SIROLL PICKLING LINE SOLUTIONS FOUNTAIN OF YOUTH[1]

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Abstract
Pickling line technology is one of the oldest cold processes so that numerous lines, in operation since several decades, have not enough powerful process or equipment to produce as per the expected market growth. Instead of investing into costly new equipment, an alternate solution to improve the existing lines is to go forward with an upgrade using the latest available technologies. This way gives a second life with high powerful performances similar or comparable to a brand new pickling line. Thanks to its spectrum of solutions, Siemens Metals Technologies provides in all critical areas of a pickling line proven technologies to clients anxious to modernize their processing line.
Keywords: Pickling lines; Modernization; Laser welder; DWA side trimmer.

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1 INTRODUCTION

Pickling process is one of the oldest processes in the cold band treatment for steel. The premise of pickle process which consists by taking away the sticking oxide and scale from the strip steel by means of a chemical attack is coming out in the fifties. During this period, the pickle liquor was made of sulphuric acid in a concentration of 25% heated at ~65°C to get a better efficiency in removing the scale. As the market was more demanding not only in term of production but also quality, a new development based on a chloride acid was initiated. This new process requested a concentration of 18% of chloride heated at ~85°C. This development started in the last 30 years and is currently the most applied process to pickle carbon steel sheet.
An analysis of the pool of existing pickling lines shows that lots of them are old and require an upgrade to maintain their level of performance either in term of production or quality. Luckily new technologies give advantage to better perform at most attractive operational cost.

2 NEW TRENDS IN PICKLING PROCESS

Improvement of steel performances, such as Advanced High Strength Steel (AHSS) with their evolved chemical composition, brought the necessity to adjust the process parameters, such as the coiling temperature at the hot strip mill (HSM) for instance (Figure 1), key parameter governing the oxide and scale growth. As a consequence, such new hard materials request different pickle duration to get the total oxide and scale removed after dipping the strip into the pickle tanks.

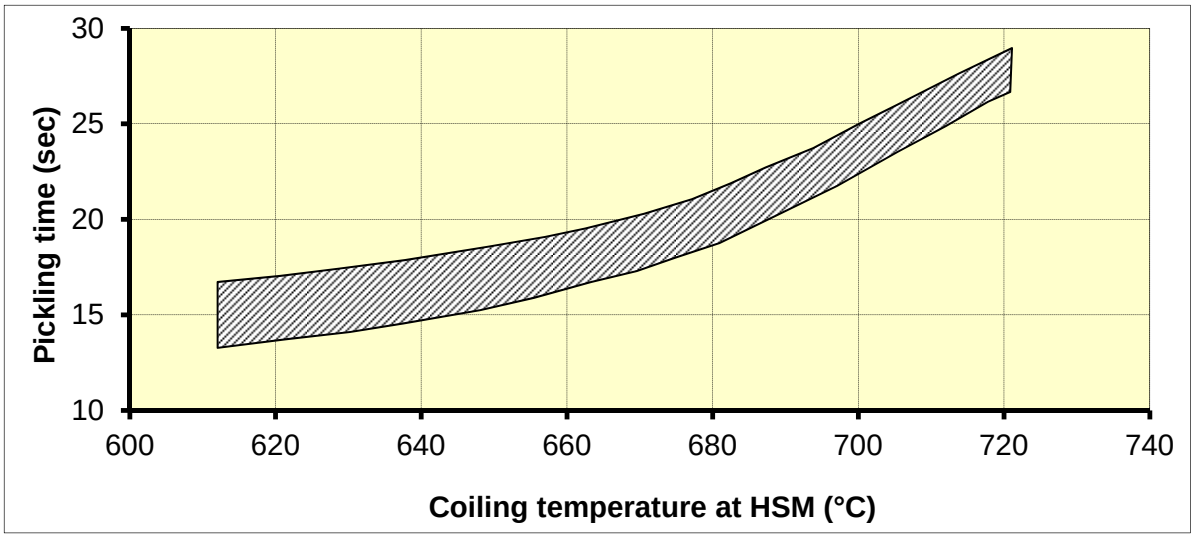

Figure 1. Relation between coiling temperature and pickling time.

3 SIROLL PICKLING LINE SOLUTIONS

Until recently, the competition between steelmakers was no so constraining in regards of line product throughput and quality level as it is nowadays. The watchwords are now: delivering the best strip quality, processing new steel grades and cut operational costs. To meet these challenges, Siemens Metals Technologies developed a spectrum of solutions to provide, in all critical areas of a pickling line (Figure 2), proven technologies to its clients anxious to modernize their existing line.

