EWR® "ENDLESS WELDING ROLLING MILL" THE RESULTS OF INNOVATIVE EQUIPMENT FOR EFFECTIVE COST SAVING OPERATING PLANTS(01)

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1-Abstract
Today effective solutions are available for drastically reducing production cost in wire rod and bar mills. In the last years Danieli Morgardshammar developed several new technologies for increasing mill efficiency and minimise production cost.

Among the most significant, the "Endless Rolling" process by billet welding after the re-heating furnace (EWR®).

EWR® enables elimination of billet gap time, reduction of cobble rate, reduction of mill downtimes, elimination of short bars in cooling bed, head and tail cropping granting, longer life of consumables, easier plant management and "tailor-made" coil weight.

This article describes the process in detail and the feed-back from the operating plants that confirm the absolute validity of this revolutionary process.

Keywords: reduction, process , efficiency

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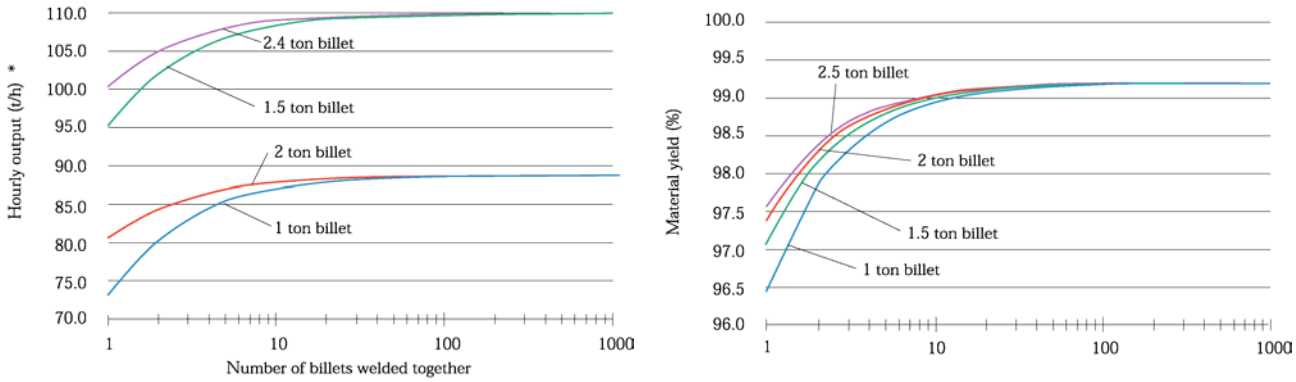
2- Foreword

Competitiveness is the main goal common to all steel producers to hold a leading position in today's market more demanding and tougher than ever. Competitiveness means top quality products and high output capacity at the lowest possible transformation costs.
Plant manufacturer's mission is to provide steel producers with the most advanced technology both in terms of machinery and production processes, in order to enable them to reach their targets.
Continuous efforts in research & development have made it possible to introduce several significant innovations, some of which are absolutely revolutionary and unique, resulting in a "generation change", in the production of long products.
The revolutionary EWR® Endless Welding Rolling is specifically presented.

3-EWR® Endless Welding Rolling process

Pic. 1 - EWR® line at ALPA-bar mill- France

EWR® Endless Welding Rolling is the innovative process that, by automatic continuous on-line welding of billets at re-heating furnace delivery side, enables uninterrupted production at the rolling mill (see pic.1).
The process makes it possible to roll an "endless bar", eliminating billet gap time and the related bar front/back ends, for straight bars, sections, wire rod and bar-in-coil production (in variable "customised-weight" coils).
EWR® process enhances plant capacity, efficiency and material yield (see pic. 2), granting consistent product quality, easier production planning, plant management and lower production costs.
EWR® can weld 100 to 200-mm square & round billets and corresponding sections with 30% max ratio between the two sides, in all grades of carbon and alloy steels including stainless steels.
It is ideally applicable to new plants and for the revamping or upgrading of existing rolling mills, both for commercial and speciality steel grades.



Pic. 2 - Effect of EWR® process on hourly output capacity and on material yield

3.1- EWR® process means a 12-14% increase in production capacity and better plant efficiency, up to 99% material yield, homogeneous and repetitive material quality, better production planning with easier plant management and average 3-6% reduction in specific energy consumption (for a 250,000-750,000-tpy rolling mill).

