PICKLING LINE FOR HSS PRODUCT[1]

Jacques Leroyer [2]
Philippe Mouls [3]

Abstract
POSCO has modernized the PLTCM No.1 in Kwang Yang works (KOREA) in order to process High Strength strip with a tensile strength of 1380 MPA. The total capacity of the new unit is 2 150 000 tons per year. For this purpose an entire new Pickling Line has been built and coupled to the existing Tandem Mill. The line supplied by SIEMENS VAI for POSCO incorporates a double entry to fulfill the production requirements and a top of the art *fully automatic* pickling section with high turbulent tanks controlled through a mathematical model. The high levels of strip tension required and installed make this pickling line the most powerful of its kind. This Pickling line is the new reference for today and tomorrow High Strength Steel material.
Key words: Pickling line; High strength steel; PLTCM

[1] *43rd Rolling Seminar – Processes, Rolled and Coated Products, October 17th to 20th, 2006 – Curitiba – PR – Brazil*
[2] *Product Manager – Siemens VAI Metal Technologies – VAI CLECIM St Chamond - France*
[3] *Rolling & Processing Manager – Siemens VAI Metal Technologies – VAI MS Belo Horizonte - Brazil*

INTRODUCTION

In 2005 Siemens VAI has built a hydrochloric acid pickling line to process **H**igh **S**trength **S**teel with a tensile strength of 1380 MPA. These products are in line with the today market requirements.
The new Pickling Line has been built and coupled to the existing Tandem Mill.
Special attention was taken for critical technical challenges as :

- Take into account the spring back effect of the strip
- Mechanical equipment sizing for **HSS**
- Strip tension in all sections and mainly into the loopers area
- Avoid strip brightness after pickling
- Possibility to proceed bad shape material

This Pickling line is the reference for today and tomorrow **H**igh **S**trength **S**teel material.

GENERAL DESCRIPTION

Plant design data

Yearly production	2 150 000 ton/year
Hourly capacity	450 ton/hour
Thickness	1.4 – 7 mm
Width	750 – 1880 mm
Material	Hot rolled carbon steel
Tensile strength	up to 1380 MPA
Entry speed	650 mpm
Process speed	260 mpm
Exit speed	350 mpm

Entry end

The entry of the line includes :

- A Coil handling section with preparation Station
- Two pass-lines with 800 kw uncoiler,
  7 work rolls type flattener and shear design to cut strip cross-section 9 x 1880mm
- A welder

Figure 1. No. 1 pass-line

Process section

The process section of the line includes:

- A four-Strand entry looper with a 1300 kw power
- A scale breaker
- A pickling section with
    - 4 Polypropylene pickling tanks 26 meters long each one
    - A five stage cascade spray rinse section
- Two-Strand intermediate and exit loopers
- A side Trimmer

Figure 2. Pickling tank 26m long

PICKLING SECTION

The process section uses high turbulent tanks. This arrangement has been chosen due to:

- The high surface quality of the finished product
- The design guarantees that the strip will never touch any fixed part to avoid any surface defects when processing **HSS** product **no well flatten**.
- The high efficiency of pickling at low temperature (75°C)
- The high flexibility of the process section and adaptation to low speed situation.

The pickling tanks are designed to follow the shape of the strip under tension between the two top deflector rolls partially immerged in the acid bath.

The top deflector rolls installed above the strip will :

- Prevent the strip from being raised out of the acid bath in case of tension control inaccuracy.
- Prevent any hydroplaning effect of the strip
- Together with the side jets avoid acid drag out

