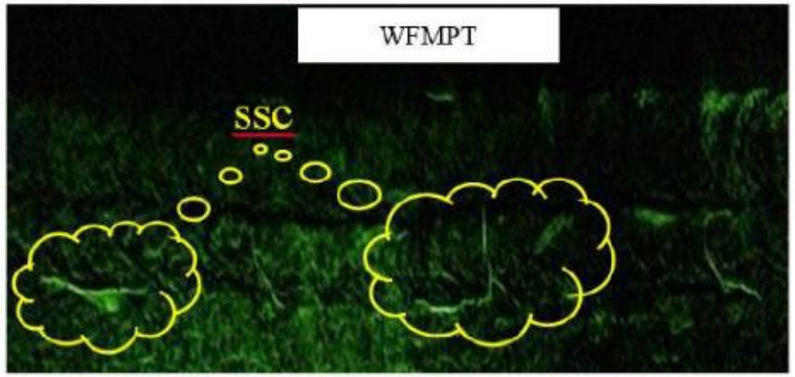


AMINE AND SOUR SERVICE CASE STUDIES:

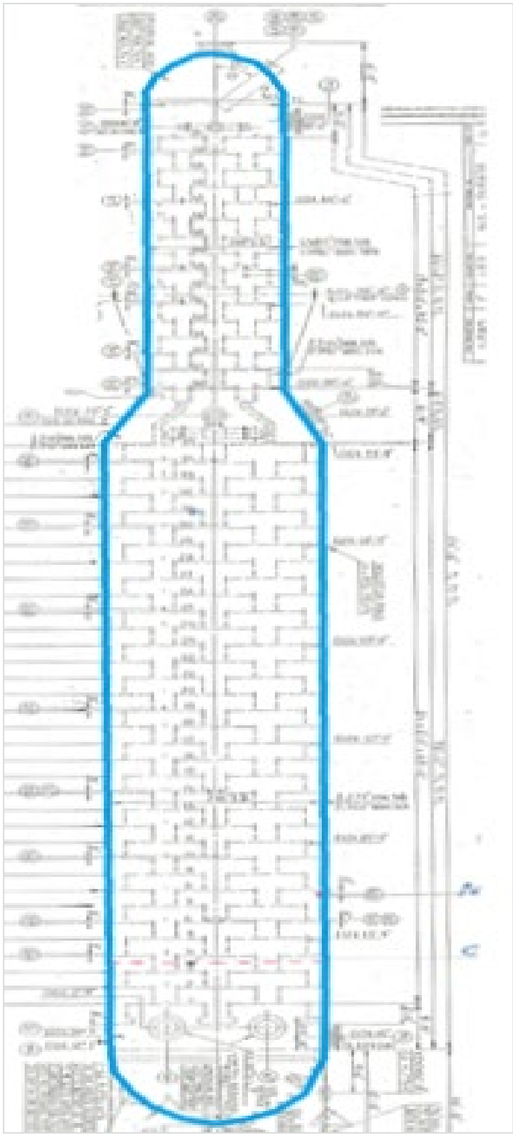
DE-ETHANIZER COLUMN SUFFERING FROM HIC

- De-Ethanizer column built in 1975 from non-HIC resistant material, suffering from Sulphide Stress Cracking (SSC).
- Internal H2S (sour) corrosion activity generating atomic Hydrogen which diffused into the metal substrate, leading to hydrogen embrittlement, blistering and stepwise cracking due to Hydrogen Induced Cracking (HIC).





