RECONNECT SYMPOSIUM 2022

KNOWLEDGE • OPTIMIZATION • INNOVATION

Urea Reactor Replacement - SPIC's Experience

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SPIC @ Tuticorin, Tamil Nadu – Connectivity Hub

Vision

"To add value to the Agriculture by being an Ethical Partner"

SPIC – Company Profile

- SPIC, the flagship company of the AM International group
- One of India's first petrochemical companies with a focus on Fertilizers
- Company established in December 1969 in southern part of India
- Started the first production of Nitrogenous Fertilizer called UREA in the year 1975.
- Ammonia plant of 1100 MTPD was one of the largest Naphtha based single stream plants in Asia in 70's.
- Urea plant of 1600 MTPD was one of the largest single stream Plants of its kind in the world, when commissioned.

SPIC – Urea Reactor

Process	:	Mitsui Toatsu Total Recycle Improved "C" Process
Engineering	:	TOYO Engg., Japan
Name Plate Capacity	:	1600 MT/Day
Re-Assessed Capacity	:	1880 MT/Day
Current Capability	:	2100 MT/Day

Specific Consumption – Per MT of Urea

Ammonia	: 577 Kg
CO2	: 770 Kg
Steam	: 850 Kg
Power	: 115 KWHr

SPIC – Urea Reactor - History

- First reactor was erected & commissioned during the year 1975
  - KOBE steel make
  - Served for 18 years
  - 1975 to 1993
  - It was repaired twice at CS Pad & Bottom pad plate, Ammonia injection nozzle pad plate, Ammonium carbamate nozzle pad plate
  - Replaced in April 1993 due to ageing
- Second reactor was erected & commissioned during the year 1993
  - KOBE steel make
  - Served for 23 + 3 (unproductive years)
  - 1993 to 2019
  - Improved design with increase in height from 28600 mm to 29600 mm
  - Leak noticed in the Reactor during every year from 2017 especially in 6th segment and repaired with in-house expertise
  - Decided to replace with new Reactor due to unplanned shutdown
- Need for New Reactor (3rd)
  - Frequent Leaks in Old Reactor
  - Improvement towards New Technology
  - Capacity Augmentation & Energy Conservation
  - Reliability Improvement

Old Reactor during Leak

SPIC – Urea Reactor – Technical Bid Analysis

S.No	Description	Units	Reactor in Service	New Reactor - Offer	
			KOBE Make	KOBE Steel	Stamicarbon
1	Inside Diameter	mm	2200	2200	2200
2	Distance between head tangent line	mm	29900	29900	29900
3	Top head Thickness	mm	125	118	76
4	Bottom Head Thickness	mm	125	118	76
5	Shell Thickness	mm	153	119.6	120
6	Lining Thickness (From Bottom)	mm	0 to 10 m - 5 mm Balance - 3 mmm	Double lining (Ti) Inner shell - 16 + 4 mm clad liner - 5mm (min.)	5
7	Design Code	-	HP Gas Control Law, Japan	ASME VIII Div 2, 2010 and 2011 Addendam without code stamp	AD 2000
8	Design Pressure	Kg/cm2	260	260	260
9	Design Temperature	Deg C	210	210	210
10	Hydrostatic Test Pressure	Kg/cm2	390	As per code	As per code
11	Pneumatic Test Pressure	Kg/cm2	260	Not Applicable	Not Applicable

SPIC – Urea Reactor – Technical Bid Analysis

S.No	Description	Existing Reactor	KOBE Steel	Stamicarbon
12	**Shells**	SA 724 Gr.A	Inner shell - SA516-70 with SB265-1 clad 7 Layers - SA724-B Outer layer - SA516-70	Safurex Lined with internal tray type reactor / Shell with MOC of SA 533 Cl2.
13	**Heads**	SA 516 Gr.70	SA 516 Gr.70 + SA 516 Gr.70 with SB265 Gr1 clad liner	
14	**Lining**	TP 35 for Shell & TP 28 + SB 410 for Dish	SB 265 Gr.2	
15	**Support**	SS 400	SA 516 Gr.70 / JIS SS400-P	
16	**Bolts**	SA 193 Gr B7	SA 193 Gr B7	
17	**Nuts**	SA 194 Gr 2H	SA 194 Gr 2H	
18	**Externals**	SS 400	CS	
19	**Internals**	-		
20	**Gasket for Manhole**	Ti Gasket	Titanium for Delta Gasket	Special gaskets supplied by STAMICARBON
21	**Nozzle Gasket**	Ti Gasket	Ti Gasket	
22	**Nozzle Bend**	SA 182 F316	SA 182 F316	
23	**Nozzle Flange**	SA 266 Cl2		
24	**Weight (MT)**	325	297	240