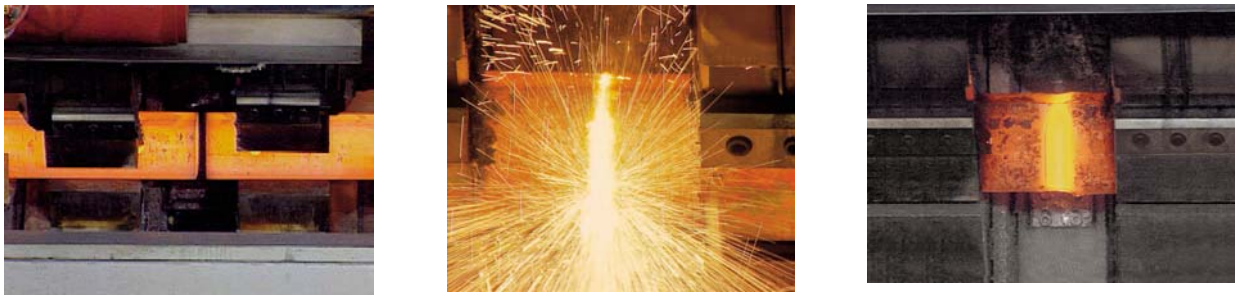
As a result, substantial production cost savings can be obtained (3.5-4.0 US $/ton on average). This is made possible thanks to no inter billet time, no bar head and tail cropping during rolling, no short bars/short ends, no coil trimming in wire rod production, high rolling speed easy maintained after mill tuning, lower occurrence of cobbles, longer life of entry guides, rolling rolls laying pipe in wire rod mills and guiding elements in general and lower requirement in maintenance, spare parts and consumables.

The process contributes to making the product higher marketable through the homogeneous and repetitive material quality between bar lots or between coil and coil also market supply with customised coil weight in bar-in-coil or in wire rod lines (the coil reforming pit fitted with rolled stock dividing unit enables the desired coil weight to be selected from the endlessly-rolled stock, according to specific customer request).

All this means finding new niches in today's ever more difficult market for long products.

3.2-Danieli billet welding unit main highlights are DC drive, unique billet self-centering & clamping system, On-board mounted automatic deburring system, for on-line precise deburring immediately after flash-welding and unique off-line machine positioning system for maintenance without interference with normal production.

In addition, the latest generation EWR® units (first one successfully operating in Greece since December 2002), features a unique advanced system for the fine control and monitoring of the flashing phase. Named "SFC- Smart Flashing Controller", the system grants a real on-time control of the welding stage in order to grant consistent and repetitive high quality welding standards, billet after billet during the production shift (see pic. 3).



Pic 3 - Main steps of the welding sequence

3.3-EWR® coupled with other Danieli advanced production processes:

Highly effective combination of technology can today be formed to cut costs, increase productivity and improve quality in long product rolling mills.

As for wire rod coils:
When coupled with TMB-Twin Module Block® technology, EWR® process enables endless rolling of extra-small size (down to 4.5-mm dia) wire-rod at ultra-high production speeds well over 120 mps, with up to 92% efficiency and up to 99% material yield. First plant in the world using this combined technology is Xinjiang Bayi I&S speciality steel wire rod mill, operating in China since autumn 2002.

As for bar in coils

If coupled with the innovative Spooler line, EWR® enables uninterrupted twist-free winding of hot-rolled & on-line control-cooled round, square & flat bars into high-quality/heavy-weight/ultra-compact coils weighing up to 5-Ton, even using low-weight starting billets.

First plant in the world to operate the joint EWR® & Spooler technologies will be ALFA Acciai bar mill in Italy as from middle 2004.

As for straight bars

Coupled with the High-Speed Twin Channel and/or to Multi-Strand Slitting system, EWR® process makes it possible to fully exploit bar mill productivity and efficiency, even for the smallest bar sizes. World's top performances are achieved through endless production of small-size bars at 40-mps, on two finishing strands.

3.4-EWR® plants in the world.

To date Danieli EWR® lines reference-list totals 11 lines: nine of them installed world-wide plus another two presently under supply in Mexico and in Italy.

