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REVAMPING OF THE 80 t MRP-L CONVERTER AT APERAM TIMOTEO*

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Abstract

Aperam is a global player in producing of stainless, electrical and special steel qualities. The steelmaking plant in Timoteo Brasil is equipped with one AOD-converter for stainless steel and one MRPL-converter for special steel production. The MRP-L converter is almost in operation for 20 years. In order to improve production Aperam decided to install a new converter with increased reaction volume equipped with DANIELI state of art technology. This paper describes the major changes and improvements of the new converter installation.

Keywords: Converter; Steelmaking; Suspension system.

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1 INTRODUCTION

The existing MRP-L converter is already in operation since 1996 and has now reached the end of its life time. In order to upgrade the equipment to the state of the art technology the management of Aperam Timoteo decided to change the vessel shell, the trunnion ring and the suspension system. In December 2014 Danieli was honored with this project. The major improvements are described in this paper. In particular the change of the trunnion ring opens new opportunities for the MRP-L converter. The existing design is based on bolted connection between trunnion ring body and its pins while new trunnion rings using welding connections.

Consequently the large flange and the bolts can be avoided which comes along with gaining space to the dog house which is used to increase the vessel shell and additional reaction volume for the process is given. To use fully this additional space a slender suspension system is a pre-condition which is composed of vertical lamella- and horizontal DANI-ELLA-elements. This maintenance free suspension system is minimized in space and does not affect the titling circle of the equipment.

Another important factors for this project were to maximize the sizes of equipment to be delivered and to avoid site welding. By introduction of an additional flange connection in the barrel section this demand could be fulfilled as well.

Finally DANIELI could offer a suitable solution based on:

- New trunnion ring with welded pins
- Converter with increased reaction volume from 56 m^3 to 62.2 m^3, this is a plus of 11 %
- Maintenance free converter suspension system based on the DANI-ELLA horizontal and lamella type vertical elements
- Maintaining the existing tilting drive, bearing size, bearing housings and dog house
- Avoiding welding on site by introduction of a flange connection in the barrel section of the vessel shell
- Optimized slag shield design
- Keeping the delivery time to a minimum

2 CONVERTER DESIGN

The MRP-L process is a special steelmaking process based on bottom stirring combined with oxygen top blowing. The main products are special electro- and Si-steel grades. The converter consists of top cone, barrel section, bottom cone with detachable bottom. The suspension system is based on the classical tendon-type suspension system consisting of four vertical tendon type- and two horizontal pin type elements. An overview is shown in
Figure 1.

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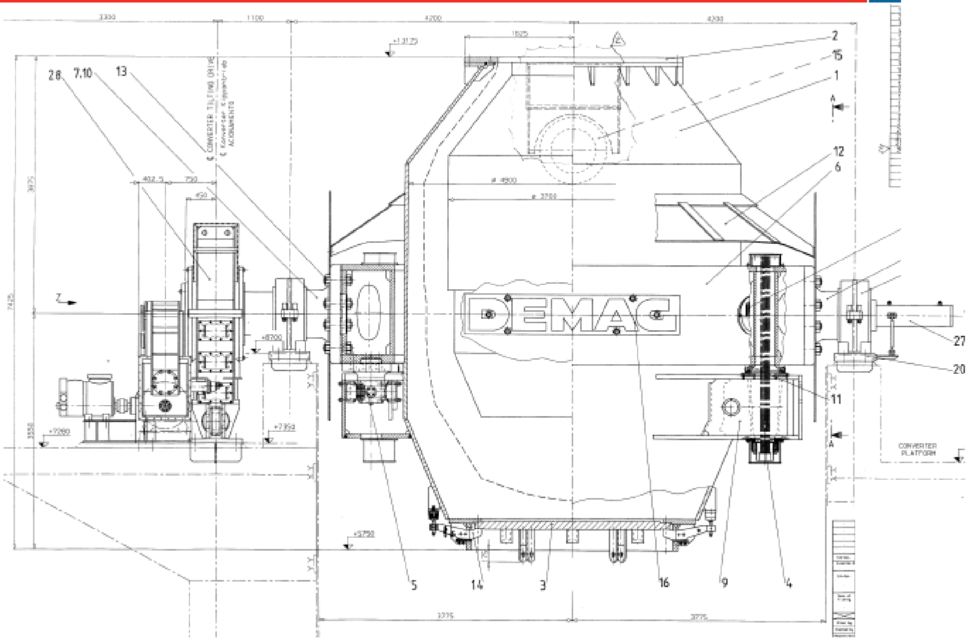

Figure 1: Overview of the existing MRP-L converter arrangement.