SPIC – New Urea Reactor – Selection Criteria

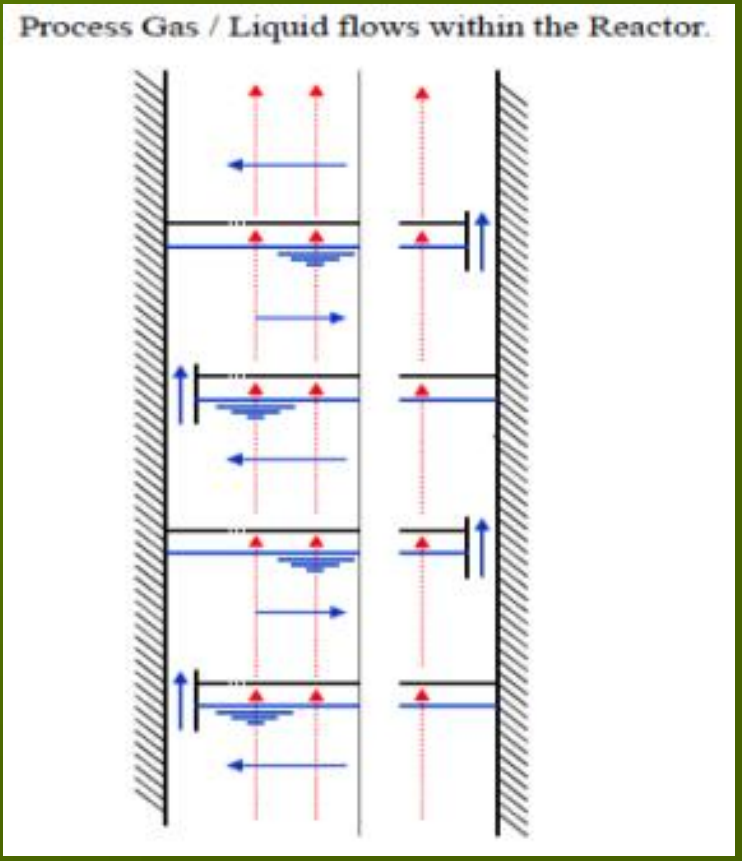
S.No.	Description	M/s.KOBE Steel, Japan	M/s.STAMICARBON, Netherlands
1	Vendor Credential	Existing Reactor Supplier	New vendor for SPIC
2	Technology	Proven Technology & being used in several companies	Proven Technology / Recently converted reactors in India are working well
3	Material of Construction	Proven Material of Construction	Superior Material of Construction
4	Performance	No difference in performance improvement	4% conversion efficiency expected
5	Expected Life	20 Years	20 Years
6	Price Details	L1	L2

New Urea Reactor – Technological Advantages`

1. Ease of installation due to less weight
2. -High Efficiency trays & Inlet mixer
   -Limited Maintenance Requirements
3. Additional temperature indications for better supervision
4. Superior MOC of **Safurex®** which has high corrosion resistance towards Ammonium Carbamates.

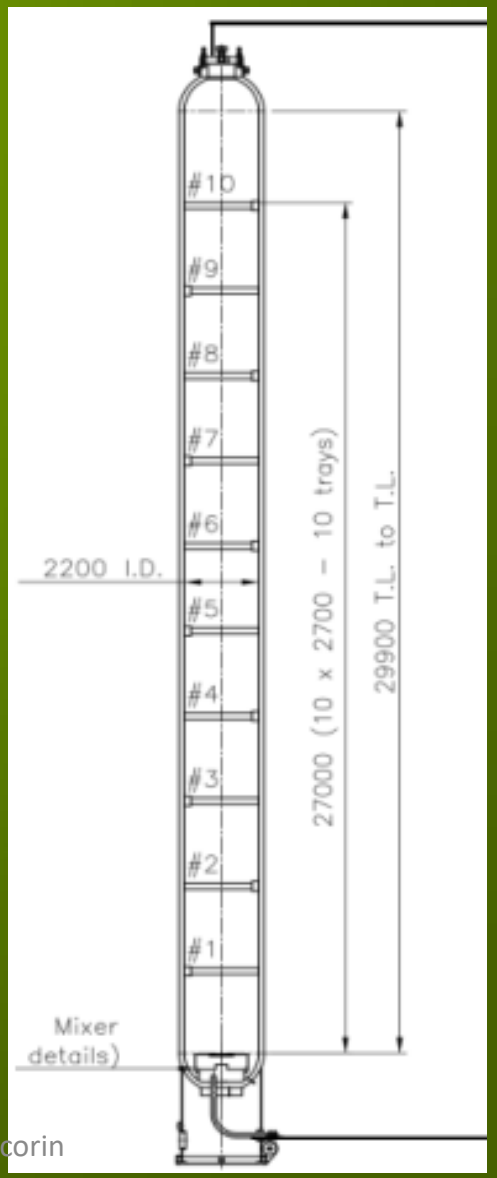
New Urea Reactor – High Efficiency Trays

