EXCHANGE OF THE 130 T LD CONVERTERS AT BELGO – JOAO MONLEVADE WORKS WITH A NEW VAI-CON® LINK SUSPENSION SYSTEM[1]

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Abstract
In September 2003 Belgo Mineira awarded a turnkey contract to VAI (now SIEMENS-VAI) for the exchange of two 110 t converters with new converters with 130 t capacity. The new converters were built using creep resistant steel (ASTM A 204 Gr.A) and the well proven VAI-CON® Link suspension system which replaced the lamella suspension system of the original converters. In order to reach increased lifetime of the converters, a barrel cooling system was installed, which lowers the converter shell temperature by approximately 100 degrees C in the critical area of the trunnion ring. Cone cooling was also installed using reinforced cooling channels. The great challenge for converter exchanges is typically to minimize the shut down time. In the case of converter 2, which was exchanged first, the work beginning with removal of interferences up to and including refractory work, was concluded within 24 days. In case of converter 1, the same work could be reduced to 22 days. These times are remarkable considering the continuing production of the other converter.
Key words: LD-Converter; VAI-CON® Link.

TROCA DOS CONVERTEDORES DE 130t NA BELGO – JOÃO MONLEVADE TRABALHA COM O NOVO SISTEMA DE SUSPENSÃO VAI-CON® LINK

Resumo
Em Setembro de 2003, a BELGO Mineira concedeu à VAI (atualmente Siemens VAI) um contrato para a troca de dois convertedores de 110t por convertedores de 130t de capacidade. Os novos convertedores foram construídos usando aço resistente a fluência (ASTM A204 Gr.A) e o já provado sistema de suspensão VAI-CON® Link, o qual substituiu o sistema de suspensão de lamela dos convertedores originais. Para se obter um tempo maior de vida dos convertedores, foi instalado um sistema de resfriamento da carcaça, o qual diminui sua temperatura em aproximadamente 100ºCelsius na área crítica da cinta do convertedor. Um sistema de resfriamento do cone também foi instalado usando canais de resfriamento reforçados. O grande desafio para trocas de convertedores é, tipicamente, minimizar o tempo de parada. No caso do convertedor 2, o primeiro a ser trocado, desde o inicio do trabalho com a remoção das interferências até o trabalho de refratários foi concluído em 24 dias. No caso do convertedor 2, o mesmo trabalho pôde ser reduzido para 22 dias. Esses tempos são memoráveis, considerando-se a continuidade de produção do convertedor.
Palavras-chave: Convertedor-LD; VAI-CON® LINK.

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INTRODUCTION

The two existing LD-converters with an original design capacity of 110-t at Belgo, Usina de João Monlevade, Brazil, originally installed in 1984, have been in service for approximately 20 years. As the vessels neared the end of their useful lifetime, problems associated with creep deformation and dislocation of the trunnion pins were temporarily remedied by Belgo in 1990 and 1996 by repositioning the free side bearing support. In 2002 Belgo decided to exchange the two existing LD converter vessels. VAI was awarded the turnkey contract for this converter exchange project in October 2003. The new project considered the same converter shell geometry as for the original vessels, and by changing the refractory design and verification of the tilting drives, an increased capacity of 130 t could be reached.
A particular challenge of this turnkey project was to fully install the new converters, trunnion rings, using the existing tilting drives and bull-gears by December 2004, only 15 months after the commencement of the project. In order to keep at least one converter operational at all times, the converter exchange itself was carried out in less than 27 days from shut down to start up for each converter.

Project Milestones	
Order	October 2003
Engineering	by January, 2004
1. Set for Plant LD 2	
Ship-Transport	September, 2004
Erection	7th October to 1st November, 2004
Charge	4th November , 2004
2. Set for Plant LD 1	
Ship-Transport	October, 2004
Erection	19th November to 13th December, 2004
Charge and final acceptance	15th December, 2004

MODERNIZATION PROJECT

The goal of the modernization project was to replace the existing converters with state of the art technology, considering the reuse of some existing equipment and maintaining the available space requirements.
The following equipment had to be reused:

- Converter pedestals
- Tilting Drive
- Removable Converter Bottom

The existing converter, suspension and trunnion ring were already significantly deformed and had to be replaced. The picture below shows the condition of the converter before the exchange.