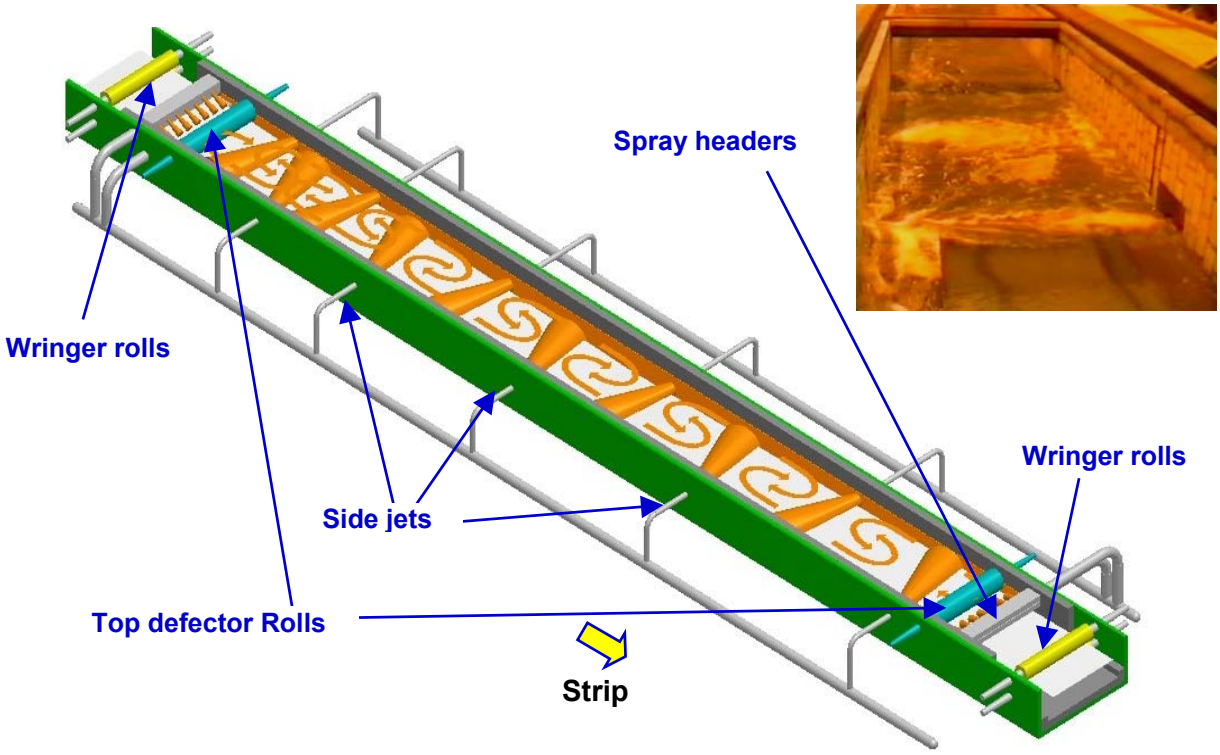

Figure 3. Principle of turbulent tank

The pickling tanks can be either in polypropylene or in steel with rubber lining and bricks.
On this project the Polypropylene material has been chosen due to :

- Excellent Acid Resistance
- Eliminates Brickwork, Rubber Lining and Exposed Steel
- No Corrosion and Associated Repair & Cleanup
- Easy Repair w/ Simple Welding Equipment
- Protected w/ Granite Blocks in Chevron Pattern
- Reduction in Structural Support due to Lightweight Design
- Reduced Capital Cost over Brick Lined Steel Tanks

MAIN FEATURES OF SIEMENS VAI TURBULENT PICKLE SECTION

Tank technology

- The spray headers installed at the entry each tank maximise the strip length in contact with acid
- The Side jets located on both sides of the tanks are special nozzles design to maintain high turbulence all along the tanks to enhance the pickling efficiency.
    - This turbulence will renew the acid in contact with the strip with hot acid coming from the heat exchangers
    - This turbulence will break the laminar layer on the surface of the strip to evacuate the iron
    - The energy of the jets will improve the acid penetration into the oxide cracks created by the scale breaker

- Side Jets target pickling action on the strip edge area where the scale layer is the thickest
- The turbulence created by the side jets is independent of strip speed allowing efficient pickling action at any line speed
- High side jet efficiency minimizes the use of steam to reduce operating cost. Bath temperature is usually maintained around 75° Celsius compared to 85 for other design.

Figure 4. Side jets into action

- "Slow pickling mode": Siemens VAI pickle section will automatically operate at reduced tank level and without forced turbulence when the line is slowed to creep speed (25 mpm) avoiding over-pickling or staining. This feature is particularly useful on a linked line as any delays may be accommodated without stopping the pickle section.
- After a line stop, oxidation does appear on the strip located in the rinsing section. Since 2001 VAI has implemented a line restart procedure in order to eliminate these rinsing stains.
    - Strip in the rinsing section is sent back into the last pickling tank with an automatic backward jog (35m). Stains are then removed by the acid liquor. The strip coming out from the pickling tank N°1 to the scale breaker is rinsed with water and squeezed with wringer rolls. The strip direction is reversed and the line can run to the nominal speed.
- The cover water seal design across the tanks allow drastic reduction of the fume exhaust flow minimising acid, heat loss and water consumption. The fume scrubber can keep the acid level in the fume far below the European requirement

