PRIMETALS TECHNOLOGIES

PROCESSING LINES

CONTINUOUS PROCESSING LINES
CREATIVELY FLEXIBLE TECHNOLOGIES

Over the past 50 years, Mitsubishi Heavy Industries and Hitachi, have individually worked with the world's steel industry supplying advanced technologies, increasing production and improving quality. In the face of increased global competition, the steel industry divisions of Mitsubishi Heavy Industries and Hitachi joined on October 2, 2000 and established a joint venture to provide superior service and products.

Primetals Technologies Japan, Ltd. (PTJ) has massive experience in the processing lines. PTJ's processing lines meet various customers' requirements for product quality, energy savings, automation, etc.

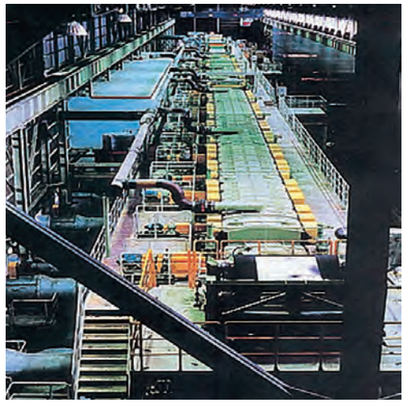
PTJ's processing lines

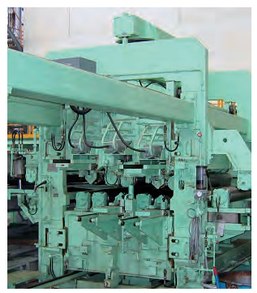
1. Continuous pickling line (PL)
i Box® pickling tank
Jet pickling tank
Shallow bath pickling tank

2. Continuous galvanizing line (CGL)
High quality CGL for automobile application
Small or middle range compact CGL

3. Continuous annealing line (CAL)
High speed tin plate CAL
Sheet CAL
Double duty CAL for tin and sheet

4. Annealing and pickling line for stainless steel
Combination of :
- Salt bath tank,
- Neutral salt electrical pickling tank,
- Nitric acid electrolytic pickling tank,
- Mix acid pickling tank





CONTINUOUS PICKLING LINE (PL) TECHNOLOGIES

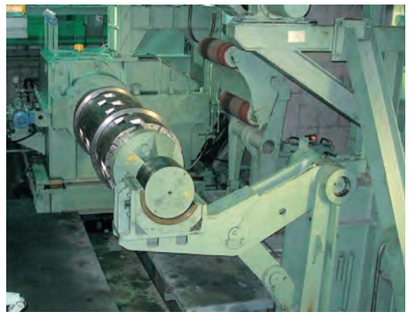
Suppliy Capabilities and Features

- Primetals Technologies Japan, Ltd. (PTJ) has supplied a total 76 continuous pickling lines since 1955 to customers worldwide.
- PTJ has several types of pickling tanks to meet customer's requirements. Specifically, the newest ***i***Box® pickling tank serves the same pickling performance as jet tank, and saves energy without a ciruclation pump.
- Reliable equipment achieves stable operation. PTJ has numerous patented and original equipment as the following.