2.1 Boundary Condition for New Converter Application

As like as in classical revamping projects also here the main data of the existing converter arrangement should remain unchanged, which are:

- Trunnion ring bearing distance
- Top level of converter mouth
- Bottom level of converter bottom
- Converter mouth diameter
- Tilting circle of the converter
- Reusing of exchangeable converter bottom

Under this boundary condition the main parameter for increasing the inner volume is the barrel diameter of the converter. The key to success was the changing of the trunnion design.

2.2 Trunnion Ring Design

As already mentioned one key factor for this project was the design change from bolted trunnion pins to welded ones (see

Figure 2). This allows an enlargement of the converter diameter and consequently an increase in the reaction volume.
Another feature in terms of reducing tilting torques (see chapter 2.4) of the new converter is the offset of the trunnion ring body in respect to the tilting axes by 100 mm. Special care has to be taken on the welding of the trunnion pins to the shield plate. Due to this offset the remaining material is reduced in one location and overheating as well as distortion during welding has to be avoided. These design changes allow a weight reduction by 10 %.

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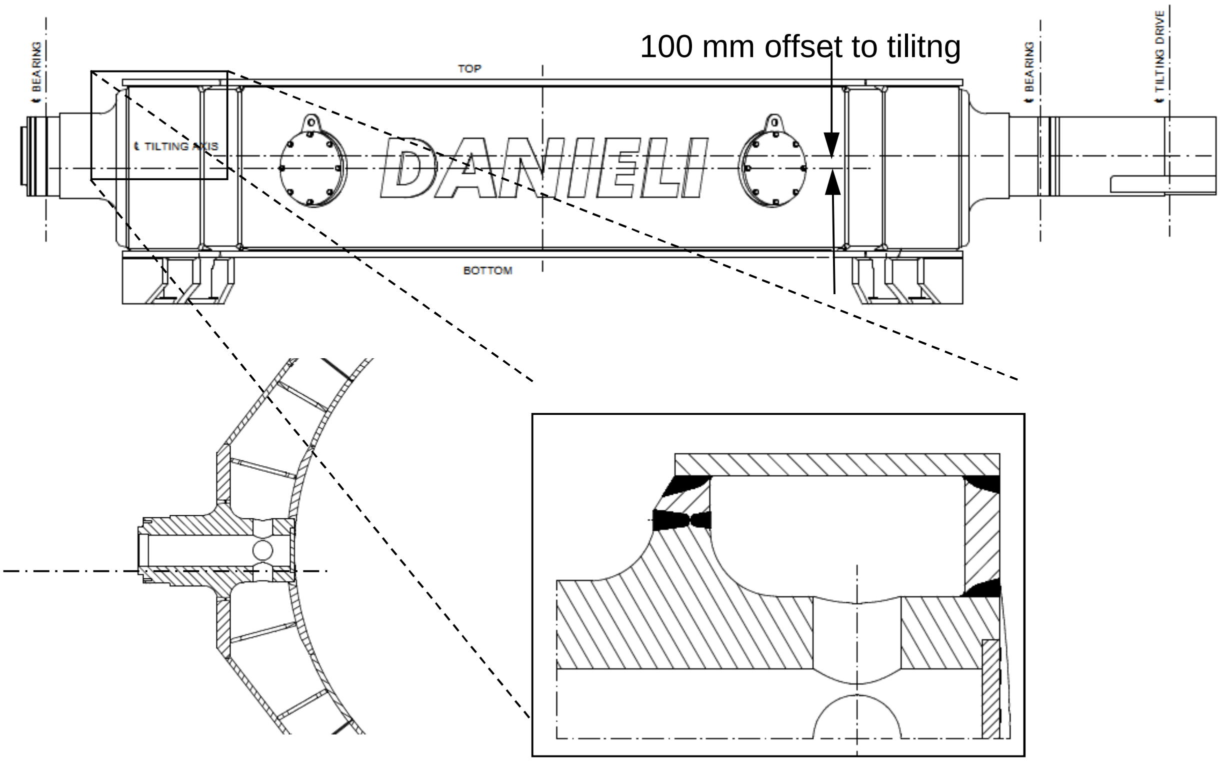

Figure 2: Details of trunnion ring design with welded in pins.