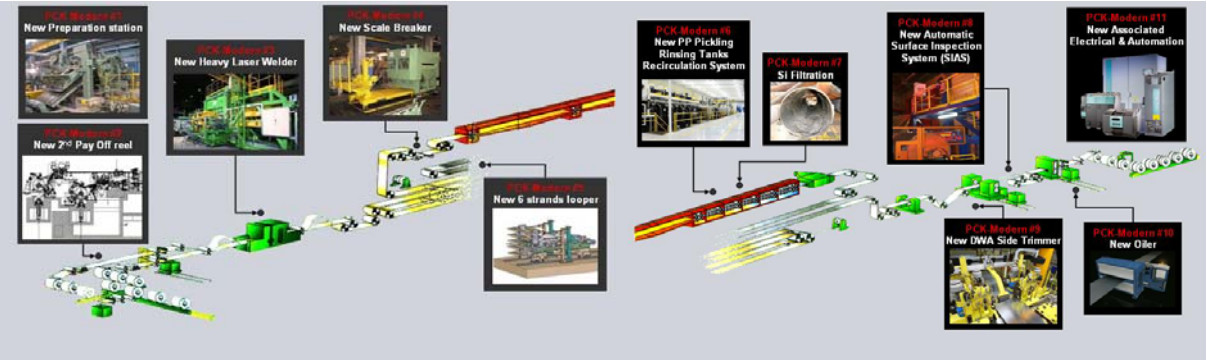

Figure 2. Siroll modernization packages for pickling line.

3.1 Savings Time by Reducing entry Section Downtime

Production increase is achievable by upgrading the pickling line entry section mainly by reducing the entry down time. Most of the old lines are equipped with a single uncoiler. Such a line entry arrangement only based on one pass line creates a waiting time that transforms this section into a bottleneck. The solution is to install a second pay-off reel or an additional coil transfer car used as auxiliary uncoiler. Already used for high pickling line production continuous or coupled to a tandem cold mill, this new concept can drop down the entry time cycle from 120 seconds affordable with the old single entry pass line to 90 seconds, leading to a production increase of ~4%.
An other solution could be to add a new off line preparation station at the entry part of the continuous pickling line, if it is not possible to add a second entry uncoiler. With such a preparation station, operator can cut and scrap bad parts of the coil, and prepare the head to help the strip threading later in the line. Advantage of this solution is to prepare the coil head during line running.

3.2 A New Generation of Strip Welding Machine

One year of pickling line production of 1 million tons is processed by accomplishing ~45,000 strip weld joints. Such figure shows, if need be, that the welder is a crucial machine to secure. The strip has to be kept running in continuous mode without changing process parameters to guarantee the best quality all along the production. To smoothly execute the process, any possible trouble has to be avoided; therefore the laser weld joint brings high level of quality and reliability those prevent line speed slowdown, strip tension release in the scale breaker area, mill rolling force release or more severe issue as per a strip breakage.

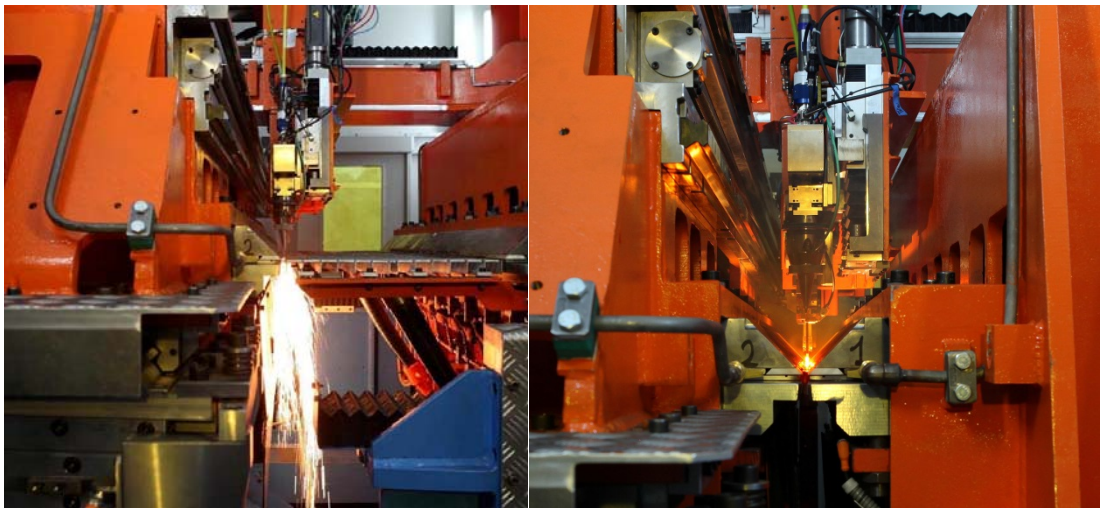

Figure 3. Heavy-gauge laser welder, cutting and welding phases.

