

## GEMACO's Added Value for Maintenance, Revamp and Turnaround Projects

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### 1. Introduction

Urea and Nitric Acid plants are prone to various corrosion phenomena and on stream times of these plants can be endangered in case no spare parts or replacement materials are readily available. The costs involved when these plants are out of operation are very high due to the large plant capacity sizes and not even considering the impact on downstream production plants such as for example ammonium nitrate plants.

Urea and Nitric Acid plants require austenitic stainless steels of specific quality. Experience has proven that the chemical substances involved in these processes together with the applied pressures and temperature require stainless steels which fulfill strict specifications. In some situations applying inferior materials seems attractive as it might be more easily available but this can lead to unacceptable safety risks and/or unplanned shut downs.

## 2. Urea and Nitric Acid Austenitic Stainless Steels

### 2.1 Urea

The manufacturing process of urea requires special stainless steels able to withstand severe production conditions. Indeed, the cocktail of corrosive carbamate, high pressure (140-200 bars) and high temperatures (up to 200 °C) forces producers to use special stainless steels such as 316L Urea Grade and 25.22.2 (1.4465/1.4466 – UNS S 31050).

In order to guarantee the lifetime of their installations, specialized licensees (Stamicarbon, Saipem, Toyo Engineering Corporation and Urea Casale) have developed their own specifications regarding the chemical composition, the micrographic structure, the mechanical properties and the corrosion resistance (Huey test) of the steel grade. Although all have similar requirements however there are some differences in the details.

#### *316 L Urea Grade (1.4435-1.4406-1.4429)*

The UREA 316L Urea Grade (or also called UREA 316L Modified) has been specially developed for Urea plant applications. It is a 316L modified stainless steel with extra-low silicon content and a substantial higher molybdenum content. The low carbon content, combined with a well balanced chemistry (low silicon and nickel content close to 14%) makes the alloy fully austenitic, free of inter-metallic phase precipitations. The ferrite level is kept under 0.6% in the solution annealing and water quenched conditions. The alloy is designed for improved corrosion resistance properties in urea carbamate environments.

#### *25.22.2 – UNS S 31050 (1.4466)*

UREA 25.22.2 chemical composition has been optimized for specific applications in Urea plants. It is a 310L modified austenitic stainless steel with low carbon, low silicon and high nitrogen additions in order to stabilize and strengthen the austenitic phase.

The alloy is designed to obtain a fully austenitic stainless steel free of inter-metallic phases as inter-granular carbide precipitations which affect drastically the corrosion resistance properties of the alloy in urea containing solutions. The ferrite level is kept under 0.6% in the solution annealing and water quenched conditions.

The alloy is particularly designed for improved corrosion resistance properties in urea carbamate environments such as for example high pressure strippers. The grade is also well designed for resistance in wet corrosive conditions due to its high contents of chromium, molybdenum and nitrogen (PREN  $\geq$  33).

### 2.2 Nitric acid

Concentrated nitric solutions (> 90 %) may require special stainless steel grades without any trace of Molybdenum. Addition of Silicon to austenitic stainless steels type 304L influences favorably the resistance to inter-granular corrosion; WNR.1.4361 – UNS S 30600 is an 18% Cr – 15% Ni with 4% Si.

Boiling nitric acid solutions (50-65%) require WNR.1.4335 which is a 310L modified, with Silicon < 0.3% and Carbon < 0.015%.

*1.4361 – UNS S30600 – AISI 306Si*

Research shows that a strong addition of silicon to austenitic stainless steels of the 18/10 type has a favorable influence on resistance to trans-passive inter-granular corrosion.

This type of corrosion develops particularly in very concentrated nitric environments (> 90 %) up to boiling point, also in strongly oxidizing nitric environments (oxidizing ions present such as: hexavalentchromic pentavalent vanadium - ferritic salts etc...).

*1.4335 – 310L*

1.4335 – 310L is a 25 Cr 20 Ni austenitic stainless steel with sharp control of the residual elements in order to provide high corrosion resistance properties in boiling 50-65% Nitric acid solutions. The silicon content is kept under 0.3% while the carbon content is lower than 0.015%. Molybdenum additions are also well known to reduce the behavior of the steel in nitric acid solutions. This explains why the molybdenum content is guaranteed lower than 0.3%.

