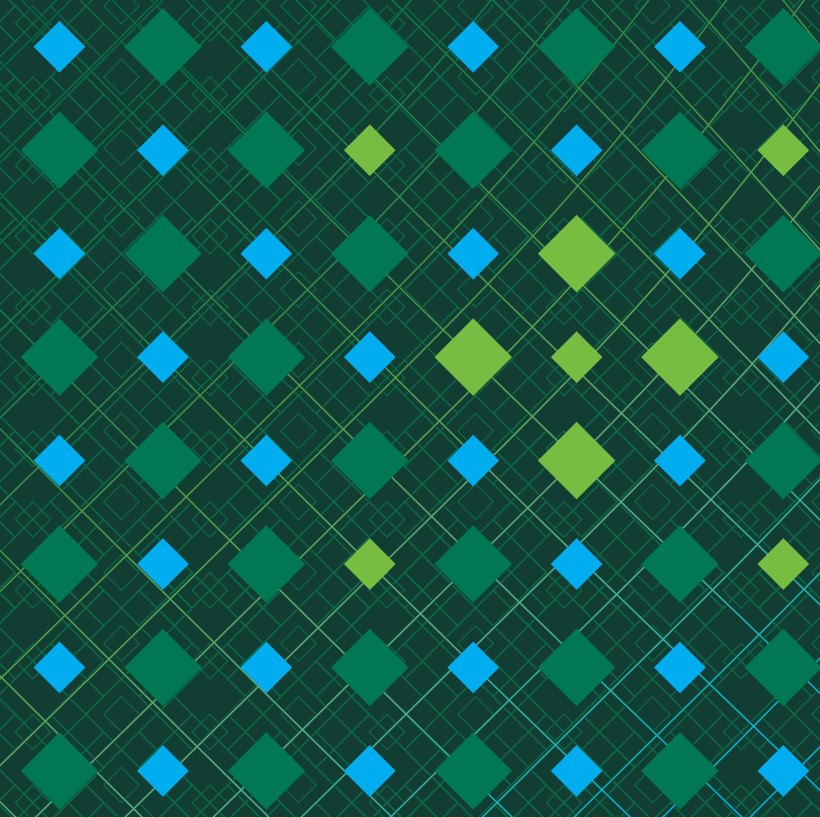


SAFUREX

Precision Resilience



Precision is the quality, condition and fact of being exact and accurate.

Resilience is the ability to withstand difficult conditions.

Precision and Resilience is the quality of being exact and accurate while being able to withstand difficult conditions.

