SPECIAL EQUIPMENT FOR PICKLING LINES AND TANDEM MILLS FOR NEW INSTALLATION AND REVAMPING[1]

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Abstract
Performance requirements have become ever higher over the last decades. In the steel industry and for various applications (pickling lines, tandem mills, galvanizing lines, inspection lines…) a lot of parameters have drastically changed in terms of thickness range to be processed, performance requirements, ease of maintenance. But one of the main highlights is the emergence of new steel grades in the product mix. Tensile strength and elongation of the steel grades are becoming ever higher with steel grades up to 2000 MPa to be expected in the forthcoming year (?). As special equipment is key point for revamping projects, Siemens VAI offers industrial solutions for inspection systems, scale breakers, side trimmers and laser welders with a comprehensive integrated package (mechanical and automation) within a short shutdown period.
Key words: Special equipment; Mechatronic; Scale breaker; Inspection system; High-strength steels.

EQUIPAMENTOS ESPECIAIS PARA LINHAS DE DECAPAGEM E TRENS LAMINADORES PARA INSTALAÇÕES NOVAS OU REFORMA DE LINHAS

Resumo
Os requisitos de desempenho têm aumentado continuamente ao longo das últimas décadas. No caso de inúmeras aplicações na indústria siderúrgica (linhas de decapagem, trens laminadores, linhas de galvanização, linhas de inspeção, ...), muitos parâmetros têm se modificado drasticamente em termos de faixa de espessura a ser processada, requisitos de desempenho, facilidade de manutenção. Mas um dos principais destaques é o surgimento de novas qualidades de aço no mix de produtos. O limite de resistência à tração e a elongação do aço estão aumentando ainda mais, prevendo-se o lançamento de qualidades de aço de até 2000 MPa no próximo ano (?). No que diz respeito à reforma de linhas de decapagem e trens laminadores, a Siemens VAI está em condições de proporcionar experiência de alto nível para oferecer aos seus clientes as soluções mais adequadas às suas necessidades. Uma vez que equipamentos especiais são um ponto essencial para projetos de reforma, a Siemens VAI oferece soluções industriais para sistemas de inspeção, removedores de carepa, aparadeiras laterais e máquinas de solda a laser com um abrangente pacote integrado (mecânica e automação), que podem ser implementadas em curtos períodos de parada.
Palavras-chave: Equipamentos especiais; Mecatrônica; Removedor de carepa; Sistema de inspeção; Aços de alta resistência.

[1] *Technical Contribution to the 45th Rolling Seminar – Processes, Rolled and Coated Products, October 21st to 24th 2008, Ipojuca - Porto de Gainhas - PE*
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1 INTRODUCTION

Siemens VAI has been developing its activity as a welder manufacturer for the iron and steel industry for more than 10 years.
In the last few years the requirements for the processing lines and its equipments have changed tremendously with:

- The emergence of new steel grades.
- Changes in the strip format range
- High level of performance with perfect quality criteria and automatic control to avoid human intervention.

Among all the equipments of a line, some specific equipment's (welders, scale breaker, side trimmer and inspection system) are highly concerned by these changes. Therefore Siemens VAI has developed a full range of products called mechatronic package. The mechatronic package performances must, therefore, incorporate all of the above aspects to be able to meet the current and future requirements of the steel industry.

2 REQUIREMENTS FOR MECHATRONIC PACKAGES

Emergence of new steel grades

Over the last few years steel grades have changed drastically. The main evolution trend concerns yield strength and elongation. New steel grades are characterized by high yield strength and high elongation level.
With TRIP and DP steel the lines are already processing steel up to 1000 / 1400 MPa and it is anticipated that they will process steel up to 2000MPa tensile strength in the future.
In addition, the new steel grades represent an ever increasing portion of the total production.

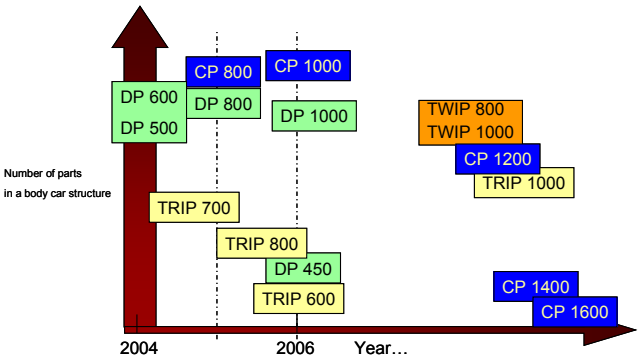

Figure 1 – New Steel Grades

Changes in product format

The main evolution is the thickness range with ever thinner gauges. The thickness range required for mechatronic products is now less than 1 mm thickness for the pickling line and tandem mill.

