STAMICARBON SAFUREX® EQUIPMENT

Full Life Cycle Support Philosophy

Dipl. Ing. Roel Trijnes
Mechanical engineer - Aftersales

October 28th 2019, Muscat
1. Introduction
2. History of Safurex
3. Why Safurex was developed
4. New Safurex developments
5. Stamicarbon value in replacement projects
6. Case study: Safurex HP stripper project
7. Conclusion
ABOUT US: INTRODUCTION

• Market leader in the **licensing and design of urea plants** and related **full life-cycle services**, including the supply of **proprietary equipment**.

• Active in **various fertilizer technologies** in collaboration with **reputable partners and EPC contractors**.

• A **pioneering company** with a vision to help enable the world to feed itself and improve quality of life.
WORLD FERTILIZER TECHNOLOGY LEADER

Awarded Capacities Stamicarbon (2010-2019 YTD)

Stamicarbon maintained its global leading technology position including 4 grassroot project awards last 24 months.

Source: Stamicarbon BI 2019

The innovation & license company of Maire Tecnimont

MENA: Urea Melt Market Share 2000-2019 YTD

MENA: Urea Granulation Market Share 2000-2019 YTD

- Based on project contract award
- Excluding Chinese copy technology
OUR FOCUS: FULL LIFECYCLE SUPPORT

Creating your plant
Optimizing your plant
Upgrading your plant

Equipment Replacement
Equipment Redesign
Retining
Emission Reductions
Mechanical Services
Lifetime Assessment
Plant Staff Training
Troubleshooting
Process Optimization Tools
Plant Inspections
Additives

The innovation & license company
of Maire Tecnimont
MATERIAL DEVELOPMENT FOR UREA APPLICATIONS

1920
First industrial urea production plants

1956
DSM | Mr. van Waes
Creating an oxidizing environment (air dosing)

1970
Stamicarbon/Sandvik
25-22-2 (Cr-Ni-Mo) material of construction

1995
Stamicarbon/Sandvik
Safurex® a high alloy ferritic-austenite stainless (“duplex”) steel

- Huge corrosion problems
- Enabling to use austenitic stainless steels possible as material of construction
- Optimized fully austenitic stainless steel, optimized for urea service.
- Excellent stress corrosion properties, ductility and weldability
WHY SAFUREX WAS DEVELOPED?

TYPICAL CORROSION IN AUSTENITIC STAINLESS STEELS (25.22.2 / 2RE69)

1 = Crevice corrosion
2 = Stress Corrosion
3 = Condensation Corrosion
4 = Strain Induced Cracking
5 = Stern Face Corrosion

Safurex® was developed to eliminate the above corrosion issues
ELIMINATING CORROSION ISSUES USING SAFUREX®

Corrosion Issues Observed with SS316L UG & 25.22.2

- Chloride Stress Corrosion Cracking
- Condensation Corrosion
- Cross Cut End Attack
- Strain Induced Intergranular Corrosion
- Active Corrosion
- Crevice Corrosion Under Deposit Corrosion

Safurex® (BE.06)

Safurex® STAR development
CORROSION TEST OF BC.01 (316L UG), BC.05 (25.22.2 / 2RE69) AND SAFUREX® INFINITY

TEST CONDITIONS:
Temperature : 183°C
Time : 75 days
Condition : oxygen free (no passivation)

BE.06 SAFUREX® INFINITY
BC.05 / 2RE69 (= 25.22.2)
BC.01 (= 316L UG)

Corrosion <0.05mm/yr
Corrosion >30.0mm/yr
gone

Safurex® shows excellent conditions compared to the severe affected 25.22.2 (2RE69) and SS316L UG
• Passive corrosion: (excluding stripper hex tubes)
  • $0.10 \text{ mm/y} < \text{SS316L UG} < 0.20 \text{ mm/y}$
  • $0.05 \text{ mm/y} < 25.22.2 < 0.09 \text{ mm/y}$
  • Safurex® Infinity < 0.01 mm/y

• Heat exchanger HP strippers:
  • Passive corrosion Safurex® Infinity comparable to 25.22.2
  • However: never experienced active corrosion also not in flooding conditions
  • Passive corrosion Safurex® Star up to 20% improved corrosion rate compared to Safurex® Infinity

**Safurex® STAR has proven superior results**
### RECENT INNOVATIONS: WITHIN SHORT TIME PERIOD, SOLID TRACK RECORD OF NEW INTRODUCED (HIGH POTENTIAL)- SAFUREX MATERIALS

#### 1998

**INTRODUCTION SAFUREX ® INFINITY**
- Standard super duplex steel
- Proven track record: >20 years in synthesis section
- Value: Reliability, safety

#### 2016

**INTRODUCTION SAFUREX ® DEGREE**
- New production process for super duplex material via the Hot Isostatic Pressing method
- Value: Handle min design metal temp of -35°C improving corrosion resistance

#### 2017

**INTRODUCTION SAFUREX ® STAR**
- Special super duplex steel
- Application in the most demanding equipment such as the HP stripper in the CO2 and thermal stripping
- Process suitable for competitive strippers
- Value: Extreme corrosion resistance

