

LESSON LEARN FROM FAILURES: FAILURE OF MIXED FEED COIL IN PRIMARY REFORMER

Nov. 2015

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No. 1

RCA TEAM

SN.	Organization	Name	Job Title
1	ALBAYRONI	1. Hussain Al-Hajari 2. Sanjay Nehete 3. Hadi Al-Zerea 4. Lokesh Pandya 5. Saad Al-Qahtani 6. Nassir Abbas 7. Virendra Gupta 8. Ajmal Abdullah 9. Ahmed Al-Mulhim	1. Sr. Manager, ESD (Team Leader) 2. Manager, Inspection 3. Manager, Ammonia 4. Manager, Process 5. RCA Specialist 6. Inspection Engineer 7. Machinery Engineer 8. Instrument Engineer 9. Process Engineer
2	SAFCO	Akbar Ali	Inspection Engineer
3	SABIC MCE (Through Consultancy)	1. Khalid Rahil Sheltami 2. Mudayeq, Fahad M. 3. Schrijen, Harry	1. Section Head, Static Equipment 2. Sr Engineer inspection & NDT 3. Advisor Material & Welding
4	SABIC E&PM (Part Time)	1. Deepak Dhankani 2. Khan, Ejaz Ahmed	1. ABEOP Project Engineer 2. QA/QC Staff Engineer

No. 2

PROBLEM STATEMENT

Location : Ammonia Plant – Primary Reformer

Date : 21 October 2014

Description : At 04:30 AM on 21st October, 2014; Ammonia plant was shut down as the primary reformer furnace box lost the vacuum due to leakage in mix-feed coil of the hot leg convection section.

Ammonia and Urea plants were shutdown safely as per SOP. This resulted in 0.81 day downtime equivalent to production loss of 768 MT of Ammonia product and 1234 MT of Urea product.

No. 3

PRIMARY REFORMER

- Ammonia Plant was established in (1983). It was revamped in 2002 to produce 1300 MT/D of liquid ammonia
- Albayroni Energy Optimization Project (ABEOP) was executed and commissioned on June 30, 2013 to save energy by 15 % total complex consumption
- Mix feed coil was modified during ABEOP for recovering more heat from the flue gases



No. 4

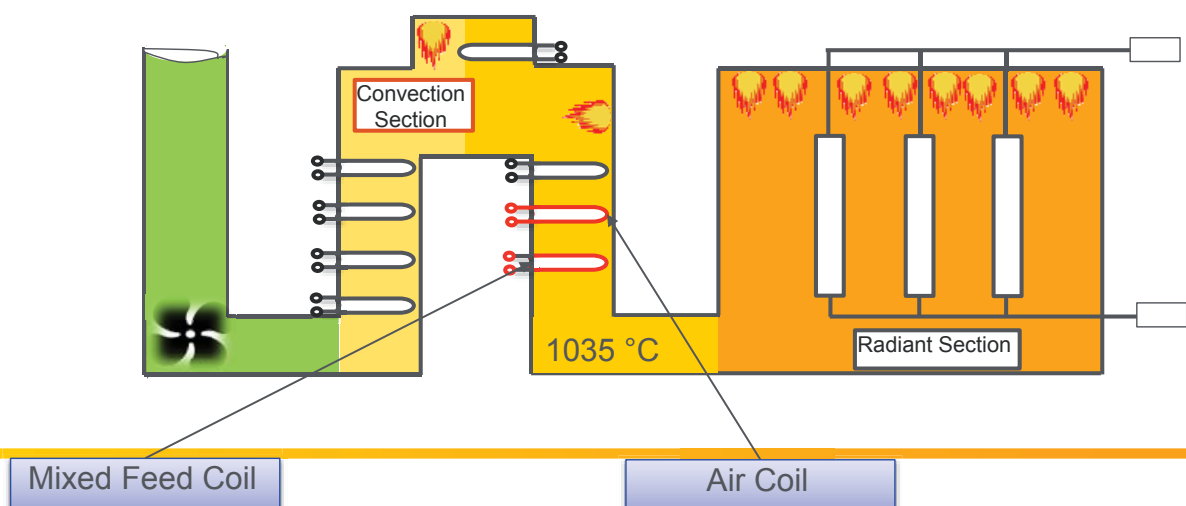
DATA GATHERED

- Process parameters and Report
- Engineering Documents
- Inspection & Test Plan and Records of ABEOP
- Site inspection records for failed coils
- Results of metallography for failed pieces by MCE Laboratory, Jubail

