

Urea and Nitric Acid Plants: Projects, shutdown, revamping, debottlenecking Improvement of Supply Chain Management

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Abstract

A presentation on special corrosion-resistant steels for nitric acid and urea service and the role played by strategic equipment from experienced suppliers and technical support in saving time, stress and money.

This paper has been presented during the Asian Nitrogen & Syngas Conference 2012 in Kuala Lumpur.



Asian NITROGEN + SYNGAS 2012

9-11 October 2012, Shangri-La Hotel, Kuala Lumpur, Malaysia

www.nitrogenasia.com



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INTRODUCTION: UREA PLANTS AND NITRIC PLANTS: DIFFERENT SOLUTIONS FOR DIFFERENT CORROSION PHENOMENA

Urea and Nitric Acid Plants are prone to various corrosion phenomena depending on the process, the concentration, the temperature, the composition of the gas itself, etc.

It is also important to consider that the role of impurities and process variables such as the oxygen content in urea carbamate solutions and oxidizing impurities in nitric media is generally as important as the nominal composition. In all cases the chlorides or halogen contents are also important.

Therefore special austenitic stainless steels with specific requirements have been developed. Experience has proven that applying inferior materials was an attractive solution, standard, easier to find, cheaper, but not reliable and leading sometimes to safety risks and/or unplanned shut downs.

If most of the problems can be anticipated by regular shutdowns (maintenance), some issues can occur unexpectedly. Such situations lead to an indefinite time during which the plant is out of operation, not producing but also sometimes impacting the downstream production.

SPECIAL STAINLESS STEELS FOR UREA AND NITRIC APPLICATIONS

UREA

The urea manufacturing process requires special stainless steels able to withstand severe production conditions. The cocktail of corrosive carbamate, high pressure (140-200 bars) and high temperatures (up to 200°C) requires special stainless steel grades such as 316 L UG and/or 25.22.2 (WNR.1.4465/1.4466 – UNS S 31050).

In order to guarantee the lifetime of their installations, specialized licensors like Stamicarbon/Tecnimont, Saipem (formerly Snamprogetti), Toyo and Urea Casale, have developed their own specifications regarding the chemical composition, the micrographic structure, the mechanical properties and the corrosion resistance (Huey Tests) of the stainless steels.

316 L UG (Urea Grade) – WNR.1.4404/1.4406/1.4429/1.4435

Also called 316 L modified, the austenitic stainless steel 316L UG corresponds to different *Werkstoff Nummer*, depending on the content of Nickel, Molybdenum or Nitrogen. This grade has extra low Carbon and Silicon contents, a higher Molybdenum content, and sometimes high Nitrogen additions. Also, the ferrite level of this particular grade is set to maximum 0,6%. These modifications aim at improving corrosion resistance in urea carbamate solutions.

25.22.2 – UNS S 31050 – AISI 310 Mo LN – WNR. 1.4465/1.4466

The 310MoLN grade has an optimized chemical composition for specific applications in Urea plants. Carbon and Silicon contents are low while Chromium and Nickel have respective levels of 25% and 22%. Moreover, Nitrogen is added to this chemical composition, which enables to stabilize and strengthen the austenitic phase.

As for 316L UG, the maximum level acceptable for Ferrite is 0,6%. The grade 310MoLN is a fully austenitic stainless steel free of inter-metallic phases as intergranular carbide precipitations, which affect drastically the corrosion resistance properties in urea solutions. This alloy is designed to improve corrosion resistance properties in urea carbamate environments such as for example high pressure strippers.

NITRIC ACID

Depending on its concentration and temperature, Nitric Acid (HNO₃) may require special stainless steel grades with low Molybdenum contents.

In concentrated nitric oleum solutions the addition of 4 % Silicon to austenitic stainless steels like 304 L favourably influences their resistance to intergranular corrosion. This gave birth to the grade WNr.1.4361 – UNS S 30600- URANUS S 1 ® (chemical composition: 18% Cr – 15 % Ni - 4 % Si). This effect is clearly visible on Fig. 1, where URS1 exhibits a unique behaviour compared to all other stainless steels.