Automatic Coil Charging System

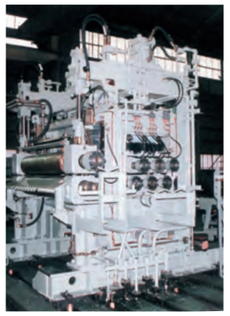
i Box® **Tank**

Jet Tank

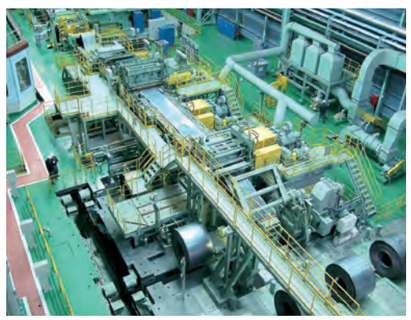


Pay-off Reel

Coil Opener



Processor



Entry Section Equipment

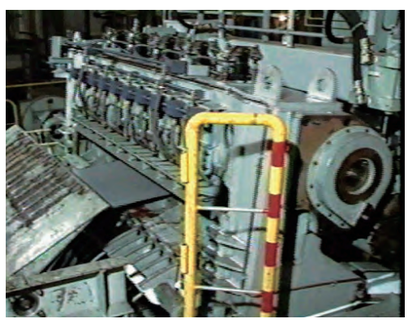
Loop Car

Side Trimmer

Rinse Tank

Polypropylene Pickling Tank

Tension Leveller



Flying Shear

Delivery Equipment

PICKLING TANK TECHNOLOGIES

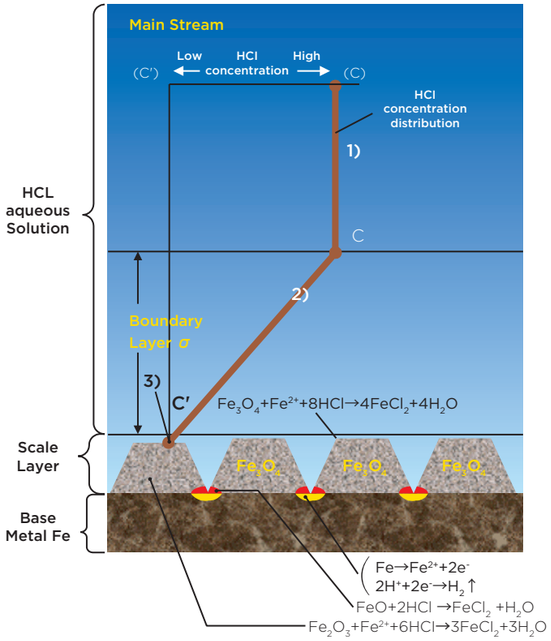


Fig. 1 Pickling reaction and HCl concentration distribution

1. Introduction

In the fields of automobiles and electrical household appliances, which have been the principal consumers of cold-rolled steel strips, recently, there is increasing demand for ultra-low carbon steel or high-tensile steel with excellent processability from the viewpoint of quality and productivity. To meet this trend, steelmakers are expanding the production of ultra-low carbon steel or high-tensile steel, but since this steel requires pickling time (descaling time) of about two or three times that of general steel in the conventional deep-bath pickling tank, the effect is operations slowed to 1/2 to 1/3. Hence, it has been difficult to increase production output.

To solve this problem, in replacing the conventional pickling method, it is necessary to develop a new method that effectively to shortens the pickling time and is capable of treating strips at high speed. To meet this requirement, Primetals Technologies Japan, Ltd. (PTJ) developed new box pickling tank systems. To meet our customer's requirement, PTJ can offer three types pickling tanks.

2. Pickling theory

2.1 Dominant factors in pickling section

Refering first to the pickling reaction, reaction theory is explained below by showing a typical case of pickling in HCl aqueous solution.

The pickling reaction may be considered to be composed of the following three processes as shown in Fig.1.

1) Supply of HCl from the mainstream of HCl aqueous solution in the pickling tank in to the boundary layer.

2) Supply of HCl onto the scale surface and into cracks through the boundary layer by molecular diffusion.

3) Chemical reaction at the scale interface.

Comparing the second and the third process, the reaction rate is sufficiently fast, the mass transfer at the boundary layer in the second process mainly dominates the pickling reaction.

2.2 Promoting a means for pickling reaction

Since it is a mass diffusion process through the boundary layer formed on the steel strip surface of the treated material that mainly dominates the pickling reaction, to promote the pickling reaction, it is necessary to accelerate the mass transfer in this process.

To encourage the reaction, the boundary layer thickness must be reduced. PTJ independently developed the three types of pickling tanks. The boundary layer thickness achieved by each tank is shown in Fig.2, and it increases in the conventional deep-bath method as the strip passes through the tank.