Consequently the outer diameter of the converter vessel shell could be increased from 5000 mm to 5320 mm. An overview of the new arrangement is shown in Figure 3.

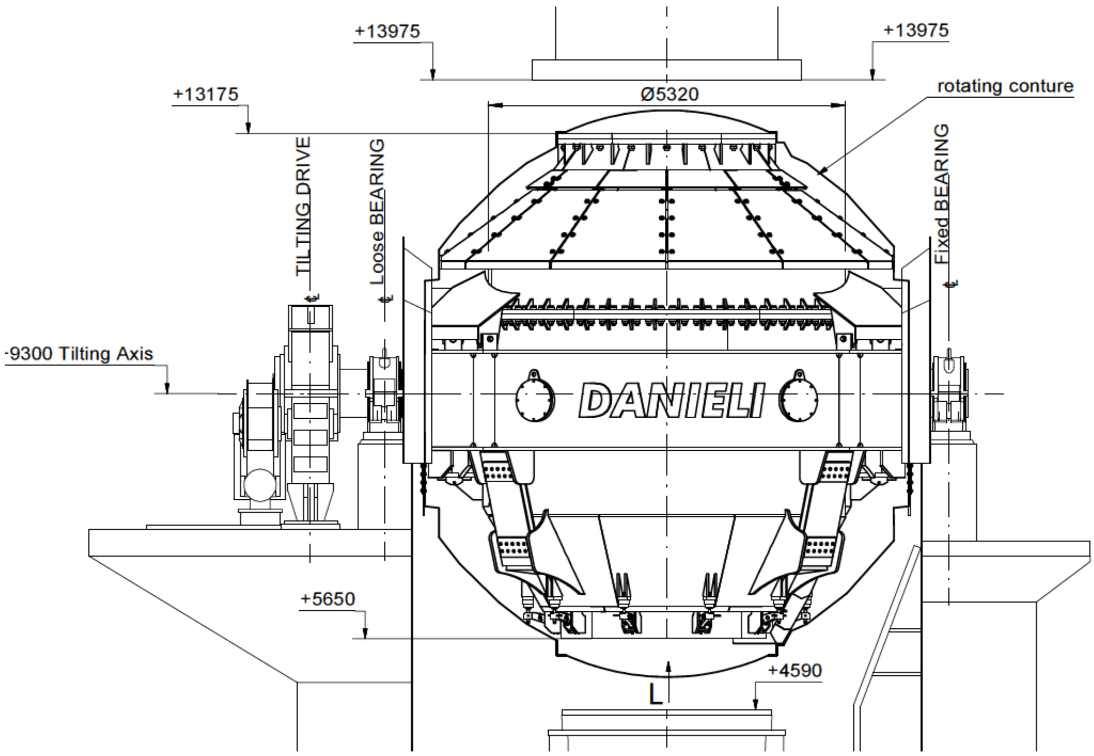

Figure 3: Overview of the new MRP-L converter arrangement.

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Additionally it was possible to enlarge the converter barrel height by 100 mm. This gave finally an increase of the reaction volume (inside lining) from 56 m³ to more than 62 m³ (see Figure 4), which means and increase by approx. 11 %. This will have a positive effect on the process in terms of decreased blowing time as well as increased yield due to less slopping activities.