#### Under Development: SAFUREX® Next Generation

- Upgrade: Stripper / heat exchanger tubes

---

**HP EQUIPMENT**
- OPR: 90 Plants
- UCT: 9 Plants

**Liquid Dividers**
- OPR: > 10 Plants
- UCT: 2 Plants

**HP EQUIPMENT**
- OPR: 2 Plants
- UCT: 4 Plants
### SAFUREX® MATERIAL PROPERTIES

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>YIELD $R_{p0.2}$ Mpa</th>
<th>TENSILE $R_m$ Mpa</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20°C/225°C</td>
<td>20°C/225°C</td>
</tr>
<tr>
<td>C-steel</td>
<td>248/202</td>
<td>482/482</td>
</tr>
<tr>
<td>BC.01 (316L UG)</td>
<td>190/135</td>
<td>490/412</td>
</tr>
<tr>
<td>BC.05 (25.22.2)</td>
<td>270/195</td>
<td>580/495</td>
</tr>
<tr>
<td>SAFUREX® INFINITY</td>
<td>650/465</td>
<td>800/717</td>
</tr>
<tr>
<td>SAFUREX® STAR</td>
<td>680/510 (250°C)</td>
<td>830</td>
</tr>
</tbody>
</table>

*Excellent properties of Safurex®*
Our Safurex® products
- HP equipment
- HP Valves
- HP Piping
- Internals of HP equipment

Our Customers
- New urea plant
- Existing urea plant

Large variety of Safurex® applications
APPLICATION OF SAFUREX FAMILY

Safurex ∞ INFINITY
• can be used everywhere

Safurex * STAR
• for Hex tubes in the stripper

Safurex ° DEGREE
• powder metallurgy by Hot Isostatic Pressing (HIP process)

• liquid dividers, radar cones, replace large forgings
# WHY STAMICARBON SAFUREX®

## MECHANICAL BENEFITS
- Physically strong material
- Reduced weight
- Same thermal expansion as CS
- Most proven welding procedures
- No active corrosion seen so far

## OPERATIONAL FLEXIBILITY
- O2 content not critical
- Plant turndown not critical
- Chloride content not critical
- Change in N/C ratio not critical
- Block-in period not critical

## ECONOMICAL BENEFIT
- Reduced emissions
- Reduced OPEX
- Increased equipment lifetime
- Maintenance interval 6 year
- Higher reliability

---

**SAFUREX**

*More than 150 Safurex® HP vessels in operation*

*Over 20 years of Safurex® operational experience*
STAMICARBON VALUE

The value of Stamicarbon in the HP equipment supply

- PROCESS & MECHANICAL design based on more than 70 years of Stamicarbon Urea experience
- *More than 100 Urea revamp projects successfully completed*
- Full Stamicarbon expediting and inspections during manufacturing to secure high quality and reliability
- *Best (price-quality) corrosion resistant material: Safurex®*
- Most proven welding procedures and experience for Safurex® material
- *More than 20 years of proven records in Safurex® material with recent successful material upgrades*
- Single point responsibility with high skilled communication and project management
- *Cooperation agreement between Stamicarbon & Sandvik materials technology*
SINGLE POINT OF CONTACT

Stamicarbon project management

Design
- Process Evaluation
- Process improvement
- Equipment Design
- Equipment Enhancement

 Manufacture
- QA and QC
- Inspections

Logistics
- Delivery time
- Importing procedures
- Customer clearance

On-site service
- Start-up assistant
- Installation service
- Performance evaluation

We can take care of everything for you!
<table>
<thead>
<tr>
<th>Category</th>
<th>Client</th>
<th>Feedback</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPEX</td>
<td>Canada</td>
<td>Happy with latest test: low oxygen levels</td>
</tr>
<tr>
<td>Safurex Star</td>
<td>Netherlands</td>
<td>Appreciation of core benefits of Safurex: less weight, reduced passivation air in relation to revamp with stripper</td>
</tr>
<tr>
<td>Safurex Star</td>
<td>Netherlands</td>
<td>Extreme fast delivery of stripper and scrubbers</td>
</tr>
<tr>
<td>Safurex Degree</td>
<td>Germany</td>
<td>Proven concept in view test results leading to installment of Degree liquid dividers.</td>
</tr>
<tr>
<td>Safurex Spares</td>
<td>Other</td>
<td>HP piping and added value appreciated with a premium in SNAM plant.</td>
</tr>
<tr>
<td>Others</td>
<td>USA</td>
<td>Appreciation for 30 days block in period enabling easy restart without drain</td>
</tr>
<tr>
<td></td>
<td>FSU</td>
<td>Stripper proofed that active corrosion will not occur anymore</td>
</tr>
</tbody>
</table>
CASE STUDY: SAFUREX HP STRIPPER PROJECT

- Safurex STAR and DEGREE stripper
- Replacement Project in The Netherlands

..\HP equipment\STAMICARBON SHOWCASE - The first HP Stripper with SAFUREX Star and Degree - v6.mp4
KEY ADVANTAGES OF SAFUREX

1. Operational flexibility
   • Oxygen passivation not critical
   • Turndown ratio not critical
   • Blocking in period not critical

2. Reduced oxygen
   • Reduced steam consumption and emissions (OPEX)
   • Safety

2. Increase corrosion resistance leading to:
   • Extended equipment lifetime
   • Extend equipment inspection intervals
   • Reduction of maintenance & repair cost (OPEX)

4. Stamicarbon value in replacement projects
THANK YOU FOR YOUR ATTENTION!
FURTHER INFORMATION NEEDED?

Contact details:
Roel.Trijnes@stamicarbon.com
www.stamicarbon.com