No. 5

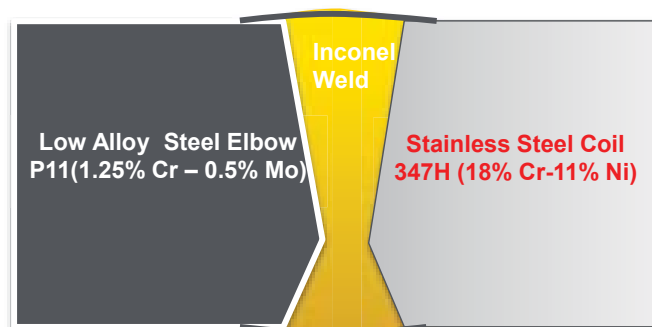
PRIMARY REFORMER PROCESS DESCRIPTION

- Primary Reformer Furnace is a conventional Top Fired Furnace having radiant and convection sections
- Radiant section houses the catalyst tubes for reforming of natural gas with steam over Nickel catalyst
- Convection Section has series of seven coils to recover the heat for process duties
- Induced Draft fan maintains the vacuum in the radiant section
- Forced draft fan provides combustion air to burners



No. 6

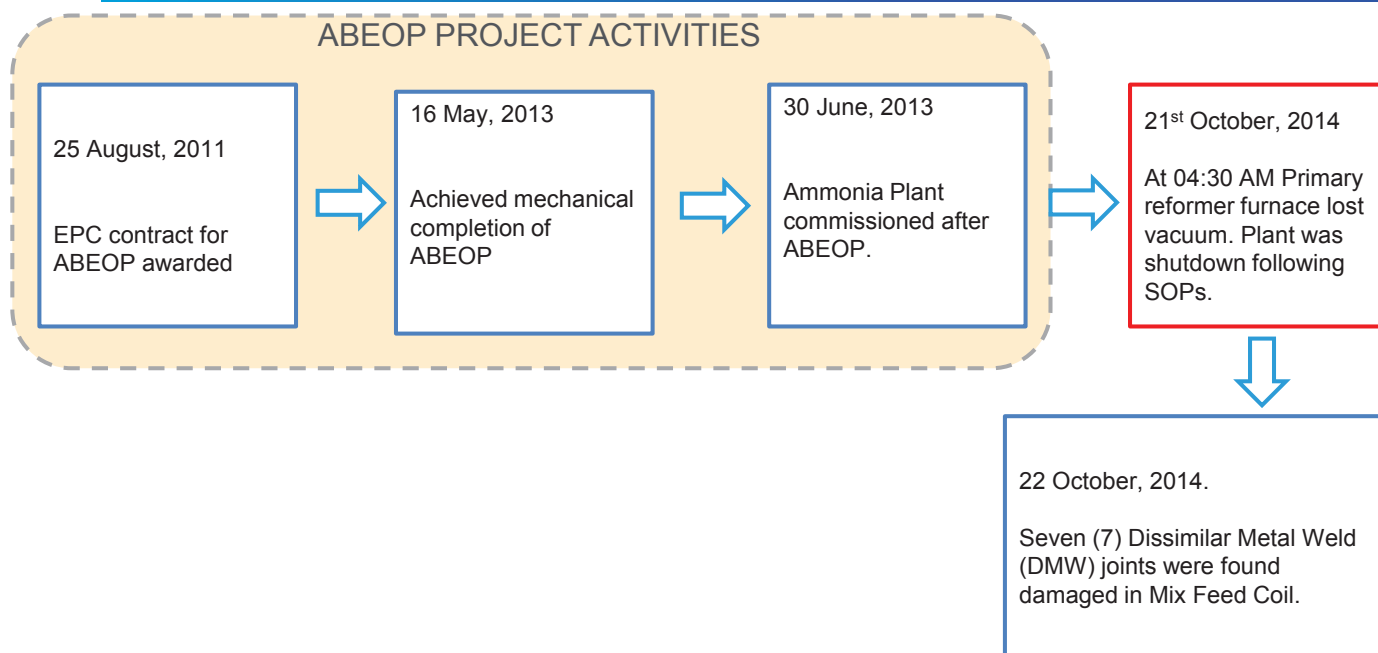
PICTURES OF FAILED JOINTS



Cracked Weld

No. 7

INCIDENT TIMELINE



No. 8

LOGIC TREE

- Total number of failure modes: 1
- Total Number of causes: 5
 - Latent causes: 2
 - Physical Cause: 1
 - Human Cause: 2
- Total Number of observations: 6



No. 9

ROOT / CONTRIBUTING CAUSES

ROOT CAUSES

- Inspection Procedure most probably not Followed (Manufacturing Defect not identified by liquid penetrant inspection and visual inspection and not reported)
- NDT technique (RT) not fully effective (ASME V & MCE) for this type of defect geometry (lack of side wall fusion)

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WHAT WENT WRONG?

- EPC contractor for ABEOP had awarded the supply of mixed feed coil to a sub-contractor including engineering. The sub-contractor awarded the mixed feed coil fabrication to one tubes Shop.
- Based on documents submitted by EPC contractor for ABEOP , it was observed that all weld defects (7 out of 28) were clustered in one area and all 28 joints were done by one welder.
- It was found from the documents supplied by EPC contractor for ABEOP , that welder's homologation was not meeting the regulatory requirements of ASME IX. Welder No. D3 submitted certificate WPQ-204.3 shows it was last done in 18/12/2006, six years before. This would have affected the continuous performance of welder.
- ALBAYRONI Inspection observed that some joints welding were not done as per WPS. This observation was also endorsed by MCE welding specialist.