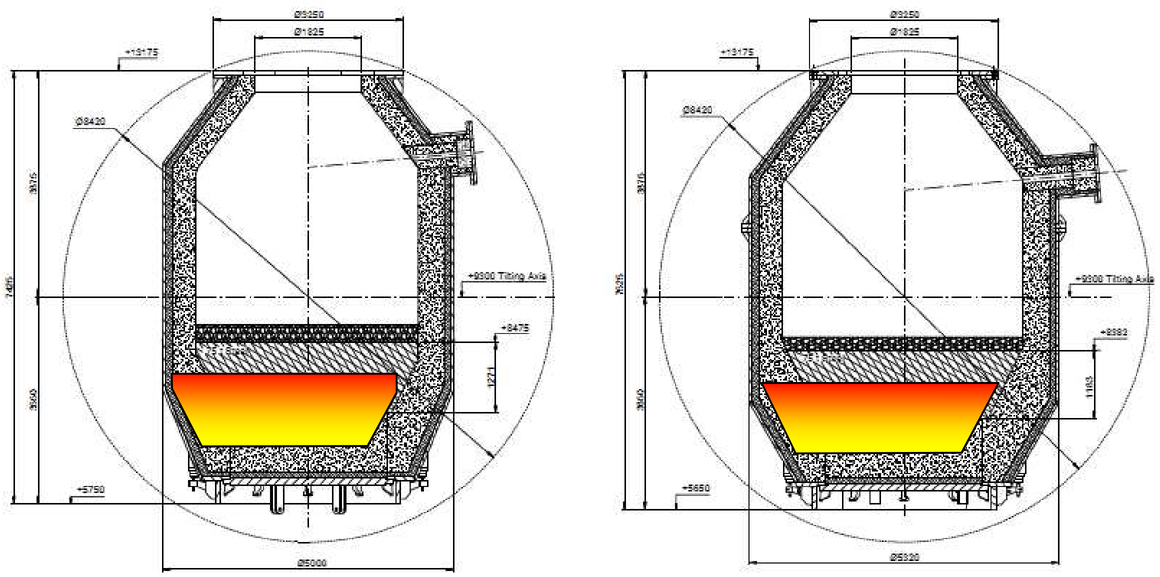

Figure 4: Comparison of existing (left) and the optimized vessel shell (right).

2.3 Suspension System

The existing suspension system is based on 4 vertical suspension tendon elements and 2 horizontal pin type elements. The continuously increased maintenance activities for the suspension elements particularly for the horizontal elements were also a major reason for the converter exchange. The new DANIELI suspension system uses four vertical lamella type- and two horizontal DANI-ELLA elements which are arranged directly underneath the pin axes (see Figure 3).

2.3.1 Vertical lamella type suspension element

Based on experience DANIELI further developed the classical vertical lamella type elements. In particular the load introduction into the trunnion ring and vessel shell could be streamlined by arranging the lamella plates on each side of the load introduction plates (see Figure 5). Consequently the load distribution is completely symmetric and very harmonic compared to the original design. However, the lamella plates have an increased distance to each other. Due to the fact of radial deformation of the vessel shell (caused by thermal expansion or creep effect during operation) the lower suspension bracket deforms basically only radially as well and there is no additional bending effect of the suspension elements. So, the lamella plates deform parallel to each other independent from their actual offset. Consequently this is an improvement of the already well proven suspension elements.

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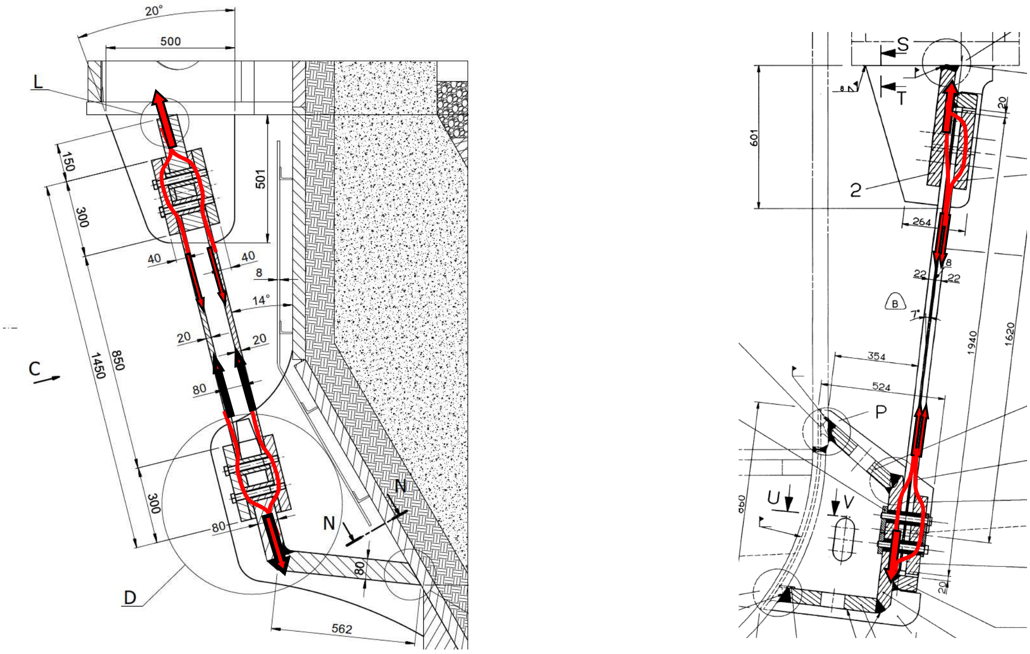