First tests were carried out at middle '90s in a Danieli pilot plant in Italy. The first two EWR® plants were started up in 1999 in Malaysia and Thailand.
The list of other reference plants continues with:

- June 2000 - Deacero Celaya 500,000-tpy n°1 bar mill-Mexico. First billet welding line in the Americas (see pic. 4).

- December 2000 - Tangshan I&S 900,000-tpy bar mill. First welding line in China.
- April 2001 - ALPA (Acièries et Laminoirs de Paris) 700,000-tpy bar mill-France. Europe's first welding line in operation.
- October 2001 - Lianyuan I&S 150-tph bar mill. The 2nd welding line operating in PR of China.
- Autumn 2001 - Xinjiang Bayi I&S-PR of China, 400,000-tpy specialty steel rod mill. World's first wire-rod endless-rolling plant (operating in connection with TMB Twin Module Block® system).
- December 2002 - Helliniky Halyvougia existing bar mill. First in Greece to operate in endless rolling mode.
- Year 2003 - Halyvourgiki Inc, Greece. The new 500,000-tpy mill will be first in Europe to produce wire-rod & sections in endless-rolling mode.
- Year 2004 - Deacero Saltillo-Mexico. This will be the second EWR® line supplied to Deacero Group and the first endless-rolling wire-rod line in the Americas.
- Year 2004 - ALFA Acciai-Italy. This will be the first combined endless rolling / spooler line, worldwide.

3.5-Practical advantages and return data from plants

Production reports and data collected from operating plants confirm EWR® process effectiveness in terms of output capacity, plant operation, reduction of production costs and product quality.

Pic 4 - Deacero Celaya EWR unit

3.5.1- About plant productivity and cost saving

Pic 2 shows the material yield improvement and related hourly output capacity increase, plotted as a function of the number of billets welded together for various billet weights. More than 90% of Endless Rolling process benefit is exploited already with a 10-billet welding sequence, whilst with 100 welding in sequence benefits are exploited almost to their fullest.

Latest return data from plants show an impressive 99.9% utilisation factor, with over 1600 weldings performed over the 3-daily shifts.

As for plant capacity, a 5% increase for a 150-200,000-tpy mill and 14% for a 900,000-1million-tpy mill can be expected.

As a practical example for a 400-500,000-tpy mill, EWR® process would mean 30-50,000-tpy extra capacity, with correspondent average extra profit of approximately 800,000-1million US $/year.

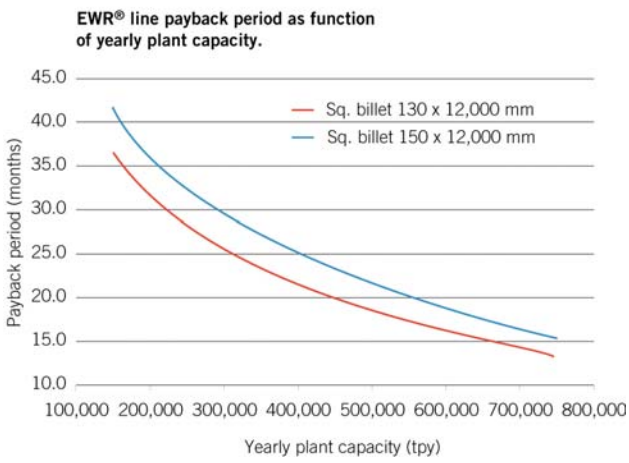
Reduction in specific energy consumption ranges from 2-4% (for a 200-250,000-tpy mill) and 5-7% (for a 700-800,000-tpy mill). A significant 3-4% increase on rolls groove life was achieved on roughing mills, while guide rollers life increase was in the range of 4%, on average.

The combination of output capacity increase with cost reduction due to lower specific consumption ends up in considerable overall conversion cost saving, ranging from 4.1-4.3 US $/ton for 200÷250,000-tpy and 3.4-3.5 US $/ton for 700-800,000-tpy mills. EWR® line installation resulting short payback period is shown in Pic 5.