However, since the PTJ shallow-bath type employs dams and rolls, the thickness of the boundary layer does not increase as much as in the deep bath line. In the ***i***Box® type and Jet pickling type, the thickness of the boundary layer is determined by the gap value of the dam, and remains almost constant and does not increase.

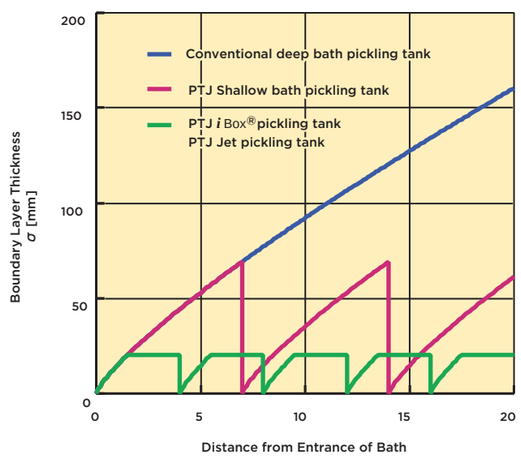
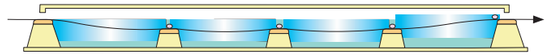


Fig. 2 Boundary layer thickness for each type of pickling tank

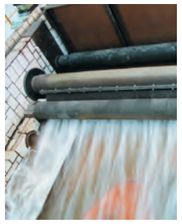
3. Various PTJ pickling tank technologies

3.1 Shallow bath pickling tank

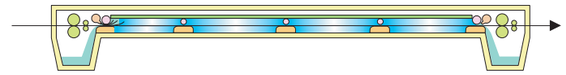
The PTJ Shallow bath tank reduces running and maintenance costs because of its in-tank heat exchanger that does not require a circulation heating system. The boundary films of the acid solution on the strip surfaces are broken by the intermediate weirs and rolls, resulting in improved pickling effect.



3.2 Jet pickling tank



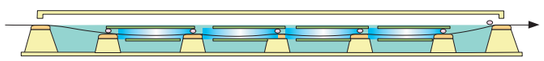
The PTJ Jet pickling tank can reduce the pickling time (descaling time) by 35% to 45% of the conventional deep-bath pickling tank. The acid solution is filled into the box area by the jet seal nozzles where are before and after box area. In the box area, the boundary layer is thinner than shallow bath tank.



3.3 *i* Box® pickling tank

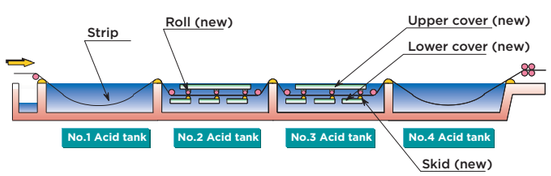
The PTJ ***i***Box® tank is the newest and most advanced box pickling tank. Even if a circulation heating system is not installed, the pickling effect is similar to the PTJ Jet pickling tank.

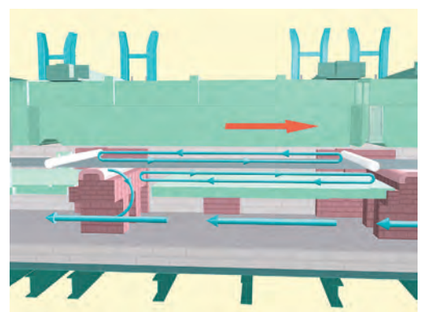
And, the ***i***Box® can be installed in a conventional deep-bath tank by simple modification. Therefore, the tank is suitable for the modification of existing pickling tanks.



3.4 *i* Box® pickling tank (modification from an existing conventional deep-bath tank)

The ***i***Box® pickling tank is suitable for modification of existing conventional deep-bath tanks. This simple modification can achieve an improvement of pickling speed.