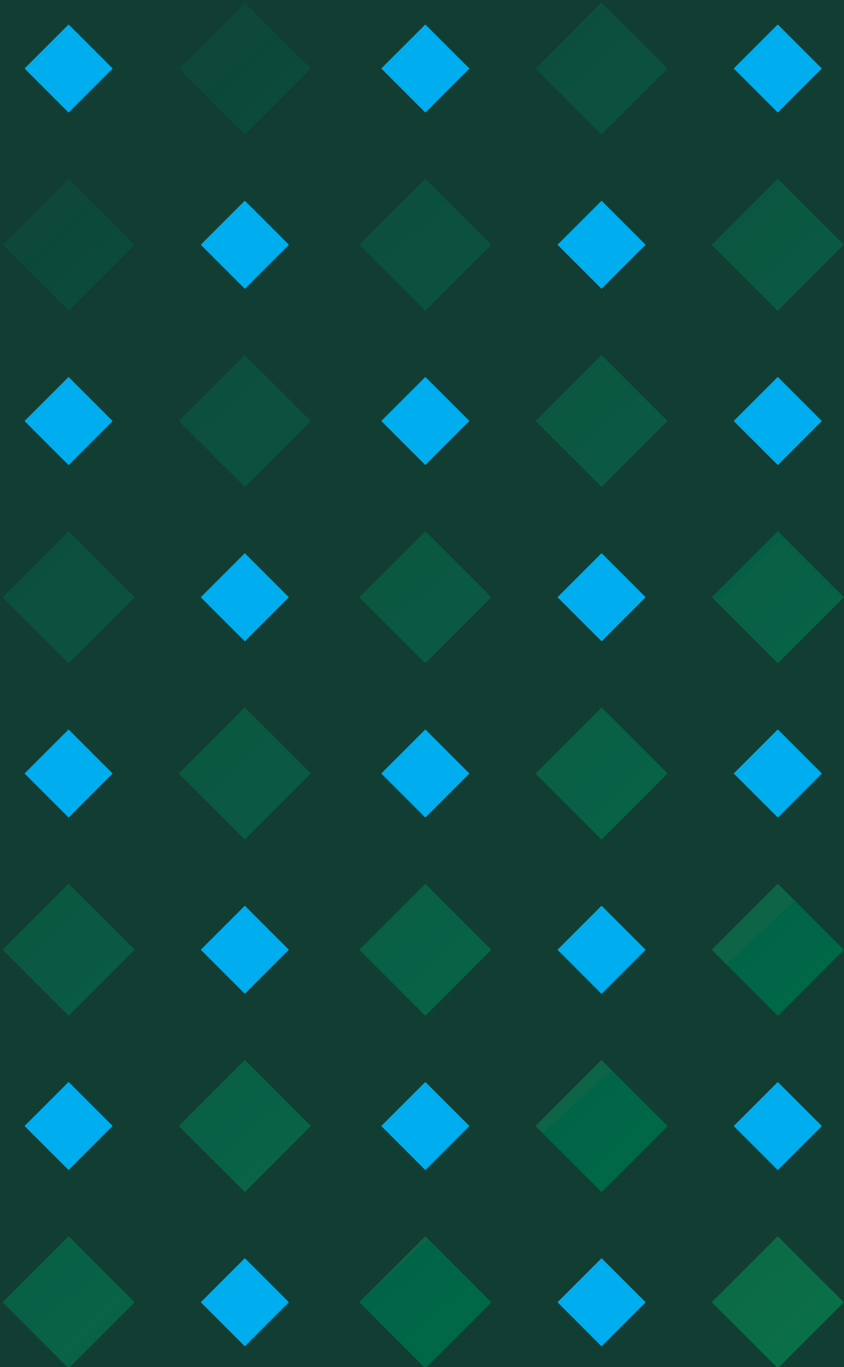
Safurex® is a family of solutions that have become the standard for enhancing urea production. Offering a continuous, controlled and exact solution in materials, products and services, Safurex® reflects the pioneering spirit of Stamicarbon.

Safurex® was initially developed by Stamicarbon in partnership with Alleima as a super duplex stainless steel that was resistant to corrosion. This initial use of Safurex® minimizes known forms of corrosion that occurs in a urea plant, thanks to its superior corrosion resistance, and improved processing. The result is that it outperforms any other viable stainless steel for high-pressure applications.

Since this initial use, the Safurex® brand has expanded into a family of long-lasting solutions, in not only materials but also products and services, which have optimized urea production in plants worldwide. Long-lasting solutions are essential when launching a plant, advancing its operations, or evolving a plant to the next level.

Safurex® offers plant operators peace-of-mind. With a solution to any challenge in a high-pressure synthesis section, the Safurex® family extends the lifetime of your plant, reduces maintenance, and enhances optimization.





In the Safurex® family continuous, controlled and exact solutions are offered in materials, products and services, together reflecting the pioneering spirit of Stamicarbon.

Our Safurex® materials have become the standard for urea plants using Stamicarbon technology and have outperformed any other viable stainless steel for high-pressure applications.

Our Safurex materials are a family of super duplex steels consisting of different material propositions. Each proposition is specially designed to deal with specific challenges for various applications in the high pressure synthesis section of a urea plant.

We at Stamicarbon have more than 20 years of experience with this material and have built over 400 pieces of equipment.

And even though almost 90% of all corrosion issues have been eliminated, we are continuously improving our technology.

With over 65 years of experience of designing urea plants, we at Stamicarbon understand the critical issues in the urea process and the severe conditions to which equipment is exposed. In our strive for continuous optimization, we realized that various applications and parts of the equipment are exposed to challenging conditions, each requiring different, but accurate material characteristics to ensure optimal performance. Therefore, we have extended our Material solutions to include:

Safurex® Infinity∞

This is the standard super duplex steel, used for almost 20 years in synthesis section of urea plants to meet all the expectations as a superior corrosion resistant material.

Safurex® Star*

This is a special super duplex steel designed for application in the most demanding equipment such as the HP Stripper in the CO₂ and thermal stripping process. It is designed especially for the heat exchanger tubes in the HP Stripper for all stripping processes.