High level of performance

Taking all above points into consideration, the level of performance required from these mechatronic packages has also been significantly improved. Availability, product quality, cycle time have reached a level never attained until now for these products.

3 SIEMENS VAI MECHATRONIC PACKAGES

An extensive R&D program has been conducted by Siemens VAI in the field of mechatronic packages for more than 10 years.
All these developments were led following a systematic approach, starting from customers needs to initial process qualifications and finalized with extensive tests over a large product mix.

CLECIM® Welders

After developing a new « Flash Butt » welder concept for pickling and fully continuous rolling mill …), the laser welding process has been developed first on light gauge (LW21L) for galvanizing lines, inspection lines…and then on heavy gauges (LW21H) for thickness ranges from 0.5 to 7 mm.

Figure 2 – Laser Welding Process

High strength steel welding requirements mainly consist of three points:

- perfect cutting quality and high capacity for high strength steel.
- high welding capacity with a high level of robustness of the parameters used.
- Improved weld zone strength by annealing treatment.

To meet the top level performance, on the last welder brought out by the Siemens VAI engineering department, an innovative design has been defined with a completely stationary and robust shear always in the same position in the line axis. All the welder components (shearing, clamping,…) have been calculated to process steel up to 2000 MPa.
Shearing parameters are automatically adjusted according to the welded thickness to optimize the cutting quality and the shear blade life time.

Figure 3 – LW21H machine

Table 1 – Main Machine Data

		LW21H
Thickness	mm	0.5 to 7
Laser source	KW	8
Clamping force	kN	400
Shearing force	KN	1500

The welding quality is also ensured by a perfect control of the gap between strips, perfect guiding of the strip through the follower rolls and an optimized welding operation because of a double focus welding head.A welding quality control system using a CCD camera permits the control of the welding quality (porosity presence and seam width) and of the seam geometry (strip level, concavity, convexity).
For high strength steel with very high yield strength an annealing system could be required to soften the welded area (weld and heat affected zone or HAZ) and to release the internal stresses created by the weld zone. The final goal is to improve the welding quality.

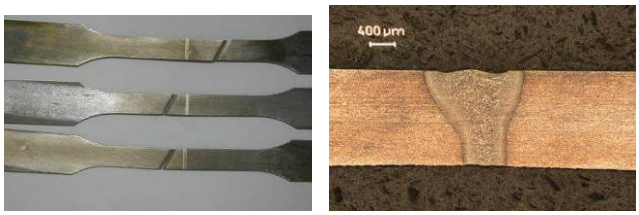

Figure 4 – Weld Samples and cross-section

Scale breakers

Scale breaking tension leveller is a time-tested technology, developed in 1953 and adapted for pickling line in 1975. CLECIM® scale breakers range covers the whole range of product, with a special care on high strength steel.
With different configuration possible, Siemens VAI is able to answer exactly to the expectation of the customer:

- different width range
- different tension inside the stand
- dry or wet system for scale exhaust system
- different solution for bridle driving

Table 2 – Scale Breaker capability

	Max tension inside the stand (Ton)		
Wok Roll Barrel length (mm)	50	65	100
1600	Angang Arcelor Wisco Bokaro		
1850		Posco Angang USS	
2100			Arcelor Ugine LC2i
2400			

The scale breaker is composed of one stand (including two sets of levelling units and one set of anti crossbow unit), a dust collection system (« dry »: by air suction or « wet »: by water spraying) and entry and exit tension bridle with their drive system (electrical or electro-mechanical drive)

Figure 5 – Scale Breaker Stand

The strip in the stand is submitted to a series of alternate flexions under tension on the work rolls. The result is an elongation of the strip which corrects the flatness and cracks the oxide layer. The performance of the Siemens VAI Mechatronic package allowed increasing the pickling efficiency by about 30% and therefore the line productivity.