The sharp control of Carbon, Silicon and phosphorus contents makes it possible to produce a more stable austenite microstructure, free of inter-metallic or carbide precipitations.

The alloy is designed for nitric acid applications. The grade is not recommended for concentrated nitric acid purposes or highly oxidizing nitric acid solutions (with Gr VI species...).

Table 1 shows an overview of suitable materials of construction in Nitric Acid plants.

**Table 1: Suitable materials of construction in a Nitric Acid plant**

| <b>NITRIC ACID: ONE GRADE FOR EACH APPLICATION</b> |                     |                                      |                     |
|--|---------------------|--------------------------------------|---------------------|
|  | <b>&lt;50%</b>      | <b>50-70%</b>                        | <b>&gt;70%</b>      |
| <b>PURE N.A.<br/>T° = 60°C</b>                     | 304L                | 1.4335 - 310L                        | 1.4361 - UNS S30600 |
| <b>PURE N.A.<br/>BOILING</b>                       |                     | 1.4335 - 310L                        | 1.4361 - UNS S30600 |
| <b>N.A<br/>+<br/>Oxidizing<br/>impurities</b>      | 1.4361 - UNS S30600 | 1.4335 - 310L                        | 1.4361 - UNS S30600 |
| <b>N.A.<br/>+<br/>Fluorides</b>                    | 1.4335 - 310L       | 1.4335 - 310L                        |                     |
| <b>N.A.<br/>+<br/>Chlorides</b>                    | 1.4466 - UNS S31050 | 1.4335 - 310L<br>1.4466 - UNS S31050 |                     |

### 3. Gemaco for urgent delivery

GEMACO stocks a large quantity of qualified urea and nitric acid grades in the shape of pre-material such as slabs, billets, plates, condenser and heat exchanger tubes, seamless pipes, bars, etcetera. All these materials are in compliance with the quality requirements of the most well-known licensors and fabricators in the world as well as engineering companies and their subcontractors.

The availability of pre-material allows us to produce already fittings, bends, forgings, and custom-made products during the same time period as the production of bigger quantities of pipes and plates. This working method shortens considerably the delivery times.



Picture 1: Gemaco's warehouse

Gemaco is able to deliver quickly the following products:

Pipes & Tubes :  
welded, seamless, cold drawn, heat exchanger

Flanges :  
all types, including nozzles and heavy collards

Fittings :  
wrought, forged or bended fittings

Bars :  
forged, rolled, cold drawn, round, square, hexagonal,...

Forgings :  
rings, disks, pieces according to drawings, ...

Plates & sheets :

hot or cold rolled, in standard sizes, cut to size or according to specifications,...

Others :

flat & hollow bars, channels, strips, wires, bolts & nuts, machined pieces, ...

There is no need for you to invest and hold a stock at your plant site, which is obviously a financial advantage. Gemaco is able to act as your emergency supplier. We can realize short delivery times as we have the pre-material already available on stock and we are able to dispatch it directly to qualified fabricators. Other materials like end-products can be delivered directly from stock to you thus these will reach your plant within hours to days depending on the distance and urgency.

We act flexible and reactive: The exact quantity which is needed for a project will be delivered, also in case during the project engineering and construction phase quantities change for any reason. There is no need any more to order large quantities. Small quantities can be delivered in a quick and efficient way.

For example for we can deliver a 12" block from 316L Urea Grade meant for a high pressure control valve in less than 4 weeks.

We did deliver even much quicker like for example for SKW Piesteritz in Germany, who ordered 18 m 25.22.2 pipelines (size 4" and schedule 160) and received it within 3 days. Or Yara Le Havre in France who ordered forged pieces according to drawing in 316L Urea Grade, which we delivered within 48 hours and Yara Harfleur who ordered flanges, lens gaskets and weldolets in 25.22.2 and 316L Urea Grade, which was partly delivered the same day and the balance within 8 days.