Safurex® Degree°

This is a super duplex steel grade fabricated via the Hot Isostatic Pressing method (HIP). This results in an isotropic and fine grained microstructure, which enhances the mechanical properties at low temperatures (-35°C) and also improves corrosion resistance, especially with respect to cross cut end attack.

Safurex Materials benefits:

- . Independency of passivation air
 - . Improved mechanical properties
 - . Resistance to chloride stress corrosion cracking
 - . Excellent weldability
-

Safurex[®] PRODUCTS



In the Safurex® family continuous, controlled and exact solutions are offered in materials, products and services, together reflecting the pioneering spirit of Stamicarbon.

Our Safurex® products have become the standard components and equipment to ensure reliable operation with long lasting results.

We are highly experienced in the design and engineering of high-pressure equipment and piping systems for urea plants. The design and fabrication of the high-pressure synthesis section are essential for the successful operation of a urea plant. Replacing the equipment can be even more critical, given design constraints and the time-sensitive nature of projects.

We combine our design and engineering competence with in-depth knowledge of the fabrication process, all of which results in an extremely efficient delivery of high-quality reactors, heat exchangers, piping and valves. Flawless project execution - with a single point of contact - is guaranteed by our own specialized project management team, who co-operate closely with carefully selected equipment fabricators and materials suppliers.

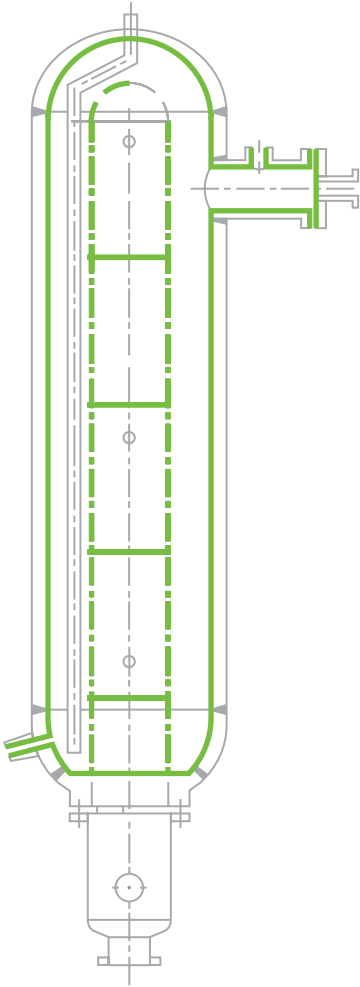
Our Safurex High Pressure Equipment are durable products that are integral to the success of optimal performance and maximum lifespan within urea production. Our designs include critical high-pressure equipment items, such as:

- . **Safurex®** Pool Condenser
- . **Safurex®** Pool Reactor
- . **Safurex®** Urea Reactor
- . **Safurex®** HP Stripper
- . **Safurex®** HP Liquid Dividers
- . **Safurex®** Scrubber
- . **Safurex®** Advance Monitor
- . **Safurex®** HP Ejector
- . **Safurex®** Control Valves
- . **Safurex®** Safety Valves

Safurex Products benefits:

- . Stamicarbon is the market leader in urea licensing and as a supplier of hardware at the same time, we combine process-design know-how with mechanical-design know-how.
 - . Project lead times are minimized by concurrent process & equipment engineering.
 - . With a single point of contact during the project you are allowed to continue to focus on your core business.
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Safurex® HP POOL CONDENSER