- For slow rate of urea equilibrium reaction, plug flow reaction is preferred
- Increase in conversion and maximum approach to equilibrium
- Plug flow is approached by installing series of CSTR's in series, i.e. by installing trays

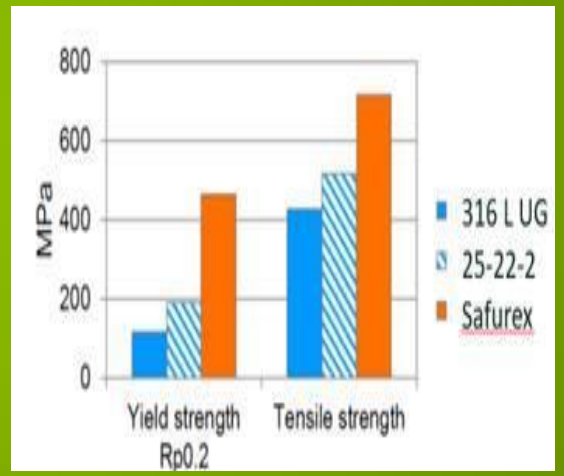


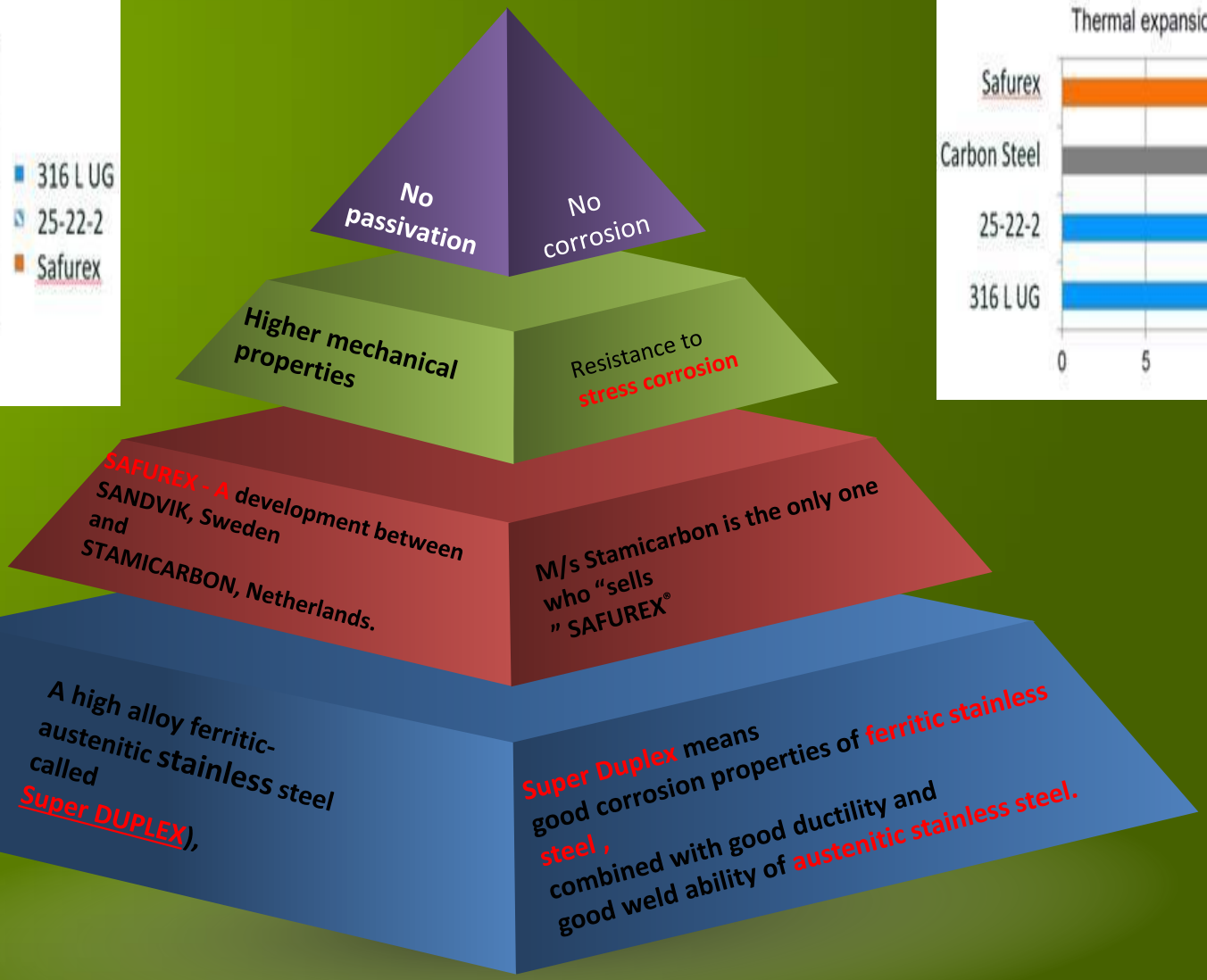
New UREA Reactor – High Efficient Trays

- 10 Trays – Equally spaced – 6 mm hole
- Equally displaced at a height of 2700 mm
- Removable type trays
- Manhole to access for Inspection during S/D