Gas Plant
De-Ethanizer
Column

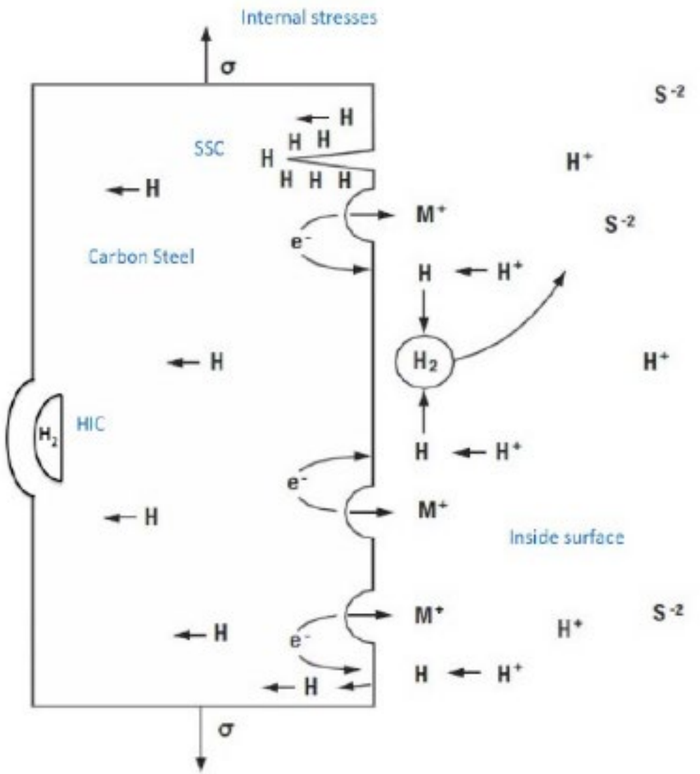


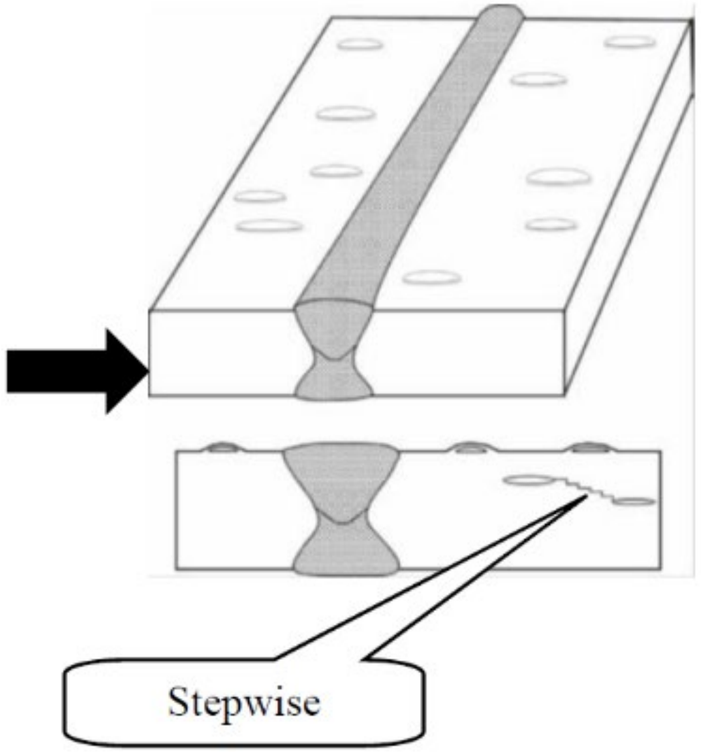
AMINE AND SOUR SERVICE CASE STUDIES:

DE-ETHANIZER COLUMN SUFFERING FROM HIC

The client ascertained that stress relieving to reduce the steel hardness levels was not viable and impractical, as this process could increase the size of existing hydrogen blisters and develop stepwise cracking between the blisters. In addition, this process would require the column to be removed and laid down horizontally to conduct stage wise stress relieving repairs.

The application of an internal Corrosion Resistant Alloy (CRA) cladding was selected, using IGS HVTS in preference to roll bonded cladding, strip lining or weld overlay.