Siemens latest laser technology makes hard incoming material welding possible and thanks to the integrated annealing unit the affected zone can be treated for stress released. The heavy laser welder has been designed as per the following main criteria:

- high performance for all steel grades (low/high carbon steel, HSS, TRIP, DP);
- ability to weld from 0.8 to 7.0 mm;
- weld break rate less than 0.2% with a perfect control of the welding quality and the welding geometry.

Through continued research efforts, Siemens reached a new step with the integration of an asolid laser source to its laser welder (Figure 3). This new technological step gives a lot of benefits to steel producers with among others, a higher efficiency, lower consumptions, higher process speed for cutting and welding, easier maintenance with no mirror installed on the machine.

By using optical fiber to transport the beam from the laser source to the process heads (for cutting and for welding), the customer does not have mirrors or beam switch on the machine. With this beam transportation system, the adjustment of the welder is very easy and the maintenance operations are reduced to almost nothing for the beam path. With the length available for the fibers, it is possible to install the laser source separate from the welder. Therefore the laser source could be installed in a dedicated space or room. Additionally, without laser source on the machine, the space required by the machine mainly on the motor side of the line is reduced. This point could be a key aspect in case of lines being revamped where the space is often an important issue.

With a higher efficiency, it makes it possible to decrease electrical consumption and sizing of other systems like the cooling unit. At a same laser power level, installed electrical power for the chiller and laser source could be reduced by 50%. Maintenance level is also drastically reduced on Asolid laser source compared to CO_2 laser source.

Because of the higher quality of the beam, with a same laser power installed, cutting and welding speed will be higher with a gain from 10 to 50% depending of the thickness. Laser cutting (non contact process) is eliminating wear of cutting tools and achieves a perfect strip preparation without strip deformation for the welding operation (Figure 4).

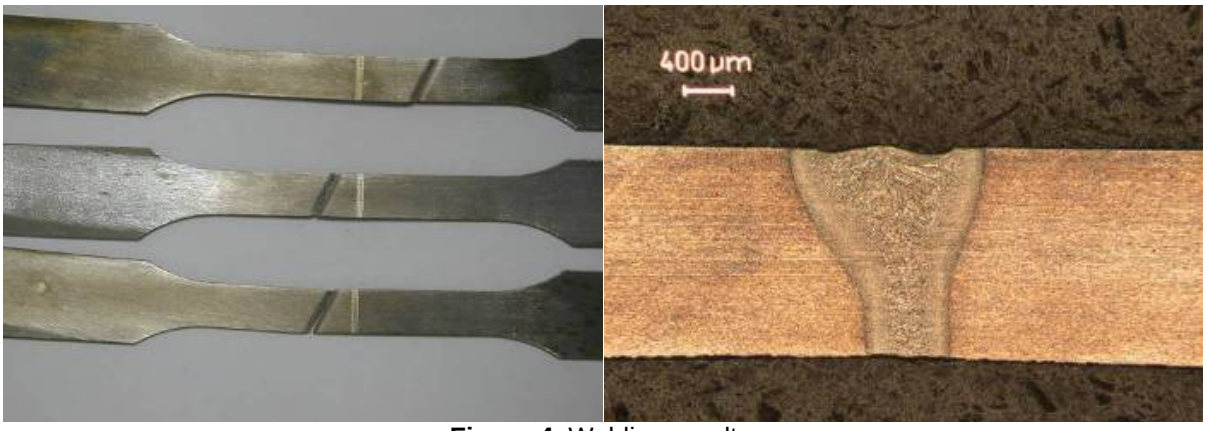

Figure 4. Welding results.