In boiling Nitric Acid solutions, the best results are obtained with high chromium grades. With a chromium content of 25%, a 310L NAG (Nitric Acid Grade) – UNS S 31002 outperforms 304L in boiling 65% acid. Its low Carbon and Phosphorus as well as its Silicon inferior to 0.3 % also improve its corrosion resistance and phase stability (Fig. 1 and 2). To maintain the austenitic structure, nickel has been also increased around 20%. This grade is also known as WNR.1.4335 - URANUS 65 ®.

The following graphics (from Arcelor Mittal), Fig. 1,2,3 will show the corrosion rates measured on different kinds of stainless steels, according to the concentration of nitric acid, as well as the results of the Huey Tests on these different grades.

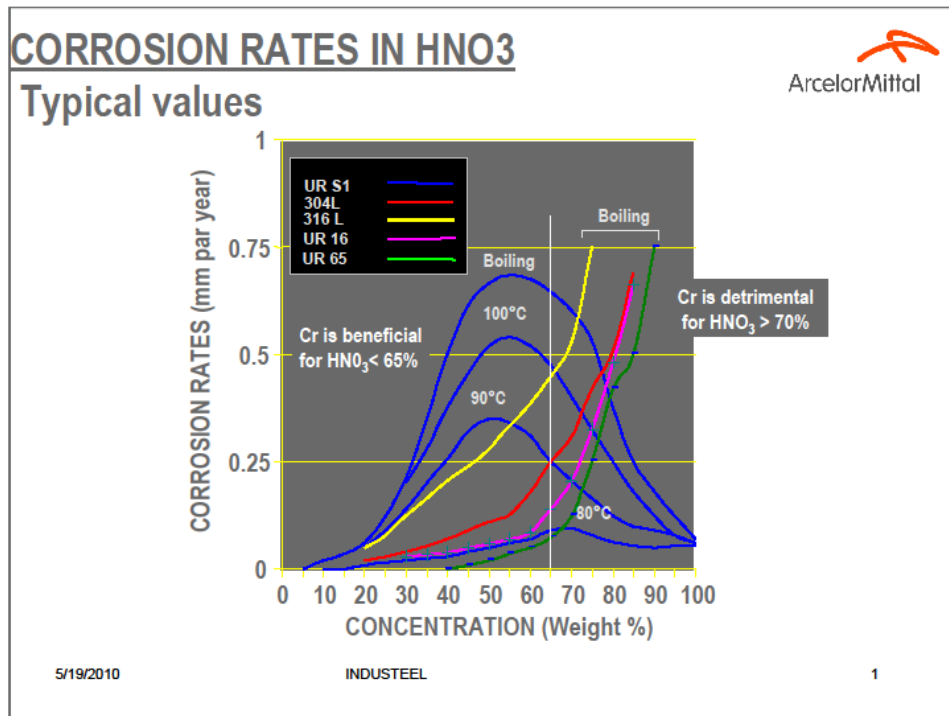


Fig. 1: Corrosion rates in HNO₃

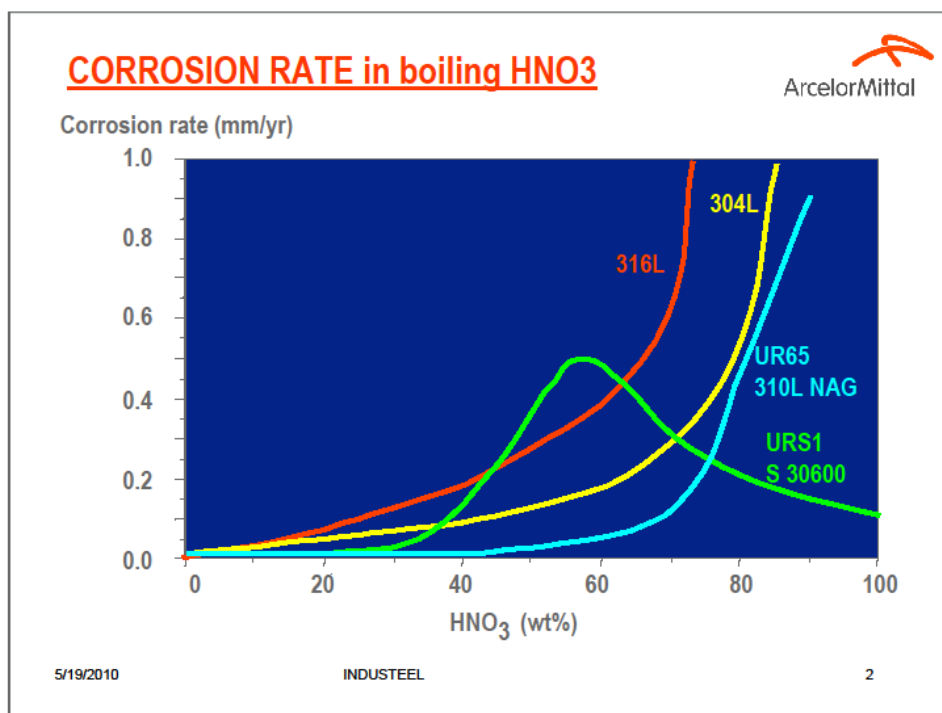


Fig. 2: Corrosion rate in boiling HNO₃

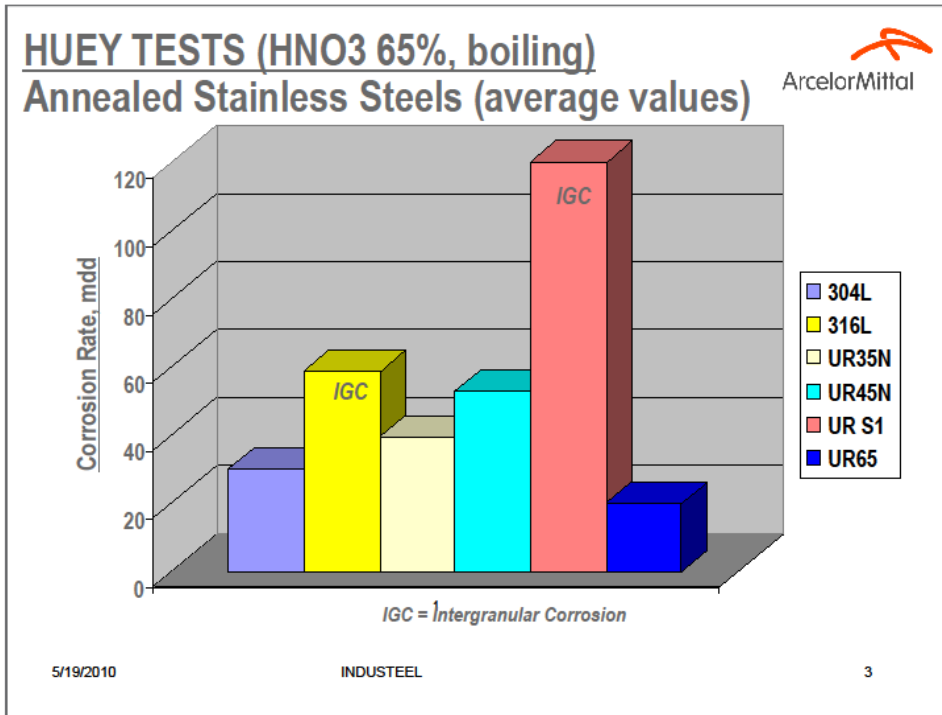


Fig.3: Huey Tests (HNO₃ 65%, boiling)

A guidance table is given in Fig. 4 showing the diversity of solutions applied in nitric acid media.