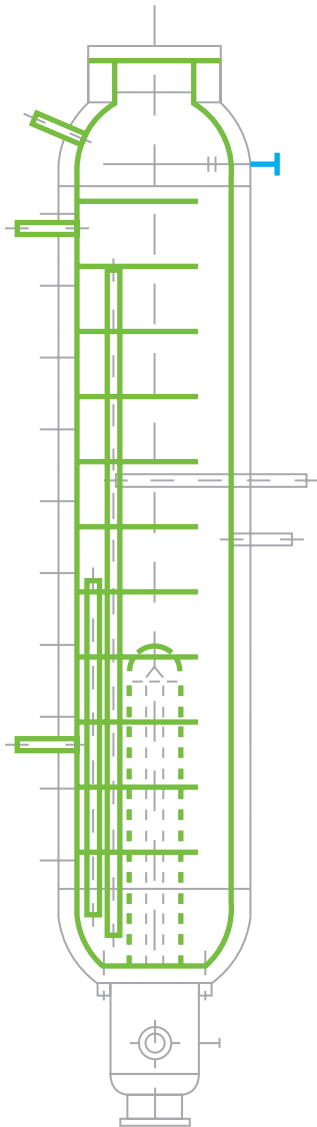


The Safurex® POOL CONDENSER is a submerged high pressure carbon steel vessel with a special alloy protection that has become the industry standard, replacing the falling film type HPCC. To generate the required optimal distribution of gas a special distributor was invented. The distributor including the process baffles and the flow deflector plates creates the most optimal crossflow distribution. The heat is transferred into LP steam by a special designed U-shaped bundle.

Safurex® POOL CONDENSER Process:

In the Pool Condenser the reaction from CO₂ and NH₃ into carbamate, as well as part of the reaction of carbamate into urea, takes place. Off-gas from the stripper is condensed on the shell-side of the Safurex® POOL CONDENSER where it is reacted with NH₃ from the NH₃ plant. The reaction into carbamate releases a large amount of heat which needs to be removed. This is done by passing low pressure steam condensate through tubes of the Safurex® POOL CONDENSER. This forms low-pressure steam that is used for process heating in downstream sections of the plant. The urea solution flows to the reactor where the reaction of carbamate into urea continues.

Safurex® HP POOL REACTOR



The Safurex® POOL REACTOR is a horizontally installed high-pressure carbon steel vessel with a special alloy protection. In this vessel, two important process steps are combined: the first step is the submerged condenser and the second step is the urea reactor. To generate the required optimal distribution of gas we invented a special distributor. This distributor, including the process baffles and the flow deflector plates, creates the most optimal crossflow distribution. The heat is transferred into LP steam by a special designed U-shaped bundle.

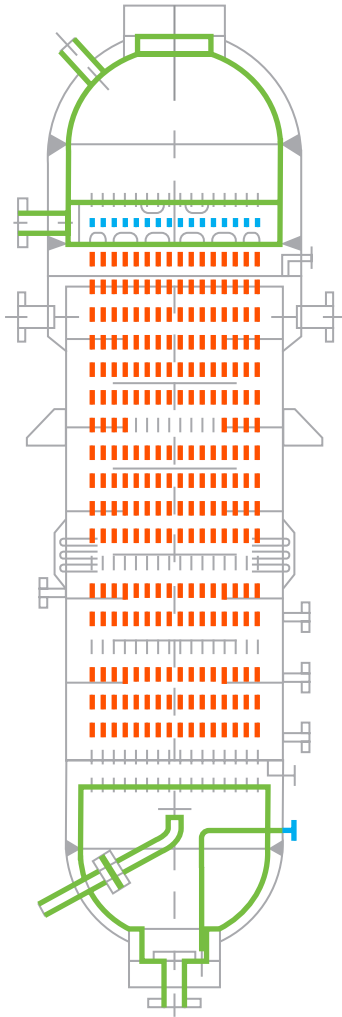
Safurex® POOL REACTOR Process:

In the Pool Reactor concept the functions of the condenser and reactor are carried out within a single horizontal vessel, providing a high residence time and optimum conditions for conversion of ammonium carbamate to urea and thus eliminating the need for a separate vertical reactor. The high-pressure scrubbing operation can also be simplified in the pool reactor design for plant capacities smaller than 2300 mtpd by placing the scrubber sphere above the Pool Reactor and adding the ammonia to the synthesis via this scrubber, thereby eliminating the need for a separate heat-exchanging section. Carbamate from the low-pressure recirculation section is fed into the pool reactor along with the absorbed gases and the ammonia feed through a sparger; no high-pressure ejector is needed. Even at smaller capacities the Pool Reactor design is advantageous from the point of view of capital investment.

● Safurex Infinity[∞]
INFINITY

● Safurex Degree[°]
DEGREE

Safurex® HP STRIPPER



The Safurex® HP STRIPPER is a high pressure carbon steel vessel with a special alloy protection. This stripper is a falling film heat exchanger where liquid is distributed by a liquid distributing system. The liquid divider is based on years of experience and design studies and will be customized according to your process condition.