- Variation in no. of holes to increase efficiency



New UREA Reactor – Material Of Construction

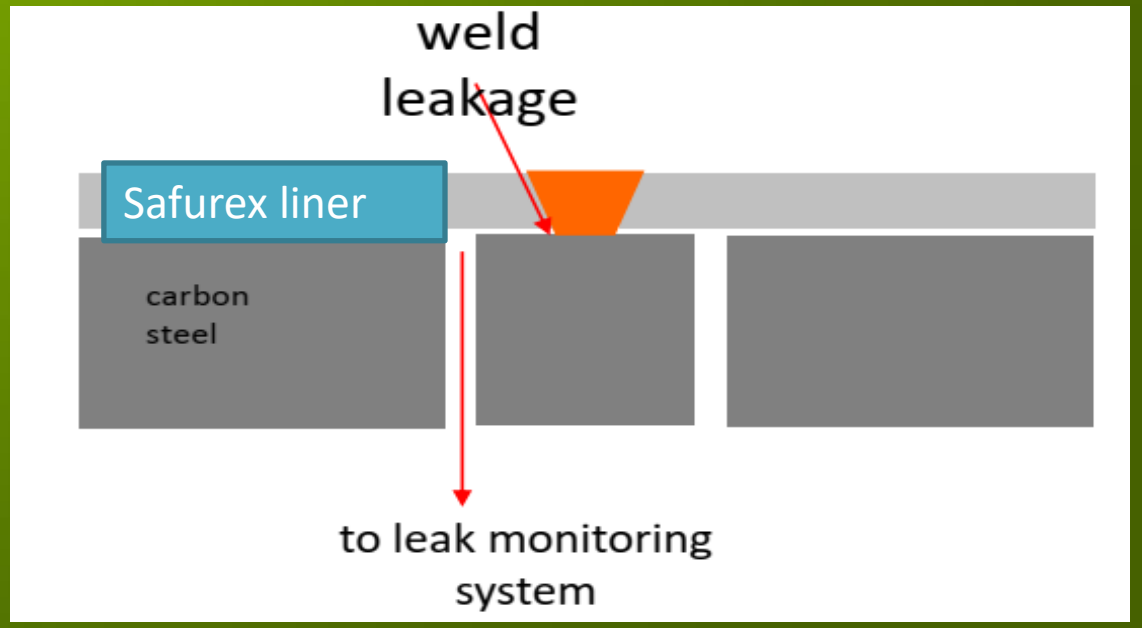




New Urea Reactor – Leak Detection System

- At synthesis conditions, Ammonium Carbamate is very corrosive
- HP Equipment made of Carbon Steel
- Inside of Equipment, Liner provided which will be in contact with high corrosive Ammonium Carbamate
- In case of leak, Carbon steel will corrode rapidly (> 1000 mm per year !)
- If HP Equipment weakens, Personnel in Plant and Environment in serious danger (“SAFETY”)