Figure 5: Optimized load distribution from lamella plate into brackets in new (left) and classical (right) vertical lamella type suspension element.

2.3.2 Horizontal DANI-ELLA suspension element

This is a special development from DANIELI based on simple welded on brackets on vessel shell and trunnion ring with elastic lamella elements in between. These lamella plates are compensation the different thermal expansion the brackets. The principle function is shown in

Figure 6.

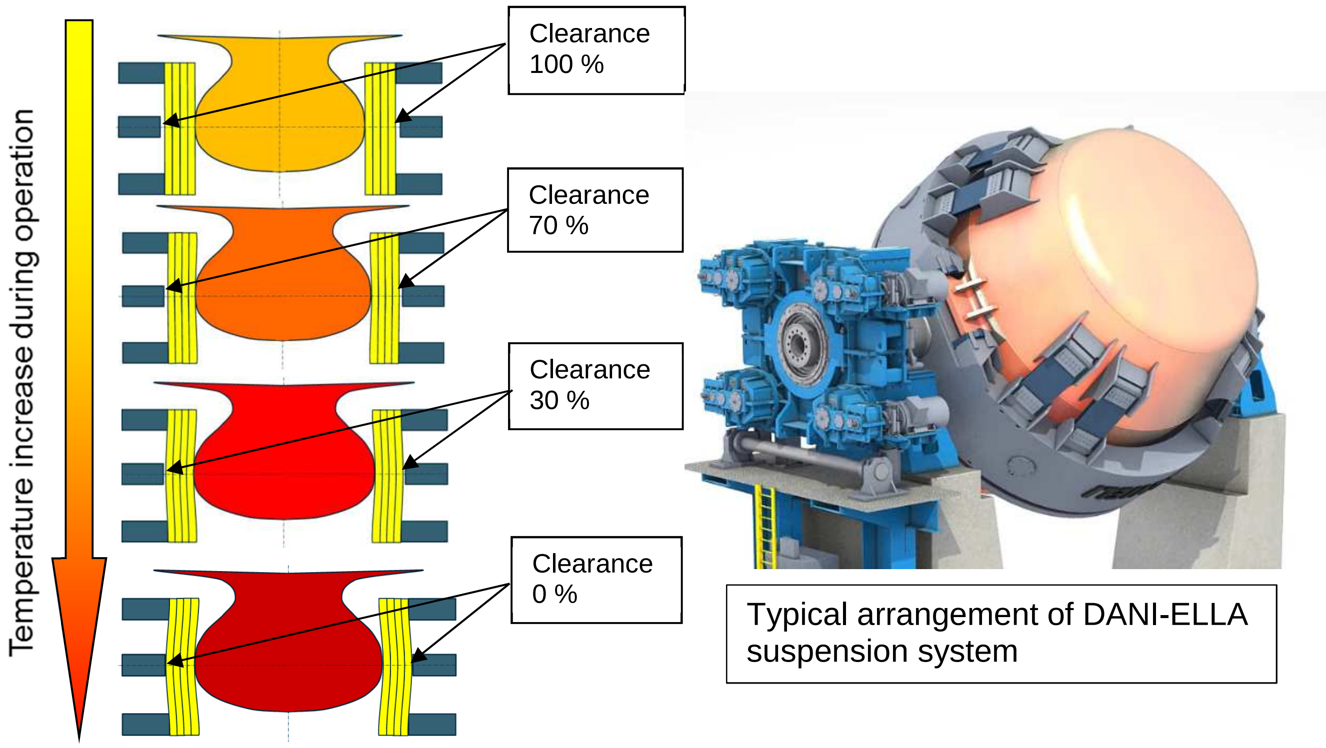

Figure 6: Principle of the DANI-ELLA suspension system.