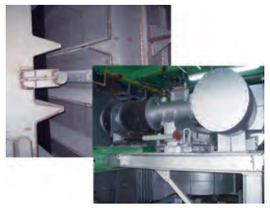
CONTINUOUS GALVANIZING LINE TECHNOLOGIES

Capabilities and Features

- Primetals Technologies Japan, Ltd. (PTJ) has supplied a total 49 CGLs since 1955 for customers in Japan, Korea, Taiwan and the United States.
- PTJ is one of a few steel plant manufacturers in the world which performs in-house design and manufacturing of all processing components which construct a continuous galvanizing line, such as the entry section, furnace, galvanizing system, skin-pass mill, tension leveller, chemical treatment, and exit section.
- PTJ will propose flexible configurations and equipment specifications in order to provide the optimal systems that will meet customers' demands.
- Flexibility in Line and Equipment Design
  In-house engineering work for custom-designed equipment enables flexible line arrangement and equipment design to meet customers' needs and expector, available with either Vertical or Horizontal Loopers, Vertical or Horizontal Cleaning Tanks, Vertical or Horizontal Annealing Furnace.
- High Degree of Line Automation
  Automated coil and strip handling, Looper control, Pre-cleaner control, Annealing furnace control, Coating weight control, Cooling control, Skin-pass mill rolling-force control, Tension leveller elongation control, Roll coater control, Side trimmer control, Electrostatic oiling control, Instrumentation and more.

Entry Section

Radiant Tube Burners in Heating Section



Cooling Equipment

After Pot Cooling

Skin Pass Mill

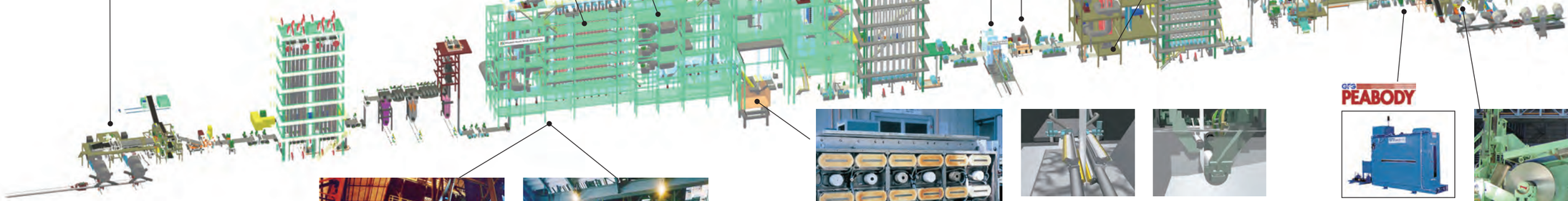
Tension Leveller

GFG

GFG Roll Coater

Side Trimmer

Scrap Baller



Vertical Furnace

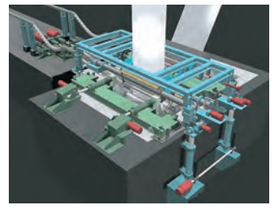
L-Shaped Furnace

Strip Stabilizer-Air Knife

"Y" Equipment

"G" Equipment

Zinc Pot



Pot (YG) Equipment
("Y": Air Wiper, "G": Pot Rolls)

GFG PEABODY

GFG Oiler

Tension Reel
(Carrousel Type)

PTJ'S FURNACE TECHNOLOGIES

A Long-time Furnace Supplier to the Steel industry

L-Shaped Annealing Furnace

For more than 40 years, PTJ has supplied vertical and horizontal furnaces to the steel industry, responding to customer requests for higher production capacity, greater energy savings, extended equipment lifetime, etc.

Heating and cooling are key technologies for furnace equipment.
Also, thanks to the long-term experience supplying furnaces,
PTJ has accumulated know-how to handle high-temperature steel strip in the furnace.