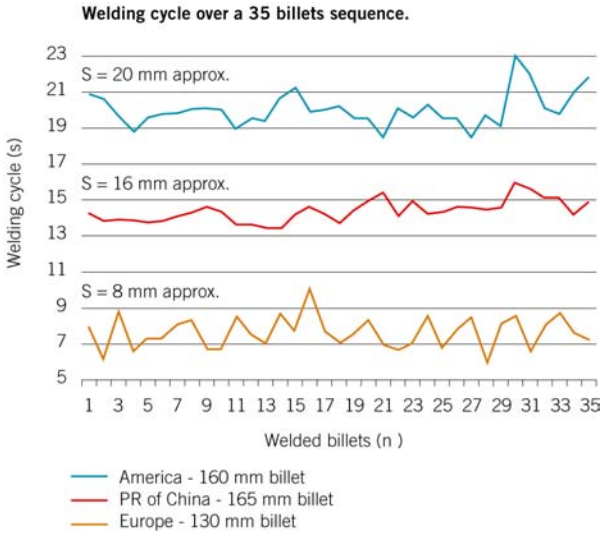
3.5.2- About the welding cycle

Billet ends condition (together with billet size) is one of the key parameters that sets the welding cycle time as it may influence the flash-melting phase in relation to the depth of material to be melted. The greater is the depth of the material to be melted, the longer is the welding cycle.

Welding cycle time and variation over three sequences of 35 billets each, recorded respectively at Tangshan I&S (PR of China), Deacero (Mexico) and ALPA (France) EWR® plants, are shown in Pic 6.



Pic 5 - EWR payback period



Pic 6 - Welding cycle

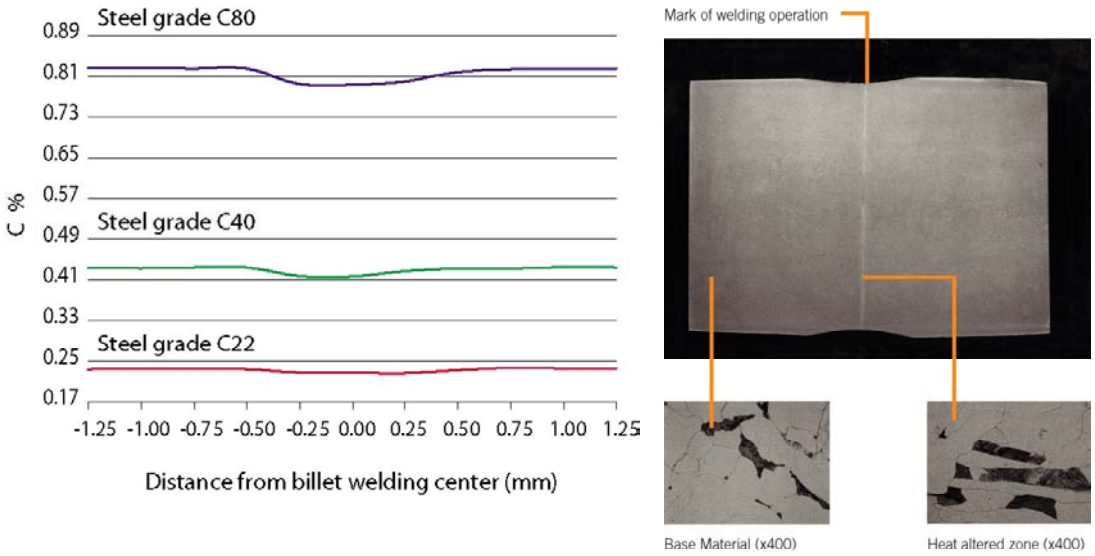
3.5.3- About the material characteristics in the welded area

Tests carried out on billet welded area and on rolled bars testify absence of surface or inner defects as well as variation in chemical composition that could affect the rolling process itself or the end product final application. More specifically:

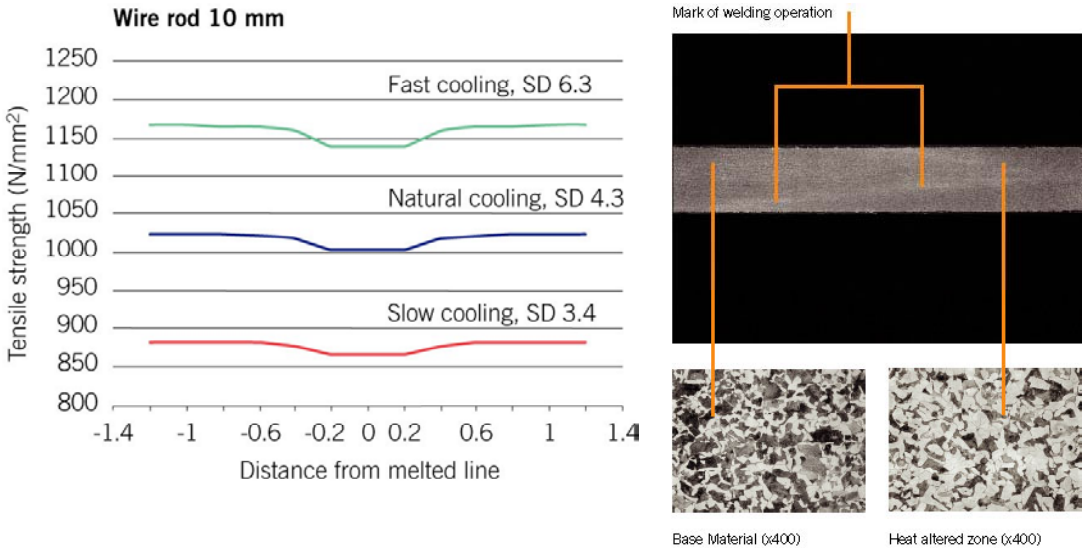
As for billet, a “white line” is the only visible evidence of the welded joint. Pic 7 shows a billet macro of the welded joint area and the negligible Carbon contents alteration in the same.

As for rolled stock, laboratory tests evidenced that yield strength and UTS in the welded area are very similar to base material.

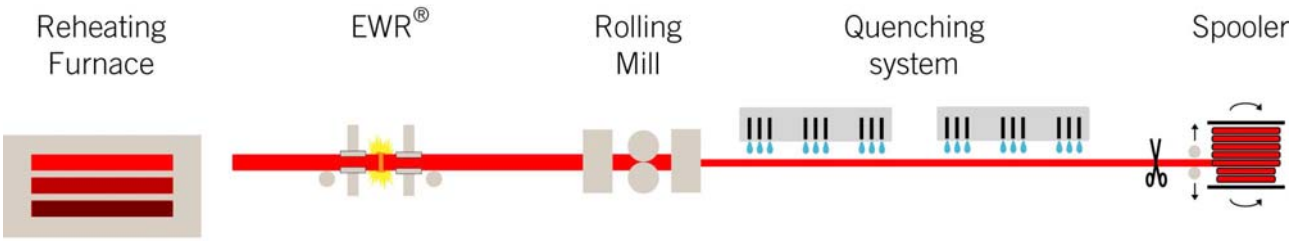
Pic 8 shows the white line deformed by rolling reduction and still visible only on bar sizes larger than 20÷25 mm, whilst in the smaller sizes it disappears.



Pic 7 - Carbon content through billet welded joint



Pic 8 - Tensile strength variation and aspect of welding on rolled stock (30-mm-dia round bar)



Pic. 9: Principle scheme of combined endless rolling spooler plant

4- Conclusion

Availability of the processes as described in the above items has substantially benefited steel producers, enabling to make remarkable steps-forward in technology resulted in lower transformation costs, better product quality, higher productivity, and in creation of new niches in today's ever demanding long products market.

Resumo

Hoje soluções efetivas estão disponíveis para reduzir drasticamente os custos de produção em laminadores de fio-máquina e barras. Nos últimos anos Danieli Morgardshammar desenvolveu várias tecnologias novas para aumentar a eficiência dos laminadores e minimizar o custo de produção.
Entre os mais significantes, o processo de “Laminação Infinita" por soldagem de tarugo após o forno de re-aquecimento (EWR®).
EWR® habilita a eliminação de interlavo de tempo entre tarugos, redução da taxa de sucatas, redução de paradas no laminador, eliminação de barras curtas no leito de resfriamento, dispensando o desponte da cabeça e calda, vida mais longa das peças de consumo, mais fácil administração da planta e a capacidade de produzir uma bobina de acordo com a necessidade.
Este artigo descreve o processo em detalhes e a avaliação das plantas operacionais que confirmam a validade absoluta deste processo revolucionário.

Palavras chaves: redução, processo, eficiência.