Hence, Early & Reliable Detection is a must



New Urea Reactor – Receipt

Urea – Old Reactor - Removal

Urea – New Reactor – Lifting from saddle supports

Urea – New Reactor - Erection

Urea – New Reactor – Hydro test - Observations

- Urea reactor hydro test was witnessed at 250ksc and found satisfactory.
- Strain measurement was carried out with dial gauge placed at bottom of the nozzle block and observed 33 divisions at 250ksc.
- All weep holes checked
- 2nd row East (1st course),4th row south (2nd course) & 27th row west(14 course) weep holes. (rows & course counted from top).
- Air flushing done and no leak observed further.

Urea – New Reactor – Commissioning / Startup

- After successful erection of New Urea Reactor, plant start up activities were initiated on 2nd November, 2019

- Startup sequence
  - CO2 booster compressor reset : 02nd Nov 2019 : 19:15 Hrs
  - Ammonia Injection to Reactor : 02nd Nov 2019 : 23:05 Hrs
  - CO2 injection to Reactor : 02nd Nov 2019 : 23:30 Hrs
  - Resumption of Urea Prilling : 03rd Nov 2019 : 10:30 Hrs

Urea – Process Benefits

- Urea concentration in reactor outlet increased from 32.4 % to about 33.5 % (Wt %). (approx. 1%)
- Increase of plant load from 2080 → 2180 MTPD, carbamate recycle reduced from 82 → 72 m^3/hr
- Reduction in steam consumption of 1.70 Mt/Hr (approx. 4%) was observed due to less decomposition load in downstream of reactor
- Net energy savings by about 0.014 Gcal/MT of Urea
- Reduction passivation air flow from 80 → 50 nm^3/h

Urea – Process Parameters

Urea - Plant Performance - With Old & New Reactor				
Description	Units	Old Reactor	New Stamicarbon reactor	
			Immediately after commissioning	After 2 years of service
		Jul-19	Oct-19	Jan-22
Plant Load	**%**	**110**	**110**	**110**
HP steam flow to UREA plant	MT/Hr	77.40	77.00	69.40
HP steam pressure	Kg/cm2(g)	43.20	43.42	43.84
CO2 Flow to reactor	Nm3/Hr	33600.00	34600.00	34140.00
Carbamate flow reactor	MT/Hr	87.00	74.50	82.00
Ammonia flow to reactor	MT/Hr	94.90	94.90	93.00
Reactor bottom temperature	Deg C	183.10	182.30	183.20
Reactor middle temperature	Deg C		194.10	195.70
Reactor top temperature	Deg C	199.80	199.20	199.40
CO2 to reactor temperature	Deg C	116.80	117.10	117.10
Reactor pressure	Kg/cm2(g)	223.10	223.40	223.20
Carbamate pump speed	rpm	6550.00	6355.00	6472.00
HD pressure	Kg/cm2(g)	15.51	15.44	15.47
LD pressure	Kg/cm2(g)	2.56	2.42	2.47
HA top temperature	Deg C	45.00	46.20	45.00
HA middle temperature	Deg C	58.00	57.30	58.30
HA bottom temperature	Deg C	89.10	74.00	74.60
HAC bottom temperature	Deg C	107.80	104.90	106.90
LA bottom temperature	Deg C	50.20	49.20	48.6

Conclusion & Remarks

- **With this urea reactor replacement project, Stamicarbon demonstrated to SPIC**
  - Added value of an experienced partner for projects in TOYO (Non-Stamicarbon) urea plants
  - Significant process benefits and increase of plant performance by installing Safurex® HE trays
  - Operational benefits by installing a complete Safurex® urea reactor

- **Achieved process benefits for SPIC**
  - Higher urea conversion
  - Less carbamate recycle
  - Lower HP steam consumption (=significant energy-/cost saving)
  - Higher plant output

- **Mechanical benefits for SPIC by changing to Safurex® materials**
  - Higher strength and more repair friendly compared to Titanium
  - Lower costs
  - No risk for active corrosion
  - Lower O_2 content in the process
  - Proven track record of Safurex® urea equipment >23years & >250 equipment worldwide

Thank You