PTJ has supplied:
22 furnaces for Continuous Annealing Line (CAL)
6 furnaces for Continuous Galvanizing Line (CGL)
20 furnaces for other lines, such as APL, annealing line for silicone steel, etc.

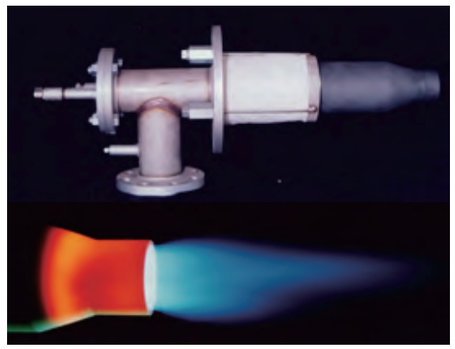
Type of furnaces PTJ has supplied are:
- Vertical Furnace
- Horizontal Furnace
- L-shaped Furnace, which is a combination of vertical and horizontal
- Rotary Hearth Furnace

Heating Technology

Radiant Tube Heating Vertical Furnace

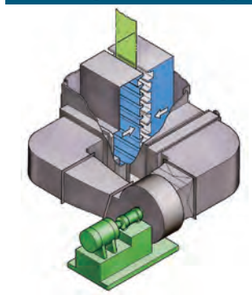
For most annealing furnaces for steel strip, indirect heating is utilized to prevent oxidization of the strip surface during the heating process.
For this purpose, the radiant-tube heating furnace has been our choice.
Design and selection of radiant-tube materials and also radiant-tube burners are carefully performed by PTJ considering energy efficiency, initial cost and lifetime, as well as environmental requirements such as NOx emission levels in the flue gas.

For the purpose of Direct Firing of the steel strip, MID* burner has been developed by PTJ.
The burner flame and high temperature flue gas will directly impinge the strip without oxidizing the surface realizing high speed heating compared to the indirect heating method.
*: PTJ impinging Deoxidizing Burner



MID Burner and the Burner Flame

Cooling Technology



Accelerated Gas Jet Cooling Equipment

Accelerated gas jet cooling equipment utilizing slit-type gas-jet nozzles realizes uniform and rapid cooling of the steel strip in the furnace.
Recently, higher cooling speeds (℃/s) have become necessary as the production of high-tensile steel increases to meet environmental demands.

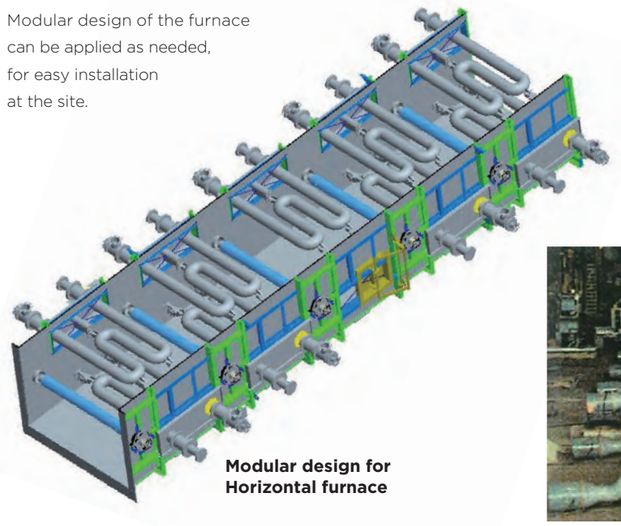
Other cooling equipment can also be applied in accordance with the process requirement:

- Roll Cooling Equipment
- Roll and Gas Jet Combined Cooling Equipment
  (Cooling roll and auxiliary gas jet)
- Conventional Gas Jet Cooling Equipment
- Fog Cooling Equipment
- Water Cooling Equipment

Auxiliary Gas Jet for Roll Cooling

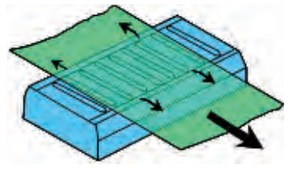
Other features for furnace design, strip transportation, etc.