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In cold condition there is a small clearance between brackets and lamella plates. During operation the temperature difference between bracket welded to vessel shell and trunnion ring increases resulting in a relative expansion between these adjacent parts. Exactly this relative expansion is compensated by closing the original clearance of the plates in terms of elastic deformation of these lamella plates. The application of this suspension system could reduce the weight compared to the existing one by 50%.

This type of element is already successfully in operation since May 2014 on a 350 t converter at ArcelorMittal Poland Katovice.

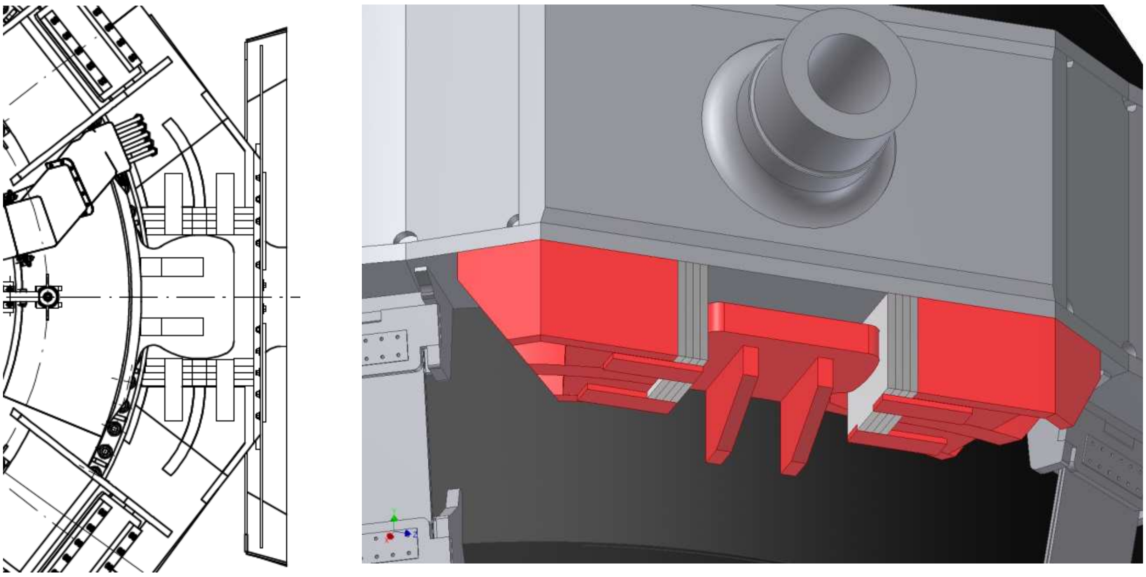

Figure 7: Special horizontal suspension element (DANI-ELLA element).

2.4 Tilting Torque

The design of the new converter is optimized in order to meet the requirements of the existing system. Particularly the maximum allowable torques of the existing tilting drive have to be respected.

In parallel the self-uprighting tendency of the converter has to be fulfilled as well. For meeting all these requirements and consideration of all boundary conditions this issue could be solved by enlarging the barrel section by 100 mm and apply a design for the trunnion ring with an eccentric arrangement of the trunnion ring body relative to its pins by 100 mm.

In Figure 8 the resulting tilting torques are shown as a function of the tilting angle for different lining and operation conditions as well as converter in frozen steel bath condition. It has to be noticed that solidified steel is a very extreme condition (catastrophic condition) for which much higher allowable torques can be accepted for a very limit time. However, all these requirements could be fulfilled.