3.3 Improve Strip Shape and Better Remove Oxides

Increase in mechanical properties of new steel grades is mainly due to new concept in alloying elements, leading to harder incoming material. Considering this new trend, a higher strip tension is mandatory to improve strip shape in the scale breaker area. Siemens meets the challenge and developed a machine (Figure 5) with powerful strip tension capacity (from 65 to 95 tons) which enables to get, for a material with a yield stress between 750 and 1,000 MPa, a range from 0.5 to 3% elongation. Such performance in strip elongation leads to:

- strip shape improvement which carry through uniform and homogeneous acid attack along the strip body;
- oxides breaking in a sufficient amount to improve acid attack.

Figure 5. Speed up the overall pickling process by removing efficiently the scale layer.

3.4 New 6-Strands Entry Accumulator

To increase pickling capacity it is essential to consider entry accumulator capacity. Lots of pickling lines are still using small capacity entry horizontal accumulator with 2 or 4 strands. If space in the existing line building is available, Siemens proposes to upgrade the complete entry section with a new 6 strands accumulator. This operation can be done during production, and only a short shutdown is needed to link the new part with the existing. Benefit of this solution is to increase the line capacity by ~5% on existing line configuration.

3.5 New Generation of Pickling and Rinsing Tanks

Originally, the tanks were made of SRB (**S**teel shell with additional protective layers made of **R**ubber and **B**ricks linings) to prevent any possible acid migration up to the steel tank, which can result in severe tank body damages, line stoppage and production lost. Associated with its polypropylene shallow or flat tank design (Figure 6), Siemens developed its own turbulent acid circulation technology with side jets concept to improve acid liquor efficiency.
Previous configurations lead to the following benefits:

- better acid attack to strip surfaces;
- avoidance of unscheduled line stoppages due to necessary repair in case of tank leakage;
- significant turbulent effect in pickling process allowing line speed increase from 10 to 15%.

Concerning the rinsing section, new generation is made of 5 stages cascade plus a high pressure rinse at the last stage. The purpose of this solution is to minimize carrying out acid residues and to improve the control of the rinse step by implementing an acid concentration control in the first 2 steps cascade. This last improvement enhanced the strip surface quality by avoiding stains and brown color.

Figure 6. Example of modernized equipment (pickling and rinsing tanks).

3.6 Pickling Process Model

Siemens developed the FAPLAC® (Fully Automatic Pickling Liquor Analysis and Control) system to help line operators in their daily work to maintain high production with an optimized pickle liquor management. This solution gives advantage in controlling the waste pickle liquor to reduce operating cost and limit environmental impact, improve pickling efficiency by automatic acid and iron concentration monitoring and control.

3.7 Online Filtration System

Silicon is increasingly being used in carbon steelmaking to produce steels with a higher mechanical strength. Pickling lines, which are dedicated to removing the oxide layer formed on the steel strip during the upstream treatment steps, process a high portion of such steels. The dissolving of silica in the pickling liquor eventually leads to equipment clogging and reduced pickling efficiency. Siemens offers an innovative solution to this problem based on a new filter system. The principle is based on continuous extraction of the insoluble silica from the pickling liquor by filtration through a cake.

3.8 No More Line Stoppage at Side Trimmer Section

Conventional side-trimmer, consists of two heads travelling in machined slide ways on a common base, trims strip edges by means of two pairs of circular knives. The main function of the machine is to remove the edge defects of the strip and to cut it with high strip width accuracy. Every time a new coil enters the side-trimming area, the line exit section is stopped, if necessary welded strip is notched, and the side trimmer between-head distance is adjusted according to the new strip width.
Line production is always hampered by strip width change when the strip is trimmed as the line needs to be stopped for side trimmer head positioning. This operation takes time and thus affects the production yield. Siemens developed the so-called DWA (Dynamic Width Adjustment) to avoid the line stoppage. Such a system gives a benefit of ~5% production increase.
When enabling the Dynamic Width Adjustment (DWA) function, the Siroll DWA Side-Trimmer, no longer stops during a strip width change. The line decelerates between 30 and 60 mpm in the side-trimmer area and the head frame rotates by few degree and accurately (without unlocking the heads) until the side cuts make the strip width reach the targeted value. The width adjustment can be done up to 100 mm (50 mm per side) on a maximum of 2 m strip length. There is no more need for the line to stop and this with a minimum off-width scrap (lost strip length is optimized to less than 2 m this according to the required width change).
The new product information (thickness, new strip width, new thickness, weld position, line speed, etc) are then sent by the line material tracking Programmable Logical Controller (PLC). According to the received values, the side-trimmer PLC generates a motion profile and starts the on the fly width change motion according to the weld position (Figure 7). The cutting angle is controlled by a servomotor all over the motion profile according to line data.