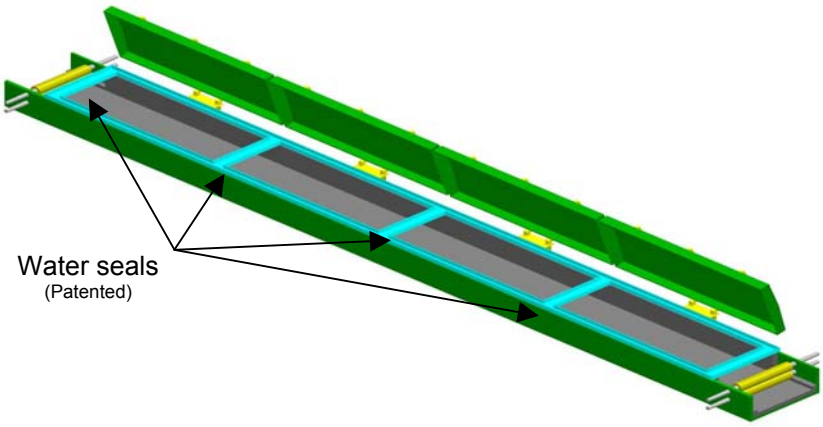

Figure 5. Patented water seals

PROCESS CONTROL SYSTEM

The Siemens VAI **F**ully **A**utomatic **P**ickle **L**iquor **A**nalysis and **C**ontrol system has been implemented (FAPLAC)
All the process section main parameters as acid-iron content, rinse water conductivity and so on are automatically measured and controlled trough a mathematical model
The main benefits for operators, production cost reduction and line productivity are :

Operator friendly

- All process information is available at Operator's station
- Minimum process section management judgements required from the operators
- Acid and Iron concentrations are automatically controlled
- Insensitive to the concentration of incoming acid
- The control system automatically protects heat exchangers during start-ups and shutdowns.

Production cost reduction

- Optimize the use of acid to reduce operating cost
- Minimize the amount of acid in the waste pickle liquor
- Minimize the use of rinse water to reduce waste processing cost.

Line productivity

- The model will predict the optimum process speed for each coil by taking into account the process parameters as strip quality, baths concentration, baths temperature.

On this line the process section and FAPLAC have been adapted to the HSS products to be treated.
Some special features have been implemented to take into account the specificities of the HSS as brightness after pickling.

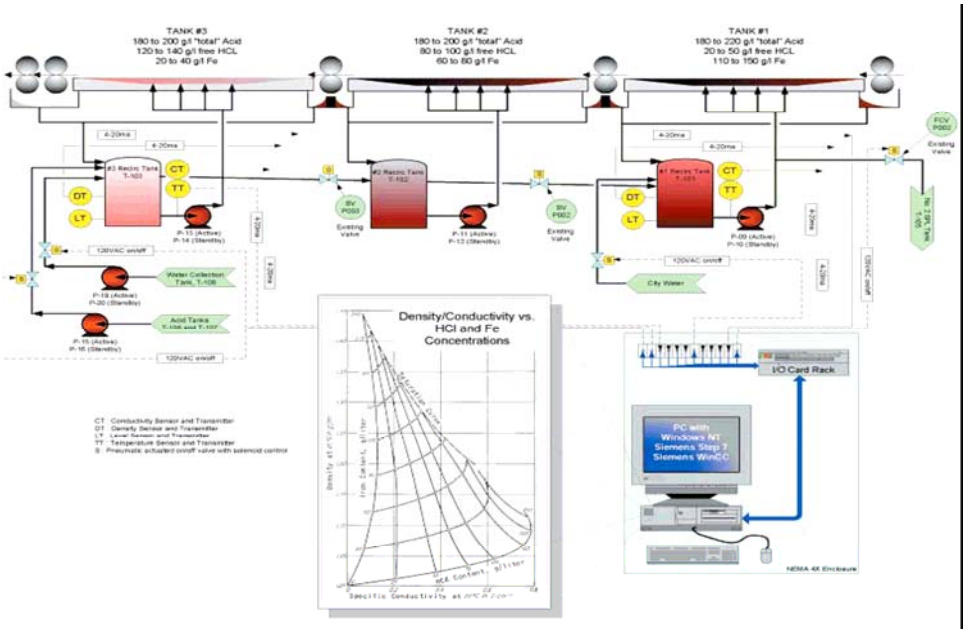

Figure 6. FAPLAC – Principle on the feed back measurements