Safurex® HP STRIPPER Process:

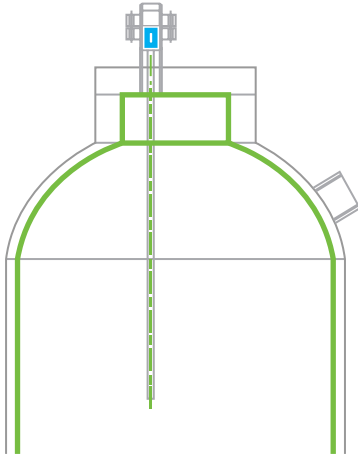
Urea solution from the reactor is sent to the Safurex® HP STRIPPER. Here the concentration of urea is increased by decomposing carbamate from the urea solution into NH_3 and CO_2 . This is done by contacting the urea solution, flowing through the tubes of the Safurex® HP STRIPPER, with CO_2 counter currently and supplying high pressure steam on the outside of the tubes. The stripped urea solution is sent to the downstream sections of the plant. The off-gas of the decomposed carbamate is recycled back to the synthesis.

● Safurex Infinity[∞]
INFINITY

● Safurex Star*
STAR

● Safurex Degree[°]
DEGREE

Safurex® HP ADVANCE MONITOR



Safurex® HP ADVANCE MONITOR Radar Level Measurement advantages:

Excellent signal focusing allows use even in confined spaces;

High measurement certainty due to low number of interfering reflections from internals;

Highly chemical resistant materials ensure long service life of the sensors.

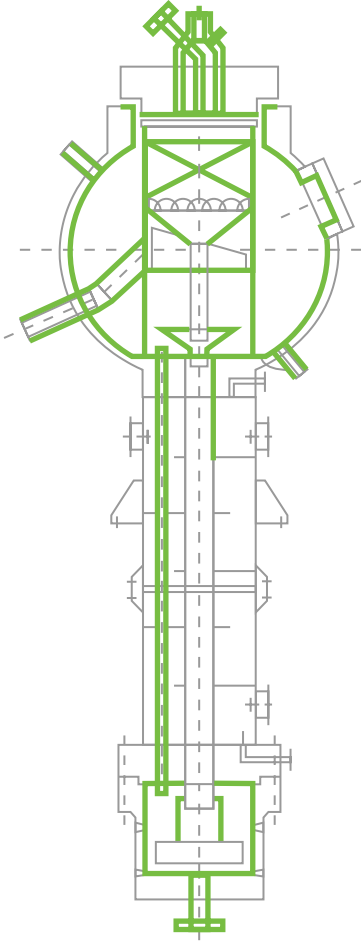
Safurex® HP ADVANCE MONITOR Process:

The Safurex HP ADVANCE MONITOR Radar Level Measurement, designed by Vega, operates with a transmission frequency of 80 GHz. With an 80mm antenna, this results in a beam angle of only 3 degrees. The radar sensor receives only distinct, definitive reflections from the product surface. This makes the measurement more accurate and reliable.

• **Safurex Infinity[∞]**
INFINITY

• **Safurex Degree[°]**
DEGREE

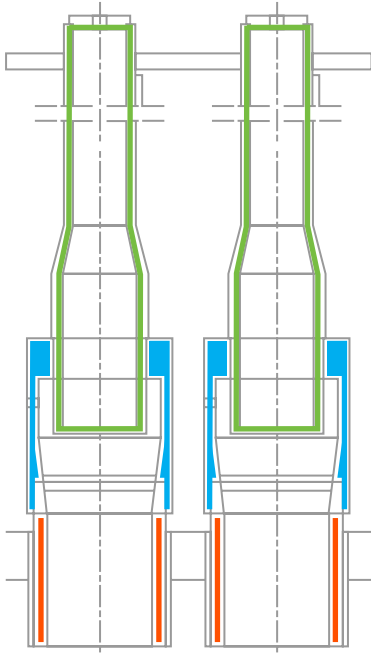
Safurex® HP SCRUBBER



The Safurex® HP SCRUBBER is designed to minimize emissions from the synthesis section. Minor amounts of non-condensable gases enter the plant in the carbon dioxide feed and as inert components of the air introduced for the purpose of passivating the plant equipment. To allow them to be discharged, they are washed with the carbamate solution from the low-pressure recirculation stage to recover residual ammonia. The enriched carbamate solution is then fed via the high-pressure ejector to the HP Carbamate Condenser or Pool Condenser / Reactor, as the case may be.