Modular design of the furnace can be applied as needed, for easy installation at the site.



Modular design for Horizontal furnace

Strip transportation in the furnace is another key aspect of the furnace design.
Proper profile design for stable operation will be applied to furnace rolls.
For special purpose applications, floaters will be applied to transfer strip without contacting the rolls.



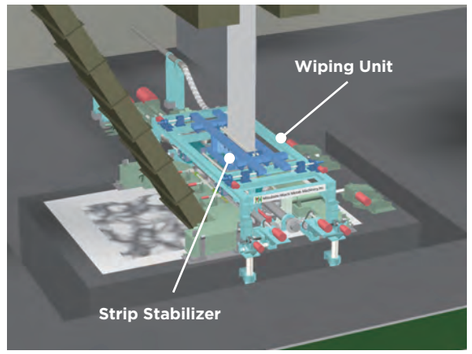
Floater for strip transportation without rolls

PTJ NON-CONTACT STRIP STABILIZER

PTJ Non-Contact type Strip Stabilizer is an electro magnetic damping system for reduction of the strip vibration amplitude and simultaneous correction of the strip shape, such as cross-bow, with high processing speed, resulting in improvement of uniformity of zinc coating weight in hot-dip galvanizing lines.

PTJ Non-Contact Strip Stabilizer allows the flexible design for installation on the existing wiping unit with the minor modification in addition to complete integrated unit with PTJ wiping unit.

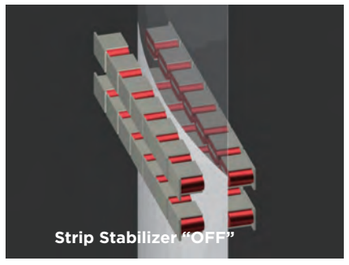
Electromagnets on both sides of the strip, installed in two (2) separate housings, are the core of the Strip Stabilizer.



Typical Application

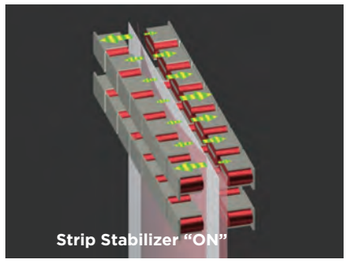
1) Strip Thickness	:	0.3 to 4.5mm
2) Strip Width	:	600 to 1,850mm
3) Material	:	Zn, Al gal. steel
4) Process Speed	:	Up to 200mpm
5) Strip Tension	:	0.6 to 2.5 kgf/mm^2

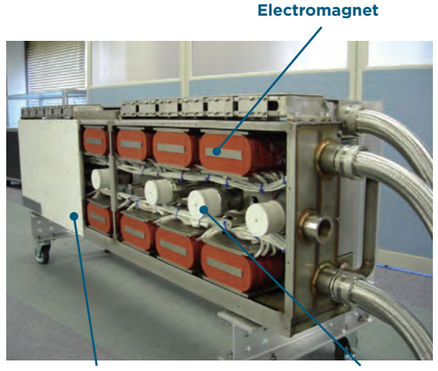
Function Principle



The strip positioning is implemented by individual control of the attractive force of each electromagnet according to the measured distance using a distance sensor.

Two (2) units, consisting each of two (2) electromagnets sandwiching the distance sensor and positioned on opposite side of the strip, compose 1-axis.
By locating plural axes, the reduction of strip vibration and correction of cross-bow are implemented at the same time.