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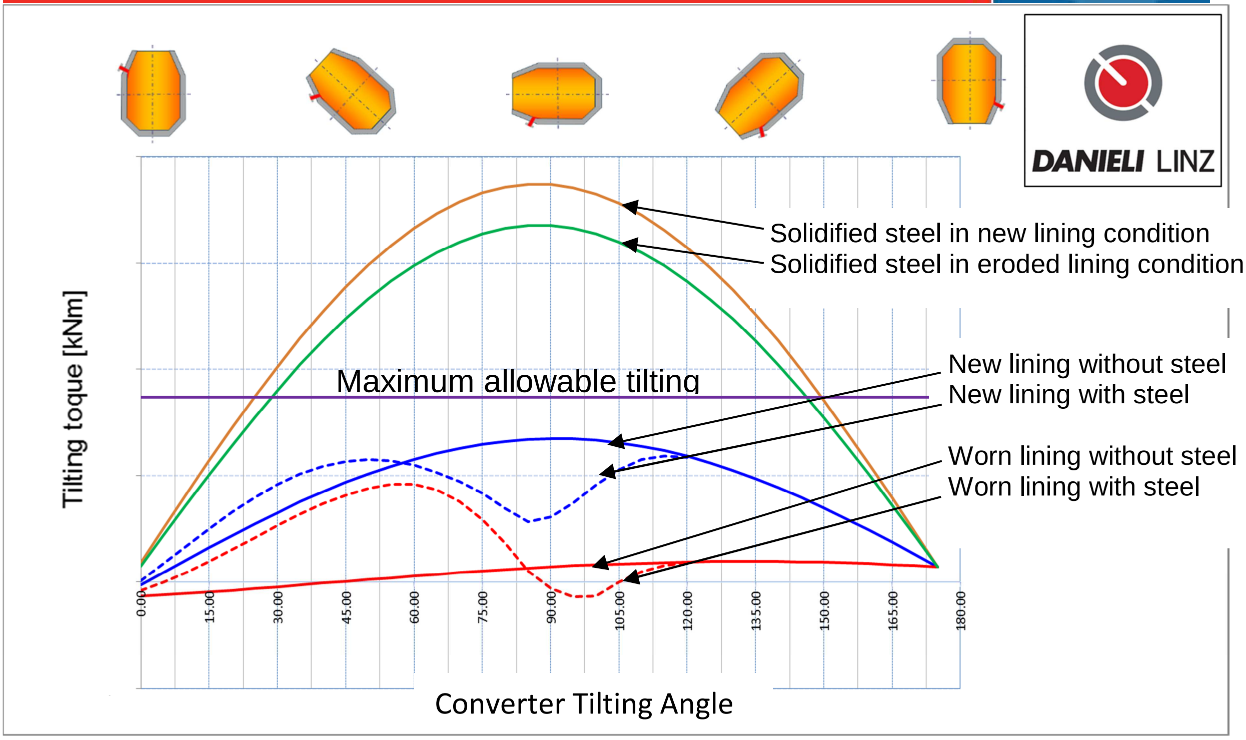

Figure 8: Calculated torque curves of new converter arrangement.

3. PRE-ASSEMBLY OF CONVERTER EQUIPMENT ON SITE

Another strong request was to minimize the pre-assembly activities on site such as welding due to quality reasons. Detailed investigation of the transport possibilities confirmed that an almost fully pre-assembled converter vessel shell with the trunnion ring and the suspension system is possible to be transported to site.

Due to the fact that the top cone should have a bolted connection no welding has to be applied on site. Unfortunately a classical flange connection between top cone and barrel section was not applicable because the tap hole is arranged exactly on the edge zone. Not losing this opportunity a special flange connection in the barrel section between upper part and lower part of the vessel shell was created (see Figure **9**).

This arrangement is a complete new feature of the converter vessel and a new option in case of interferences. Additionally the flange outer diameter was chosen small enough that an installation of the complete vessel shell into the finalized trunnion ring is possible. With this feature the welding of vessel shell on site at Aperam Timoteo plant could be avoided completely which reduces the pre-assembly- as well as erection-time seriously and was also a key factor for been awarded for this project.