Safurex® HP SCRUBBER is high pressure carbon steel vessel with a special alloy protection. The internals including pall rings are made of Safurex®. There is no steam tracing needed at the sphere since Safurex® is not sensitive for condensation corrosion.

Safurex® LIQUID DIVIDERS HP Stripper



To create a nice falling liquid film down to the heat exchanger tubes there is a sophisticated liquid divider system including the so called liquid dividers. These dividers contain three liquid holes for the liquid distribution and on top a gas restriction for the virgin CO₂/gas distribution over the heat exchanger tubes.

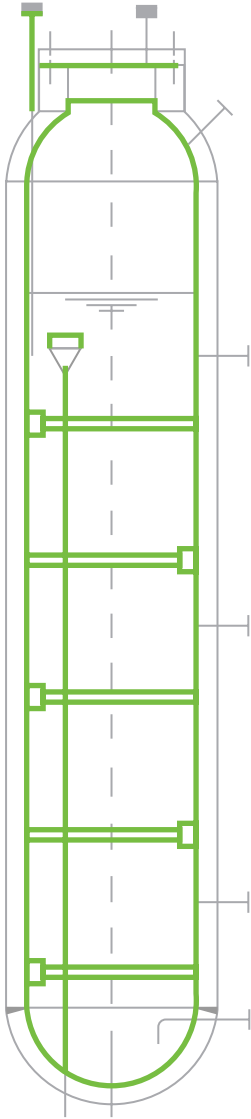
The material of construction of the **LIQUID DIVIDERS HP Stripper** is **Safurex®**. The liquid divider and so-called gas tube are weld connected and on top a gas restriction is installed. It is possible to fabricate the liquid divider using the HIP (Hot Isostatic Pressing) process.

● **Safurex Infinity[∞]**
INFINITY

● **Safurex Star^{*}**
STAR

● **Safurex Degree[°]**
DEGREE

Safurex® HP UREA REACTOR



The conversion of ammonium carbamate to urea is a much slower reaction than the formation of ammonium carbamate, and the purpose of the urea reactor is to provide a large space in which the reaction medium will be retained for long enough for it to reach equilibrium. In the conventional CO₂ stripping process some of the ammonium carbamate is first formed in the reactor as well, providing heat to drive the conversion reaction.

The gaseous CO₂ and ammonia from the HP Stripper and a mixture of ammonia and ammonium carbamate solution from the HP Carbamate Condenser are fed in at the bottom and the resultant ammonium carbamate solution rises slowly to the top of the reactor, where it overflows into an internal down comer tube which conducts it to the outlet for transfer to the HP Stripper. This arrangement minimizes heat losses and substantially reduces the amount of external pipework exposed to the highly corrosive medium at high temperature and pressure.

Safurex® UREA REACTOR is vertical high pressure carbon steel vessel with a special alloy protection. The internals are made of Safurex®. The reactor contains a number of high-efficiency trays to ensure that the flow of liquid through the reactor approaches plug flow. These trays are designed to minimize negative effects such as back-mixing, by-passing and stagnant zones in the reactor. Radar level measurement is foreseen for the Urea Reactor.

In the Safurex® family continuous, controlled and exact solutions are offered in materials, products and services, together reflecting the pioneering spirit of Stamicarbon.

Our Safurex® services help you to ensure high quality of the equipment during installation in your plant and to maintain the integrity of your equipment during operation, thereby ensuring optimum urea production during a long life time.

Urea plants are designed for a particular service life, usually 20 years or more. As long as they are well maintained and updated with state-of-the-art technology, high-pressure equipment even older than 20 years can continue to produce urea at competitive cost.

Our goal in offering Safurex® service solutions is to provide urea producers access to Stamicarbon's latest knowledge related to materials and high-end equipment. Stamicarbon has a Full Life Cycle philosophy, helping the urea producer to get maximum return on investment for 20 years or more. Reliable and durable equipment and materials are integral to the success of urea production. With the aim to contribute to the operational and performance excellence of your urea plant, we have created a series of Services that include training of your staff on material dedicated topics and inspections for high-pressure equipment, that together ensure optimum performance and maximum lifespan of your urea synthesis equipment.