Sulfide Stress Cracking (SSC) and Hydrogen Induced Cracking (HIC) Damage Mechanisms Due to Hydrogen Charging

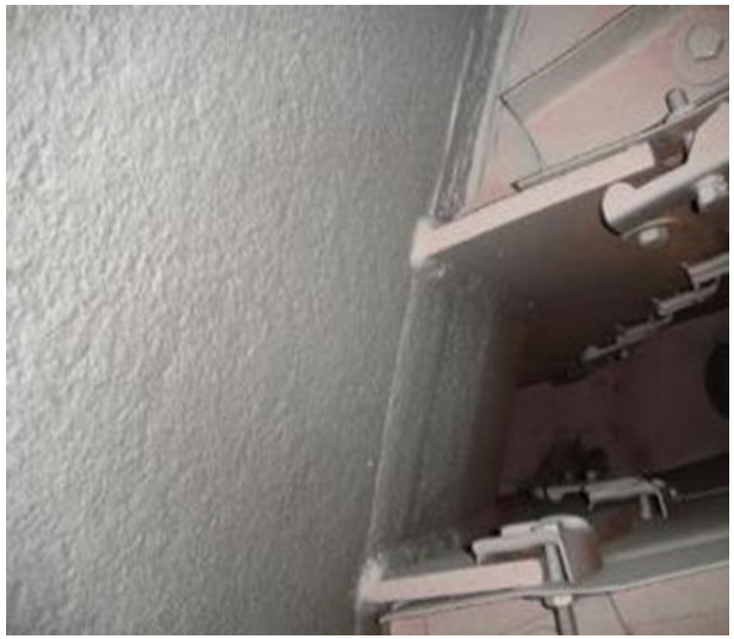
AMINE AND SOUR SERVICE CASE STUDIES:

DE-ETHANIZER COLUMN SUFFERING FROM HIC

Inspection identified the existing cracks with WFMPT, followed by grinding out cracks, engineering assessment of cracks >15mm, cleaning, preheating and welding with baked electrodes, with final WFPMT to ensure no new or remaining cracks were present.

Once this process was completed all pressure bearing surfaces and welds of the column were clad with IGS HVTS (an area of approx. 635 m^2), applied to protect the carbon steel surfaces and internal welds from sour corrosion and prevent further Hydrogen atom generation. The application was completed in **November 2013.**

Avoiding costly large column replacement due to SSC with an estimated **Life Cycle Cost Saving of >$8M**



NACE Corrosion 2015 Paper, No. 5952: Application of HVAS Cladding to mitigate Sulfide Stress Cracking and Hydrogen Induced Cracking in a De-ethanizer Column

AMINE AND SOUR SERVICE CASE STUDIES:

De-Ethanizer Column suffering from HIC, Internal Inspections: 2014, 2018, 2023

In **July 2014**, the column was taken out of service and cleaned with an approved hydro blasting procedure for a T&I. An inspection was conducted by a combined IGS and client technical team to determine the integrity of the applied HVTS cladding. No indications of SSC or corrosive coating delamination were observed. The vessel was returned to service with continued monitoring.