In case during a turnaround you are unpleasantly surprised by the corrosion attack of some materials, no stress is needed. Just call us and we will be able to supply you quickly the right quality materials.



Picture 2a/b/c/d: Examples of products delivered by Gemaco

#### 4. Gemaco for Technical & Logistic support

Gemaco has the expertise and experience to perform all kinds of expediting services, such as:

- ✓ doing quality inspections
- ✓ progress monitoring visits to the various vendors
- ✓ preparing monthly progress reports
- ✓ checking and digitally archiving all quality certificates
- ✓ perform our own internal quality checks such as PMI, US wall thickness testing, Ferrite content, etcetera.



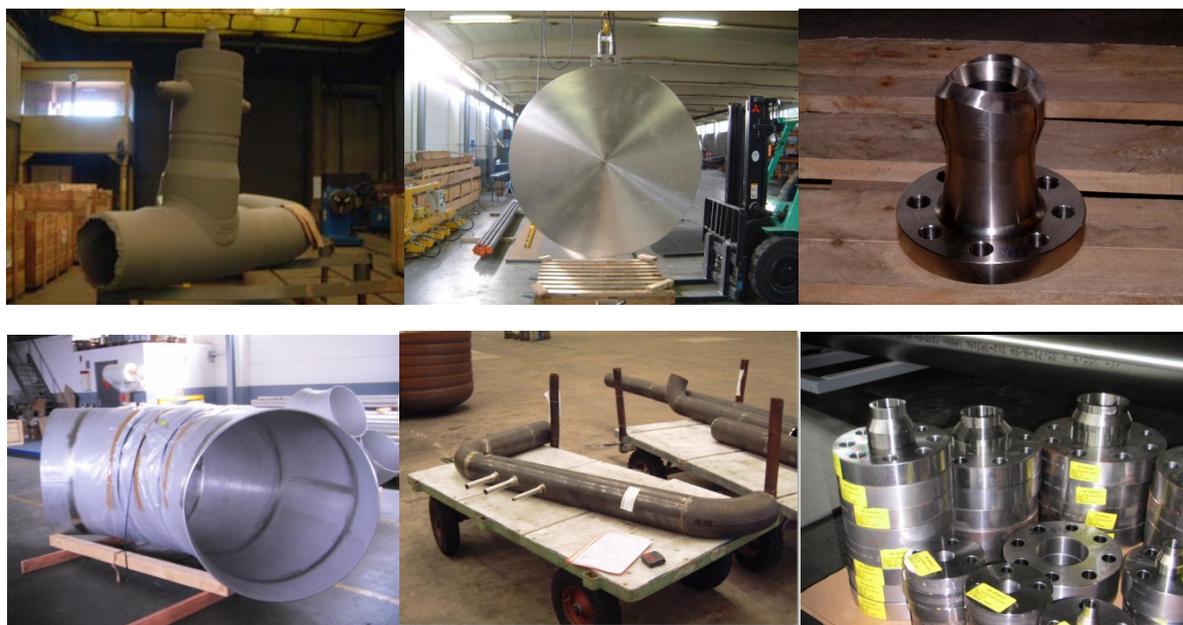
Picture 3a/b/c: Gemaco quality inspection

Several of our clients ask us to receive first all project materials and perform centrally the quality inspections together or on behalf of the client.

We are very well established to handle all kind of technical and logistic services and supports you may need.

## 5. Gemaco for Contractor Services

Gemaco has several successful references to perform Contractor Services for small and medium Maintenance, Revamp and Turnaround Projects. For you as the client this means you put all the work in one hand and obtain a single point responsibility for the procurement and fabrication including controls and expediting of specific equipment or spools.