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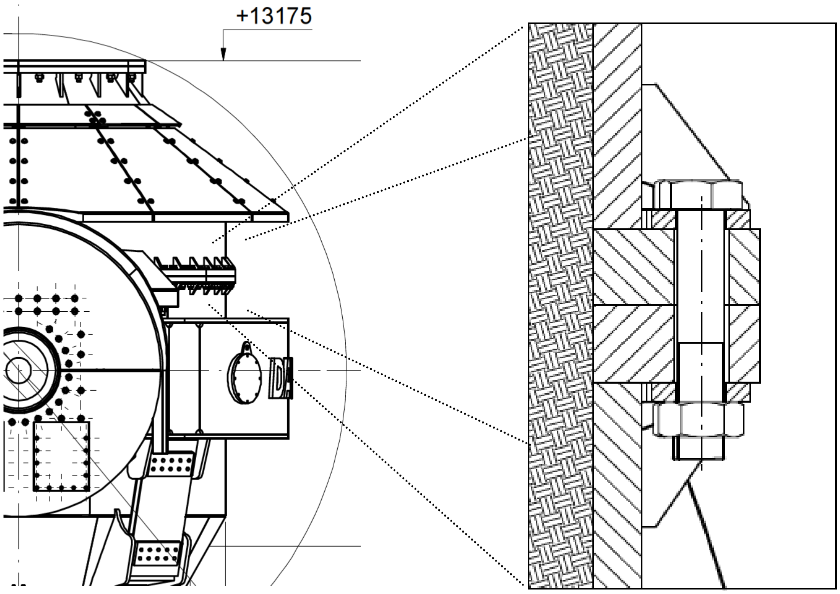

Figure 9: Arrangement of the flange connection between upper and lower part of the vessel shell (right flange details)

4 CONCLUSION

In the steelmaking shop of Aperam Timoteo the existing MRP-L converter has to be exchanged by a state of the art solution.
A key factor for the new system was the exchange of the trunnion ring. The existing one is based on a bolted connection between ring body and the pins. By applying a welded connection of the pins the large flanges and nuts can be avoided and additional space for enlarging the converter itself is gained. The maintenance free suspension system which is composed of vertical lamella and horizontal DANI-ELLA elements is a pre-condition to use fully this additional space.
With this bigger vessel the reaction volume is seriously increased which supports a lot the steelmaking process in order to reduce slopping and blowing time and increases yield.
By introduction of a flange connection in the barrel section of the converter vessel shell the high quality site welding could be avoided completely and pre-assembly time is minimized. Investigation of the transport route to site and optimizing the in-house manufacturing process the total project time is minimized as well
Based on these above mentioned features following improvements for the new MRP-L converter can be realized:

- New trunnion ring with welded pins
- Converter with increased volume from 56 m³ to 62.2 m³ → a plus of 11 %
- Maintenance free suspension system based on DANI-ELLA horizontal and lamella type vertical elements
- Maintaining the existing tilting drive, bearing size, bearing housings and dog house
- Minimizing pre-assembly activities by avoiding site welding due to flange connection of upper part of vessel shell
- Optimized slag shield design
- Minimizing the total project time

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Based on all these assumptions DANIELI was honored in December 2014 with the supply of a state of the art 80 t MRP-L converter including trunnion ring, suspension system, slag shields and bottom stirring system.

Acknowledgments

Aperam is a global player in stainless, electrical and specialty steel, with customers in over 40 countries. The business is organized in three primary operating segments: Stainless & Electrical Steel, Services & Solutions and Alloys & Specialties. Aperam has 2.5 million tonnes of flat stainless steel capacity in Brazil and Europe and is a leader in high value specialty products. Aperam has a highly integrated distribution, processing and services network and a unique capability to produce stainless and specialty from low cost biomass (charcoal). Its industrial network is concentrated in six production facilities located in Brazil, Belgium and France. Aperam has about 9,400 employees.
Aperam commits to operate in a responsible way with respect to health, safety and the well-being of its employees contractors and the communities in which it operates. It is also committed to the sustainable management of the environment and of finite resources. In 2014, Aperam had revenues of USD 5.5 billion and shipments of 1.81 million tons.
For further information, please refer to our website at www.aperam.com

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