- ALBAYRONI Inspection has also identified lapses during fabrication of the nozzles of mixed feed coil in spite of the "visual & dimensional examination report accepted by all parties with respect to the associated drawings for fabricated MFH Convection coils". EPC contractor for ABEOP has confirmed that the sub-contractor and its inspectors couldn't identify this mistake at shop.
- From the above findings and observations, it is evident that Quality Control by fabrication shop as well as the Quality Assurance by the Inspection Agencies in both EPC contractor for ABEOP and the respected sub-contractor was improper (even not complying with codes) and ineffective.



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RECOMMENDATIONS

Root/Contributing Cause(s)	Action Item	Responsibility	Target Date
Inspection Procedure not Followed (Manufacturing Defect not identified by Radiographic inspection and not reported)	Communicate with E&PM PMT on Inspection and Test Plan for mega projects to be reviewed for eliminating the recurrence of such deviations.	ESD	Feb 2015
NDT technique (RT) not fully effective (ASME V & MCE)	Raise ESTS to review the relevant SABIC Engineering Standards (SES)	ESD	Feb 2015

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KEY LEARNINGS

TECHNICAL

- Dissimilar Material Welding (DMW) joints have statistically more failure rates than normal welding joints and therefore:
 - It demands mandatory application of more stringent and additional QA/QC techniques e.g. liquid penetrant testing and hydro-test at prescribed pressure prior to putting into service
 - Application of DMW should be avoided at project stage by appropriate design substitutes like break flange

ADMINISTRATIVE or PROJECT MANAGEMENT

- For all DMW joints:
 - More stringent ITPM plan like essential witnessing and approval by owner (not to be substituted by third party)
 - Any waiver of the above technical and administrative requirements to be approved by senior management of E&PM and Affiliate
 - Revisit and revision of SES to accommodate the above technical and administrative lessons learnt for all new projects