GUIDE TABLE FOR THE SELECTION OF STAINLESS STEELS FOR NITRIC ACID SERVICE

	< 50 %	50-70 %	>70%
PURE NITRIC ACID T = 60°C	304 L	UR 16 UR 65	UR S1
PURE NITRIC ACID BOILING	UR 16	UR 65	UR S1
NITRIC ACID + OXIDIZING IMPURITIES	UR S1 (up to 30% Boiling)	UR 65	UR S1 (depending on Redox)
NITRIC ACID + FLUORIDES	UR 65	UR 65	
NITRIC ACID + CHLORIDES	UR B66 UR 25.22.2	UR 65 UR 25.22.2	

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Fig. 4: guide table for the selection of stainless steels for nitric acid service

URGENT NEEDS

GEMACO offers, from stock, a complete range of products in those different UREA and NITRIC GRADES in many shapes and conditions:

- Raw material for the production of plates and sheets, pipes and forgings (slabs, billets, bars)
- Forged or rolled bars
- Pipes and tubes (for heat exchanger, condensers, strippers or regulation), seamless or welded, thin (from 0.5 mm) or heavy wall (up to 35 mm). Diameters from 1/8" up to 14" are available
- Fittings such as elbows, reducers, tees, flanges, gaskets, o'lets, etc.
- Plates and sheets

PROJECTS AND PACKAGES

GEMACO supplies major quantities with mill advantages combined with flexibility by using its own material:

- To reduce delivery times for the fabrication of fittings or custom-made items
- To provide items with smaller quantities or accept changings during the erection of the plant.
- To offer a complete range in many shapes and conditions

GEMACO will be your single source for all your needs:

- Projects (new, revamping, debottlenecking, etc.)
- Shutdown
- Maintenance

TAILOR MADE PRODUCTS

Gemaco can provide special fittings, bendings with special radius, machined pieces, isometrics realised according to your specifications and drawings. Gemaco offers global solutions for strategic, technology based equipments from approved European suppliers.

TECHNICAL AND LOGISTIC SUPPORT

All our material is produced by European mills in compliance with the quality requirements of the most well-known licensors and fabricators in the world as well as engineering companies and their sub-contractors.

We are used to apply the most common rules of Vd TÜV Blatt, ASTM/ASME, EN norms and codes.

We can provide you a wide range of services such as:

- Technical help regarding corrosion, forming, welding
- Monthly progress reports
- Monitoring visits to the suppliers when required (Kick Off Meetings, Witness/Hold points, etc.)
- Easy follow up and traceability of each item with linked heat numbers, certificates, producer's names, etc. by digital archiving

CONTRACTOR SERVICES

With Gemaco, your high-pressure material procurement is all in one hand. Gemaco's commitment includes management and coordination of all the sub-suppliers. Gemaco is the single point of responsibility, the spider between end-user, engineering, sub-contractor and producers.

Our warehouse is the single place for final inspection, packing and expedition, which eases final inspectors' work. Gemaco also performs internal testing and additional controls to mill's inspection: visual and dimensional inspection, PMI, wall thickness measurement with US Testing, Ferrite level or Roughness measurement, etc.

Marking and tagging are realized according to your instructions.

The complete range of products available in Gemaco's stock enables a real flexibility during projects procurement: our customers have the possibility to add, decrease or modify initial quantities required. This allows us to avoid undesirable stocks at the plant or shortages.

CONCLUSIONS

Gemaco provides EXPERTISE, EFFICIENCY, FLEXIBILITY and REACTIVITY, which offers to our customers less stress and more financial advantage.

We rely on PERFORMANCE: Higher Quality for less maintenance

Gemaco provides reliable solutions contributing to cost reduction.

Therefore GEMACO is proposing **PRICE** ©: Professional Reliable Intelligent Customized Execution.

ACKNOWLEDGEMENTS

The author would like to thank Mr. Pierre Soullignac of ArcelorMittal (now retired), Mr. Mark Brouwer from UreaKnowHow and Gemaco's team for their assistance, collaboration and advices in writing this paper.