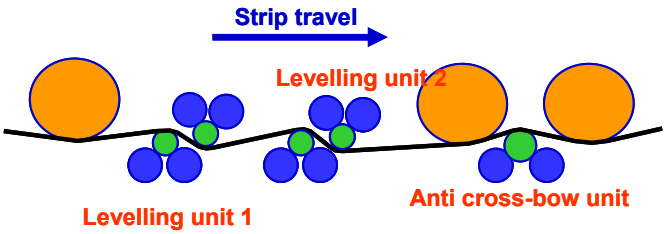

Figure 6 – Scale Breaker configuration

This Mechatronic product ensures a high improvement of the strip flatness, especially on strips with high yield strength with 2 sets of two levelling unit in operation.).
The scale breaker tension bridle may be driven by a large choice of system, the most used are the all Electric Drive and the Electro Mechanic drive. Each system has its own advantage; the choice depends on the tension, speed and available space.

An efficient scale exhaust device is the key of the line entry cleanliness, and thus the operator's safety. The choice between dry or wet system permits to have the best efficiency, depending on environmental conditions.
The Siemens VAI scale breaker compact design and the flexibility due to the different configuration available allows it to be installed in existing line including the Push Pull Pickle Line

Side trimmer

The range of side trimmer is covering all type of line from heavy thickness like 12mm up to thinner thickness 0,15mm.

Figure 7 – Side Trimmer

This mechatronic product is designed to reach a high level of performance on all the product range and especially on high strength steel with a body built in strong square shape welded structure to give stability for the knife shaft.
A full automatic control by a dedicated PLC permits the adjustment through servo motors of the trimming parameters according to the product (thickness, grade, width):

- lap
- gap
- width

This design and controls permit to obtain a high accuracy on the width adjustment with a tolerance of +0 / +1mm.

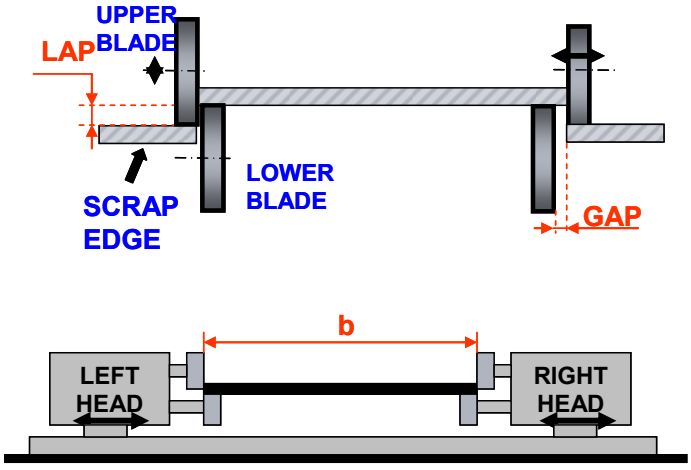

Figure 8 – Side Trimmer Adjustments

The rotation of the turret is also ensures by servo motors to authorized a fast knifes replacement
As a result of the R&D program of Siemens VAI, a new Dynamic Width Adjustment Side Trimmer has been developed. This new generation of side trimmer is able to

trim the edge continuously during the width change with the advantage to reduce the line stop during width change of the strip.
The speed of the line is only lowered when the weld arrive in the side trimmer area; the mechatronic move the knife to make a double curve and the width change in the same time (see schematic hereunder)