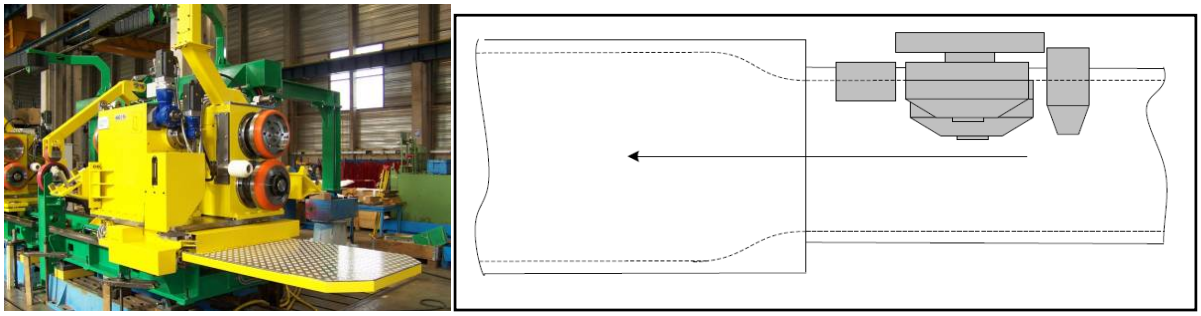

Figure 7. Side trimmer width DWA (Dynamic Width Adjustment) feature.

The dynamic width adjustment system runs in full automatic mode, is operation free and brings many advantages:

- no more need for the line exit section to stop (for product width adjustment), therefore the section cycle time is improved and the process speed can be increased, all benefit to productivity improvement. This is of particular interest for processing lines having a reduced accumulator size as the strip is never stopped.
- DWA system lowers strip break especially on small strip width. The notch can be removed and consequently it is a great advantage for strip rolling. When the weld will move to the mill, the force will vary smoothly.
- The cobbles risk is drastically reduced. The trimmed edge becomes continuous and therefore it is always pulled by the scrap chopper even if the scrap is very thin.

Benefits of this solution is to improve production yield by ~3%.

3.9 Automatic Surface Inspection for a High Strip Quality

The product quality is the final judgement or penalty for failure which is highlighted at line exit after the entire production process is achieved. In order to detect as early as possible product defects (Figure 8), Siemens developed the online automatic surface inspection (Siroll SIAS®) (Figure 9) to increase process transparency and minimize product rejection.
The main benefits of the system are:

- high performance with “high-sensitivity” inspection over the whole strip on both sides, with no data overflow.
- Easy operability, maintenance and administration thanks to a simple hardware architecture, less electronic parts to maintain, user-friendly maintenance interface
- Powerful 3rd generation LED illumination system, for high defect/non defect detection ratio.
- Linescan camera inspection for optimal image quality.

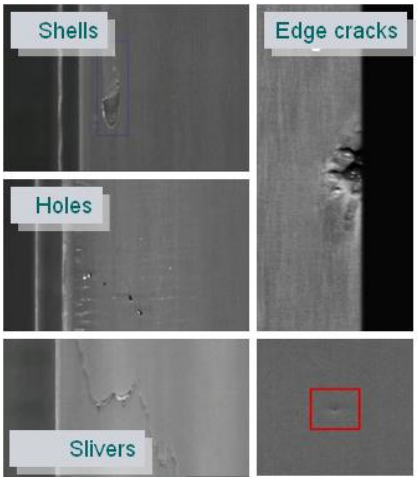

Figure 8. Typical surface defects.

Figure 9. SIROLL SIAS® solution (linescan camera, LED Illumination system, processing units, operator station).

The latest Siroll SIAS, XLine® version, with increased processing power allows:

- full strip inspection at high resolution (no saturation);
- increased archiving capability;
- easier interface and control (fully graphic user interface and dynamic settings).

3.10 Automation with Extended Diagnostics

For the operation of the line, production supervision and support of the maintenance, Siemens equipment is equipped with powerful diagnostic tools integrated into the Siroll automation (Figure 10) and HMI system (ex: guiding system to help the operators to find the right information and to assist them in keeping up production). This solution can be implemented in the existing automation system in same time mechanical equipment is upgraded. Typical benefits are effective when the line is in operation as well as for preventive maintenance.

Figure 10. Hardware components of the Siroll automation system.

4 CONCLUSION

With its spectrum of technological packages dedicated to pickling line modernizations, Siemens Metals Technologies meets the challenge and brings a new youth to your processing line.