No. 13

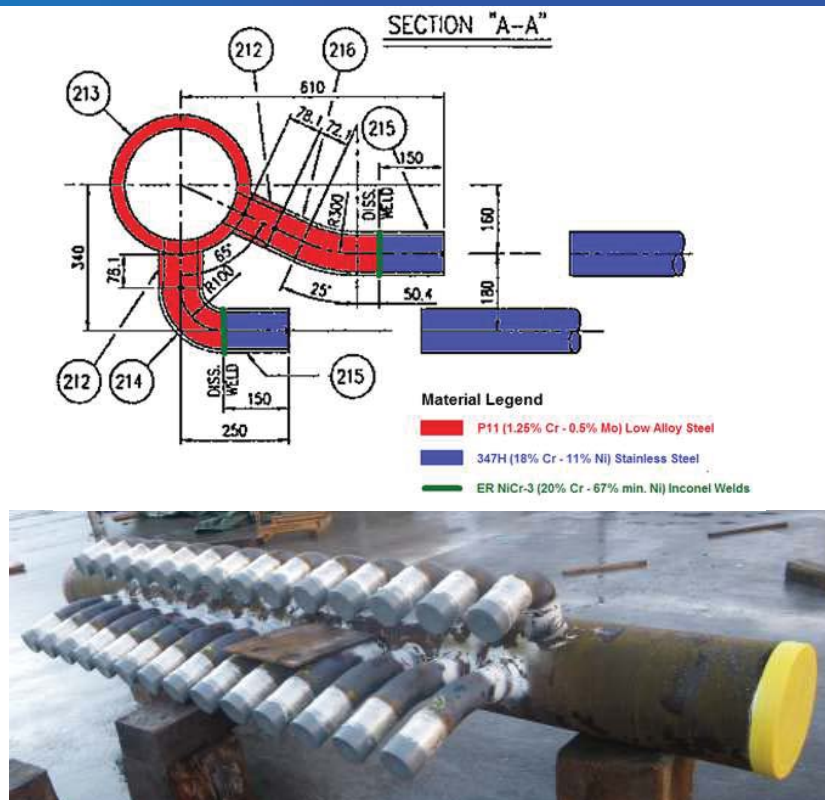
MIX FEED COIL HISTORY

#	Parameter	Unit	1983	Year 2002	Year 2008	Year 2013
1	Case Description		Original	Debottlenecking Project	Reliability Project	ABEOP
2	Rows x Coils/Row		4 x 10	2 x 10	2 x 14	2 x 28
3	Coil Material of Construction		A335 Gr22	A335 Gr22	A213 TP347H	A213 TP347H
4	Header Material of Construction (In/Out)		A106 GrB	A106 GrB	A335 P11	A335 P11
5	Operating Pressure	BarG	35.9	34.5	33.74	33.6
6	Operating Temperature (In/Out)	°C	349/510	424/511	391.9/459.7	341.3/495

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MIX FEED COIL TECHNICAL DETAILS

#	Parameter	Detail
1	Rows x Coils/Row	2 x 28
2	Coil Material of Construction	A213 TP347H
3	Header Material of Construction (In/Out)	A335 P11
4	Operating Pressure, BarG	33.6
5	Operating Temperature, °C (In/Out)	341.3/495



No. 15

FIELD INSPECTION FINDINGS

#	Major Findings
1	Total Seven (7) Dissimilar Metal Weld (DMW) joints were found damaged in Mix Feed Coil.
a	One DMW Joint (between P11 & 347H) on Mixed Feed Outlet Header side, found completely cracked & detached from WELD TOE at P11 side, in Visual Testing.
b	Cracks were revealed in Four DMW joints in other rows of the same coil, in Penetrant Testing.
c	One DMW joint was found cracked in the Radiography results.
d	Another DMW joint in same coil was found leaking during Hydro test when pressure reached to 8.0 BarG.
2	One DMW joint in Steam-Air coil was found having crack on Outlet Header side, during visual inspection.



Inspection
Report-08NOV2014

No. 16

THANKS