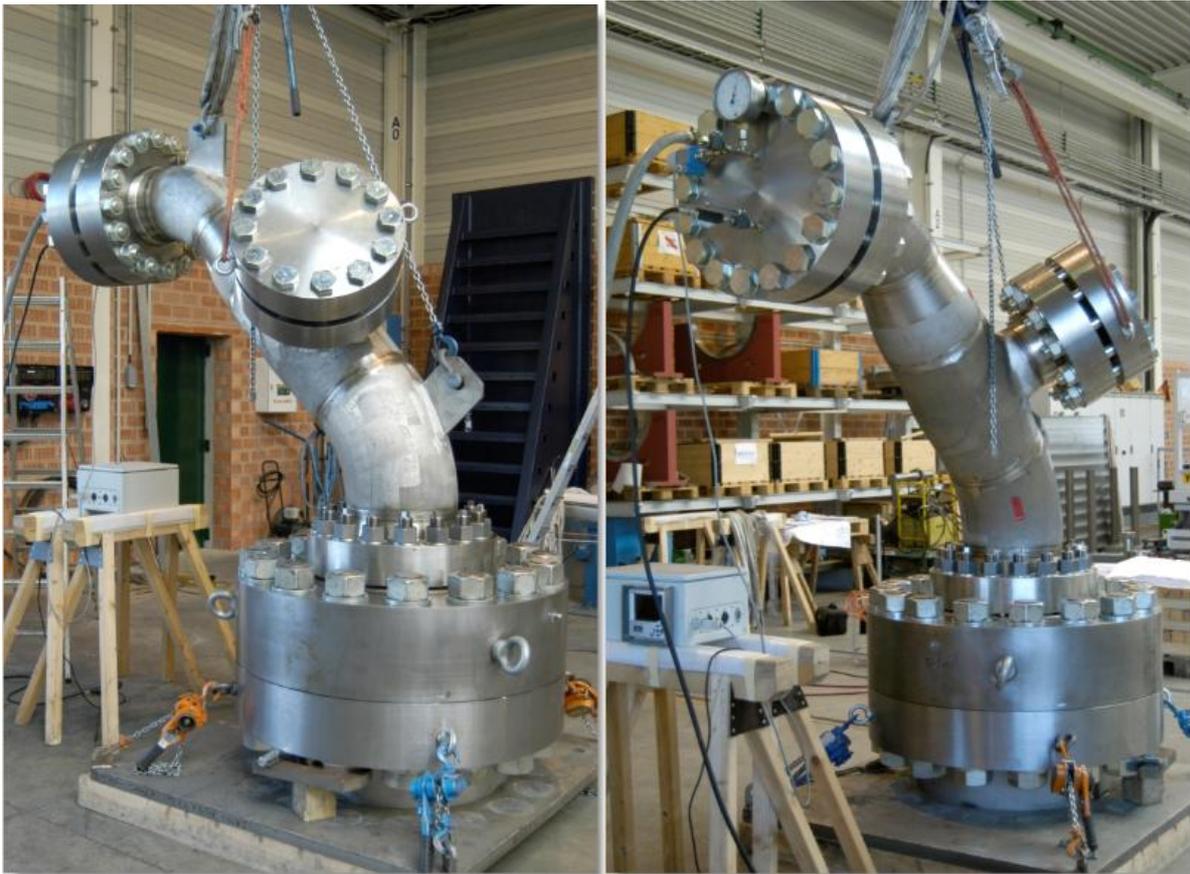
Picture 4a/b/c/d/e/f: Typical Gemaco products/projects

We will coordinate the complete project activities with all the sub suppliers and act as the spider in the web between on one side you as the client/enduser and on the other side the engineering contractor, the subcontractor, the (sub) vendors, the stockists, the transporter etc.

Gemaco will be the Solution provider for your Maintenance, Revamp and Turnaround projects. Gemaco has been responsible for several critical, technology based, equipment items, like for example the top part of a High Pressure CO<sub>2</sub> Stripper for a urea plant and a Syngas collector for an industrial gas plant.

*Example: Top cover of a High Pressure CO<sub>2</sub> Stripper for a urea plant*

Gemaco has been in charge of the procurement, fabrication, quality control and FOB supply of a complete top cover of a High Pressure CO<sub>2</sub> Stripper, which was part of a revamp project designed by Urea Casale, Switzerland.



**Picture 5a/b: Pressure Test of a complete top cover of a High Pressure CO<sub>2</sub> stripper**

The top section did consist of a new man-hole cover with a new 16" gas outline line, which included a 10" Tie-in connection.