The Services within Safurex® service solutions include:

- . Safurex® Welding Training
- . Safurex® Equipment Inspections

Safurex Services benefits:

- . Understanding the behavior of Safurex® material grades depth, significantly increases the ability to optimally maintain the equipment, enhancing its lifespan.
 - . Insight in the state of the Safurex® equipment throughout its entire lifetime, results in more durable and reliable plant operation.
-

Safurex® WELDING TRAINING

Already since 2002 Stamicarbon has used Safurex® as material of construction to protect the High Pressure (HP) vessels, piping and valves against the harsh environment of the ammonium carbamate, an intermediate product in the manufacturing of urea.

The Stamicarbon Inspection Department uses recommended vendors and an extensive inspection program during the manufacturing of the HP Synthesis equipment to keep up with the necessary high quality standards. During the construction of the urea plant, the vessels are delivered on site in an early stage of the construction. As of this point Stamicarbon's selected qualified welding company will weld the piping works and also connect the pipes to the process vessels.

To perform maintenance after several years of service Stamicarbon offers a welder's training to provide information on the maintenance and welding issues related to Safurex®.

Safurex® materials are made according to strict procedures and regulations, however during welding, the material will be re-melted and solidified again. In order to obtain the desired material structure and correct balance between the austenite and the ferrite phase it is of importance that the correct consumables and parameters are used to ensure that after welding, the superb corrosion resistance is reached again. In order to obtain this, Stamicarbon offers welders training which consists of a theoretical and hands-on training to improve or strengthen the welder's performance.

During the theoretical part the material composition, solution annealing, quenching, time transformation diagrams, heat input, interpass temperatures, shielding and backing gas compositions, 475°C embrittlement, pre-heating and post weld heat treatments amongst others will be discussed. During the hands-on training practical tips will be given for the PQR data like welding current, wire sizes, gas-flows and wire feeding etc.

The Results:

- . After the Safurex® welding training, participants will be able to understand the behavior of Safurex® materials in depth, plus how to properly weld it. The training will deal with several welding processes used for Safurex® material, and will provide more insight into which welding techniques are to be used for, amongst others; overlay welding, connection welding and repair welding.
- . Stamicarbon strongly recommends contractors, subcontractors and or maintenance crews to take part in these type of trainings to ensure that also during building and after operations the high quality standards are met.
- . It is important to know that the participants who have completed this training successfully are able to weld Safurex® U.X.M materials on non-pressure bearing parts only, for example; downcomer pipe, internals etc. If welding to Safurex® U.X.M pressure bearing parts is needed, additional training/ qualification is required.

Safurex® EQUIPMENT INSPECTIONS

Reliable and durable equipment is essential to the success of urea production. Plant Operations can be severely interrupted and even cause serious safety risks and fatal accidents that could have been prevented with a proper HP Equipment Inspection program.

Therefore, Stamicarbon has developed their equipment inspection services to ensure safety, optimum performance and maximum lifespan of your urea process equipment.

We perform inspections on urea equipment based on a thorough understanding of the urea process, equipment design and failure modes. The critical urea equipment inspection is performed by our experienced corrosion engineers and non-destructive testing (NDT) experts. When doing an inspection, our Inspection engineers report findings on a daily basis and submit a field inspection report with main conclusions and advice to management before leaving the site. This is followed by a final report with root-cause findings if applicable.

Stamicarbon can offer this service in all urea plants, based on experience gained from over 500 inspections executed over many years.

The Benefits:

- . Detailed management reporting on equipment condition, based on all measurements and findings
- . Type and level of corrosion identified such as condensation corrosion, crevice corrosion, strain-induced cracking, stress corrosion cracking, stern-face corrosion
- . Advice and recommendations on repairs and repair procedures
- . Advice and recommendations on plant operations in relation to corrosion and damages
- . Advice on scope and time interval for next planned inspection
- . Equipment lifetime prediction and when follow-up action or replacement is due

Stamicarbon is the world market leader in the design, licensing and development of urea plants for the fertilizer industry. We apply our expertise, knowledge and experience in several markets; fertilizers, air quality, emission reduction technologies and all technologies for the integration of urea and adjacent processes.

We are the leading technology provider and licensing company of the Maire Tecnimont Group, a top level international player in Engineering & Construction, Technology & Licensing and Energy Business Development & Ventures.

Alleima is a world-leading high-tech engineering company focused on advanced materials. A producer and supplier of corrosion-resistant materials for demanding applications, the company continues to develop and produce material grades for enhanced productivity, energy efficiency and safe operation.

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