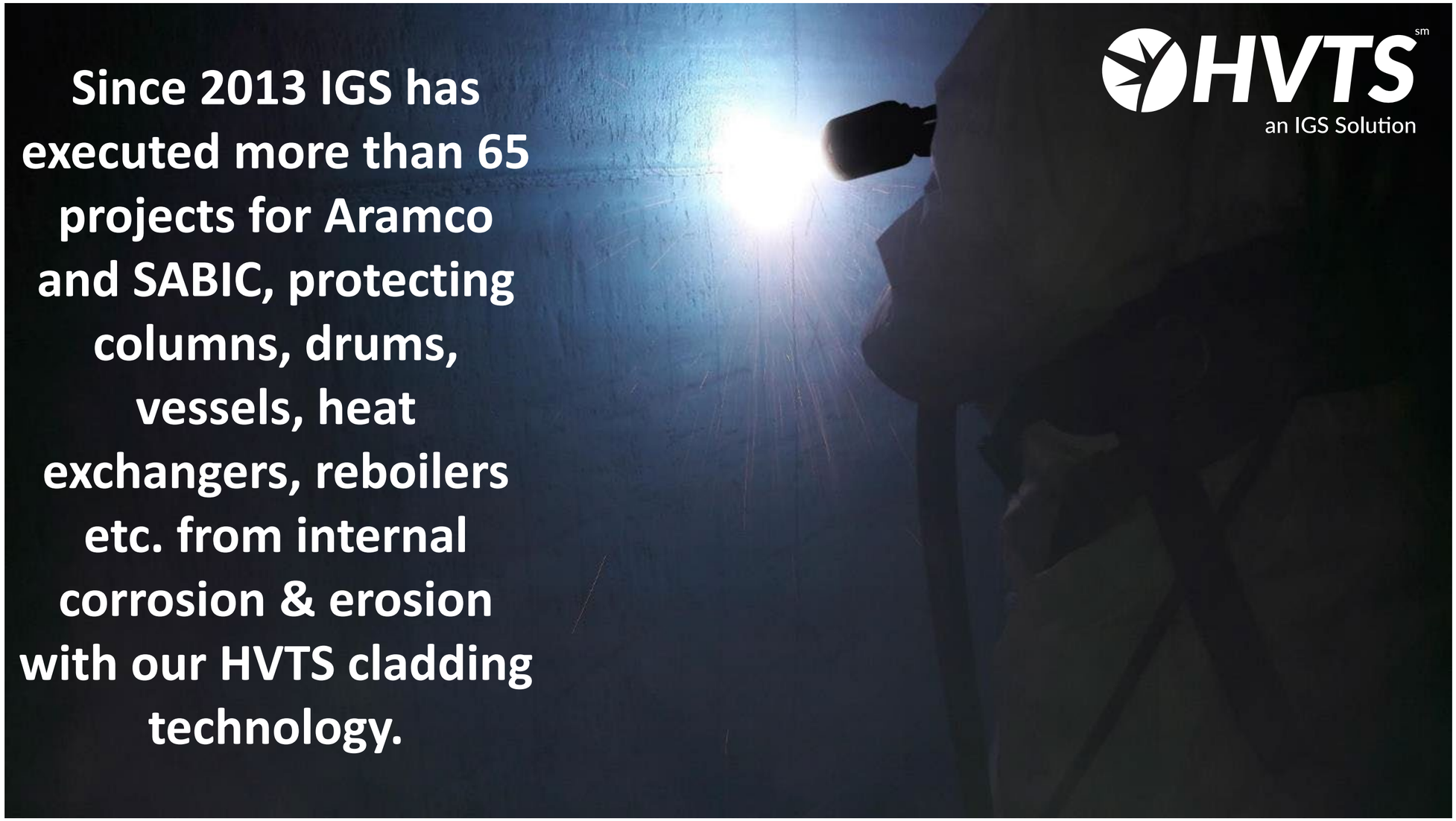
The column was shut down again at the beginning of **August 2018 and July 2023**, for maintenance and cladding inspection. The column was cleaned and inspected by IGS and client inspectors. No damage or hydrogen induced cracking was noted on the shell, welds or tray supports of the column.

The application of IGS 5420 HVTS cladding is clearly serving its purpose to prevent active corrosion, Sulphide Stress Cracking (SSC) and Hydrogen Induced Cracking (HIC) in the fillet welds of the tray supports. After approximately **10 years of operation**, the IGS HVTS cladding has not deteriorated in any shape or form.

Inspection images from August 2018.

Inspected again in July 2023.

AMINE AND SOUR SERVICE CASE STUDIES:



CONCLUSION:

IGS Field-Applied HVTS Cladding:

BUSINESS CHALLENGES ADDRESSED:

- Provides enhanced durability, chemical and temperature resistance when compared to organic coatings.
- Applied 3x faster than Weld Metal Overlay and does not require Post Weld Heat Treatment.
- Improves technical integrity and significantly extends the useful life of equipment.

BENEFITS:

- Shortens turnaround durations.
- Reduces life cycle cost of critical process equipment.
- Can be inspected online to verify integrity.
- Can be applied to upgrade existing equipment, e.g. to repurpose for new process conditions or for life extension projects

Life extension of existing assets by upgrading the internal metallurgy in-situ, repurposing equipment for new process environments, mitigating corrosion risks to asset integrity.

JUBCOR 2024

CONFERENCE & EXHIBITION

INNOVATIVE SOLUTIONS FOR CORROSION CHALLENGES

www.integratedglobal.com

THANK YOU

Reach out.

M: +966 55.401.1001

almuhannad.aljohani@integratedglobal.com