The construction material of High Pressure Piping parts was 316L Urea Grade, while the liner of the man-hole cover was 25-22-2, the design pressure was 159 bar.

The various parts were procured from qualified and experienced vendors in agreement with the client and licensor requirements and the parts were welded together by qualified welders.

## 6. References

The table below shows the reference list of Gemaco's projects. Gemaco handles projects from all parts of the world and the scope of supply range from single products to complete packages. Gemaco can provide further technical and logistic services and contractor services.

Table 2: Reference list

|  <b>LATEST PROJECTS</b><br>November 2010 |                              |            |                           |                              |
|---|------------------------------|------------|---------------------------|------------------------------|
| Year  | Enduser                      | Country    | Grade                     | Material                     |
| 2007  | TOTAL FEYZIN                 | France     | 321 / 316 / 316 L         | Complete package             |
| 2007  | AIR LIQUIDE                  | Koweit     | 304 L                     | Complete package             |
| 2007  | RAS LAFFAN OLEFIN            | Qatar      | Alloy steel               | Special pieces               |
| 2007  | RHODIA                       | France     | X1CrNi25.21 - WNr. 1.4335 | Plates                       |
| 2007/2008   | TOTAL DONGES                 | France     | 304 H / P22               | Complete package             |
| 2007/2008   | EXXONMOBIL                   | France     | grade 3 - grade 6         | Complete package             |
| 2007/2008   | ENGRO                        | Pakistan   | 316 L UG                  | Seamless pipes               |
| 2008  | EXXONMOBIL                   | France     | 304 H                     | Complete package             |
| 2008/2009   | TOTAL DONGES                 | France     | 317 L                     | Spools                       |
| 2008/2009   | GPN                          | France     | 316 L UG                  | Complete package             |
| 2008/2009   | FERTIL                       | U.A.E.     | 316 L UG                  | Complete package             |
| 2008/2009   | FERTIL                       | U.A.E.     | 316 L UG                  | Complete Cover Stripper      |
| 2008/2009   | SKW                          | Germany    | UNS S 31050               | Pipes, fittings and forgings |
| 2008/2009   | SONATRACH                    | Algeria    | UNS S 31050               | Plates                       |
| 2009  | YARA                         | Germany    | 316 L UG                  | Complete package             |
| 2009  | SALAVAT JCS                  | Russia     | 316 L UG                  | Seamless pipes               |
| 2009  | PAK-AMERICAN                 | Pakistan   | 316 L UG                  | Complete package             |
| 2009  | EXXONMOBIL                   | France     | 304 H                     | Complete package             |
| 2009  | ABU QIR                      | Egypt      | UNS S 31050               | Pipes and bendings           |
| 2009  | AL DUR POWER & WATER COMPANY | Bahrein    | 316 L                     | Complete package             |
| 2009  | HINDUSTAN                    | India      | UNS S 30600 - WNr. 1.4361 | Pipes, fittings & forgings   |
| 2009-2010   | ABU QIR                      | Egypt      | UNS S 31050               | Complete package             |
| 2009-2010   | AREVA                        | France     | X1CrNi25.21 - WNr. 1.4335 | Pipes, fittings & plates     |
| 2010  | BASF                         | Germany    | X1CrNi25.21 - WNr. 1.4335 | Pipes, fittings & plates     |
| 2010  | HUCHEMS                      | Korea      | UNS S 30600 - WNr. 1.4361 | Pipes, fittings & forgings   |
| 2010  | BURULLUS                     | Egypt      | UNS S 32750 - Superduplex | Pipes, fittings & forgings   |
| 2010  | BORSODCHEM                   | Czech Rep. | UNS S30600 - W.Nr. 1.4361 | Complete package             |

## 7. Conclusions

Urea and Nitric Acid plants require special attention:

- ✓ Special grades
- ✓ Special specifications
- ✓ Special expertise
- ✓ Special controls
- ✓ Flexibility, reactivity, reliability

Gemaco offers these services and is your single point responsibility for your next project, revamping, debottlenecking, refurbishment, repair or maintenance work.

We will be very pleased to help you.

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