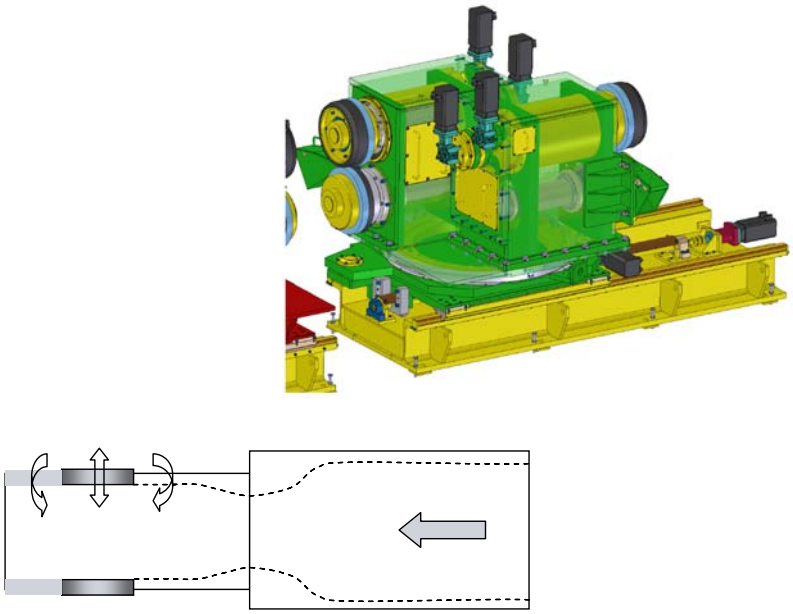

Figure 9 – Dynamic Width Adjustment

As a mechatronic package, the side trimmers are systematically fully assembled and tested in our workshop in order to have a complete control of the performances of the equipment delivered to our customers.

Surface inspection system (SIAS)

The quality of the strip surface is a key point for the final product and the final use of the strip. The surface inspection has different target:

- Final product quality
- Reduce production loses
- Tandem work roll protection

The surface inspection could be made manually by operators but this control presents a lot of limitation and in particular:

- non constant control on an important production
- no repeatability (depending of the appreciation of the operator)
- time consuming
- requires a lot of resources

SIEMENS VAI Clecim is able to propose to its customers an automatic surface inspection (SIAS) that provides.
Constant and identique control in time.

- Process interactivity (repeating defect)
- Different services access in real time.
- Hole detector

Therefore SIEMENS VAI Clecim is able to propose to its customers an automatic surface inspection (SIAS) with a high level of performance.
Coming from the space and military application (MATRA), pioneer in image processing, the detection system has been adapted to the steel industry. This mechatronic product is an association of performance, efficiency, simplicity and reliability.
The solution developed by Siemens VAI Clecim includes a maximum of 2 side line-scan cameras with specific lighting for the strip inspection, a real time detection and classification of defects with a live display of the strip image.
Introduced in 2004 and coming from the research effort of Siemens VAI team, a claim resolver enables the relevancy of a claim in every single place of a coil through a full resolution digital recording of the totality of the coil (in HDD, DVD, Data base…).

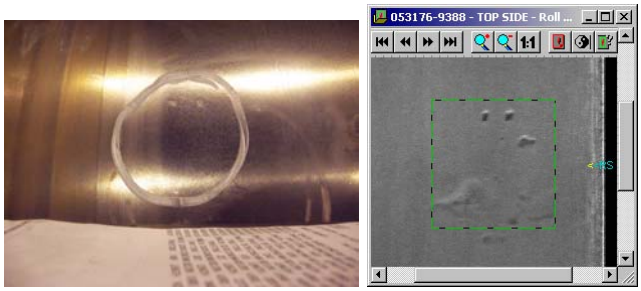

Figure 10 – Automatic Surface Inspection

Taking all this into consideration, the SIAS® system permits to have efficiency over 90%, a constant and repeatable control and to reduce the line stop. This system avoids also the line stop and because of the low investments compared to the costs saving, the payback is very fast and huge.


Figure 11 – Light system

Due to the very short space required, to the short line stop required for its installation and commissioning, this mechatronic product could be installed on new line and also very easily on existing line.

4 CONCLUSION

Due to the level of performance required for the special product over the full spectrum of steel grades having ever higher strength, only few companies are in a position to propose the full range of mechatronic product to iron and steel makers. SIEMENS VAI increased the production in POSCO for example from 1,1 to 2,2 MiT / Year – in this case however many other modifications like turbulent pickling and double POR contributed. The increase of production is measured by the speed at which the line can be operated, for same quality pickling, with and without scale breaker.

Siemens VAI, as a result of its extensive Research and Development efforts, has become one of the world leaders in the field of special machines and has demonstrated the high capacity of its products to weld high strength steel. Whatever the product (welder, scale breaker, side trimmer or surface inspection system), Siemens VAI is able to propose a high level of performance for all different mechatronic products based on customer's requirements whatever the project is from new installation to line revamping.

In addition, with its workshop facilities, Siemens VAI gives the possibility of conducting workshop tests on different mechatronic product.