Figure 1: Converter Before Exchange in 2003

The dislocation of the trunnion ring during the years made it also necessary to relocate the pedestals in order to continue operation. An example of the measured dislocation is shown in figure 2 below.

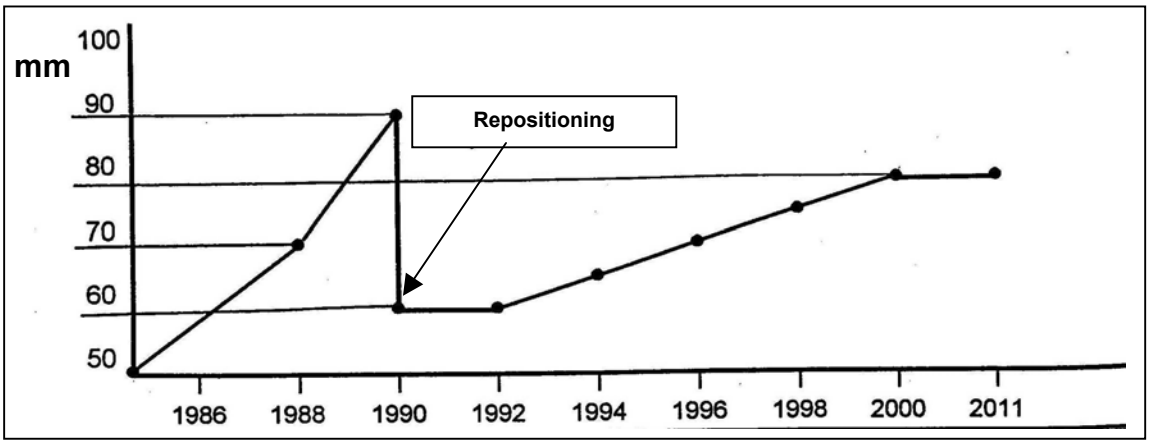

Figure 2: Dislocation of Trunnion Pin at Free Side Bearing

A further relocation of the bearing pedestal was not possible and a replacement of the converter including trunnion ring was necessary.
For the new converter system, the following main features were chosen to guarantee maximum lifetime of the converter:

- Installation of the VAI-CON® Link Suspension System for both converters
- Use of creep resistant steel (16 Mo 3) for the converter
- Application of vessel air cooling through the trunnion ring
- Application of lipring cooling

The VAI-CON® Link Suspension System was introduced to the market in 1996 [1],[2] and the first installation was at ISCOR Newcastle works in South Africa [3]. The start-

up of the first of ISCOR's three 170 t LD converters was in December of 1997. Over 35 converters with capacities varying from 67 t to 375 metric tons have now been equipped with this suspension system and are currently in successful operation.
The main design features of the new converter are shown in the figure below:

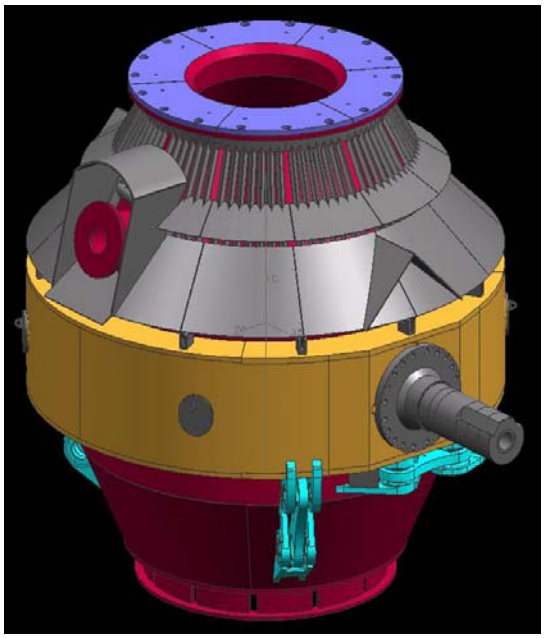

Figure 3: Belgo New Converter Design with VAI-CON® Link Suspension System

One of the most essential characteristics of a statically determinate system is that any deformation (thermal expansion, long-term deformation) does not cause any additional reaction forces in the supports. This means, when applied to a suspension system for a converter, that thermal and long-term deformation are not hindered at all. For this reason there are no additional stresses caused by restricted deformation.
Using a link as the basic element, six elements are used for the support of the converter in order to fulfill these criteria. Three "vertical links" are applied to hold the converter in blowing and up-side-down position. Another two "horizontal links" positioned perpendicularly to the axis of rotation hold the converter in charging and tapping position. A sixth element, the stabilizer, acts in the direction of the axis of rotation to stabilize the converter in the direction of the trunnion pin. Fig shows the principle of this suspension system.
With these six elements all six degrees of freedom for a body are fixed in space. Any additional element causes uncontrolled (additional) stresses and strains in the system.

Figure 4: VAI CON® Link Suspension System

MANUFACTURING AND ERECTION

In order to implement the project as quickly as possible the orders for the main equipment units and erection were placed immediately with the one of the most experienced manufacturing and erection company after commencement of the contract. On-time completion of manufacturing and fulfillment of all quality parameters were assured by the continuous presence of Siemens-VAI supervisory personnel at the factory sites.
Utmost attention was placed on the exact transport logistics from the manufacturing site to the steelmaking plant as well as on dismantling and erection of the converter plant. Careful preparation and implementation of an exact time schedule for each erection step was vital for meeting the tight project deadlines. All project activities to be carried out on a daily basis were included in the time schedule, thus ensuring precise and undisturbed project implementation.
The erection activities are summarized by the following main activities:
Site Mobilization and Pre-Assembly Work

- On-site installation and prefabrication of auxiliary structure
- Assembly of converter vessel with trunnion ring in the charging bay
- Assembly of the VAI-CON® Link Suspension System

Dismantling

- Break-out of existing lining
- Dismantling of doghouse side walls and parts of the roof
- Dismantling of fixed hood, including skirt
- Removal of the converter cone and bottom section
- Disconnection of housing of tilting-drive bearing
- Removal of trunnion ring together with the vessel mid-section in the charging bay

Figure 5: Dismantling of Old Converter Equipment

Installation of New Equipment

- Inspection and checking of tilting drive
- Transport of preassembled converter and trunnion ring to the transfer car
- Mounting of bull gear on the trunnion ring pin
- Positioning of converter with trunnion ring in the bearing housing
- Fixation of converter unit and tilting stands
- Installation of fixed hood with skirt and doghouse
- Mounting of tilting drive
- Welding and testing of top cone and taphole socket
- Installation of slag shields, bottom stirring elements, utilities, etc.
- Cold tests and function tests
- Lining of converter

Figure 6: New Converter Equipment during Installation

RESULTS

The Project was executed in the planned time schedule and the startup occurred without delays. This was possible because of the excellent collaboration between Belgo and VAI during the whole project phase.
After the startup, thermographic measurements were made to check the outside shell temperature. The figure below shows the result of the measurement, indicating the effectiveness of the top-cone cooling system.

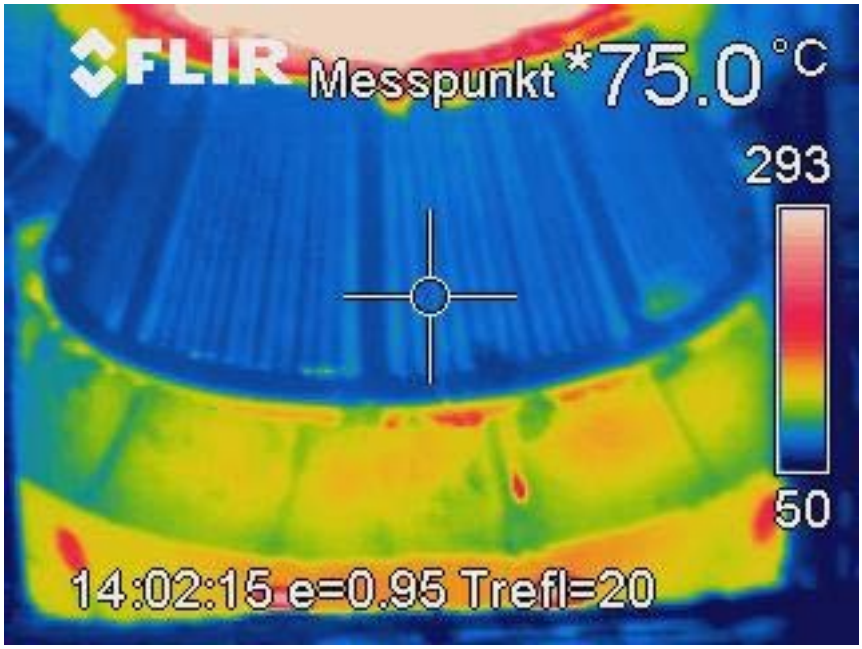

Figure 7: Thermographic Measurements of the Converter Shell

CONCLUSION

The VAI-CON® Link Suspension System represents a new generation of suspension systems. It combines the advantages of industrially proven components with the ideal design philosophy of de-coupling the distortions between the vessel shell and trunnion ring (in any operating condition) as a result of statical determinancy.
VAI was now been honored with 48 orders for following converter installations equipped with the VAI-CON® Link Suspension System.

Table 1: Overview of the current VAI-CON® Link references worldwide.

PLANT	Heat size [t]	Start up
MITTAL Steel (ISCOR) Newcastle, South Africa	175	12/1997
MITTAL Steel (ISCOR) Newcastle, South Africa	175	6/1998
MITTAL Steel (ISCOR) Newcastle, South Africa	175	2/1999
MITTAL Steel (ISCOR) Vanderbijlpark, South Africa	170	7/1998
MITTAL Steel (ISCOR) Vanderbijlpark, South Africa	170	9/1998
MITTAL Steel (ISCOR) Vanderbijlpark, South Africa	170	12/1998
HUTA Sendzimira, Poland	150	8/1998
VOEST-ALPINE Donawitz, Austria	67	10/1999
VOEST-ALPINE Donawitz, Austria	67	5/2000
ILVA Taranto, Italy	375	12/1999
ILVA Taranto, Italy	375	8/2000
ILVA Taranto, Italy	375	4/2001
SSAB Luleå, Sweden	120	7/2000
SSAB Luleå, Sweden	120	8/2000
COSIPA, Brazil	160	7/2001
COSIPA, Brazil	160	9/2001
COSIPA, Brazil	160	1/2002
XINGTAI, China	55	12/2002
XINGTAI, China	55	5/2004
XINGTAI, China	55	6/2004
Zhangjiagang, China	180	3/2004
Zhangjiagang, China	180	4/2004
Zhangjiagang, China	180	5/2004
CSN, Brazil	180	3/2006
US Steel Kosice, Slovak Republic	220	3/2005
US Steel Kosice, Slovak Republic	220	12/2005
Belgo, Brazil	110	11/2004
Belgo, Brazil	110	12/2004
Wuhan, China	300	3/2005
Taiyuan, China	180	8/2006
Taiyuan, China	180	8/2006
Alchevsk, Ukraine	250	2007
Alchevsk, Ukraine	250	2007
Maanshan, China	300	3/2007
Maanshan, China	300	4/2007
AHSMA, Mexico	60	3/2007
Tian Tie, China	180	4/2007
Tian Tie, China	180	5/2007
POSCO Pohang	210	2007
Handan, China	300	2007
Handan, China	300	2007
POSCO deP Gwang Yang	300	2007
Nishnji Tagil, Russia	180 t	10/2007
Nishnji Tagil, Russia	180 t	2007

Nishnji Tagil, Russia	180 t	2008
Nishnji Tagil, Russia	180 t	2008
CSA Thyssen Atlantic Steel, Brazil	330 t	2009
CSA Thyssen Atlantic Steel, Brazil	330 t	2009

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