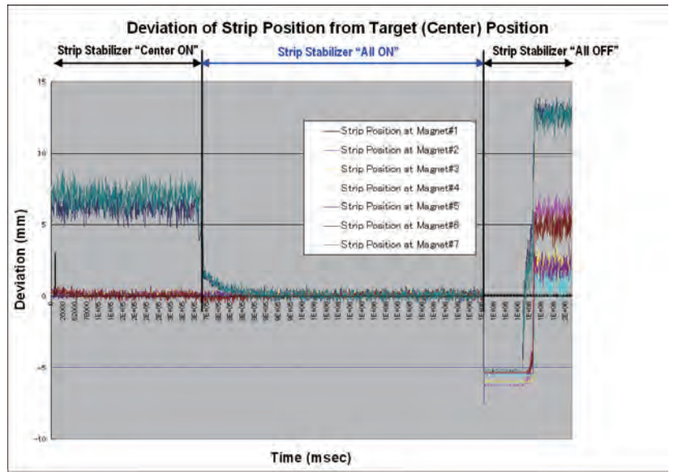




Function Capability

Stable Strip Vibration	:	Reduced down less than 25% of Max. 10mm^{P-P}
Correct Strip Shape	:	Allowable cross-bow value for correction of +/-18mm (at thick 0.8mm x width 1,220mm)
Force of Magnet	:	15 kgf/each (at thick 0.8mm)

Performance Features

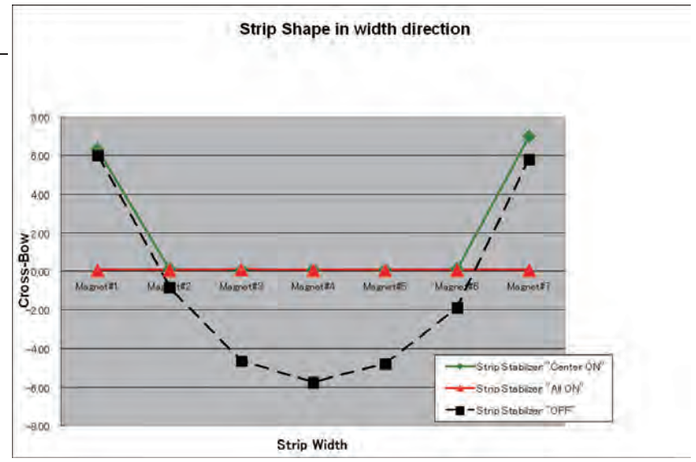


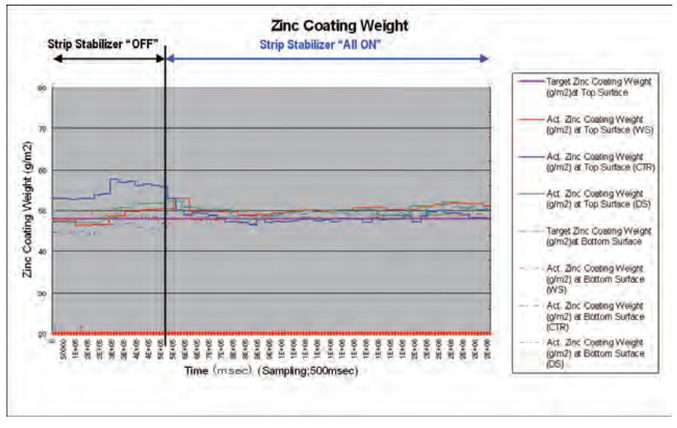
Reduce Strip Vibration Amplitude

The left actual measured data on the left shows dramatic reduction of the strip vibration amplitude down to less than +/-1.0mm instead of approx. 7mm before application of stabilizer.
Accordingly the gap between the running strip and wiping nozzle can be continuously stabilized and minimized, resulting to light zinc coating weight at higher process strip speed.

Correct Strip Shape

The actual measured data on the right shows dramatic correction of the strip cross-bow down to less than +/-1.0mm^{P-P} from +/-6.0mm^{P-P}.
Accordingly, easy and safety adjustment of pot rolls and wiping unit can be implemented, and longer maintenance intervals of the pot equipment can be realized.





Control Uniformity of Zinc Coating Weight

Actual measured record shows "Improvement of zinc coating deviation of 2g/m^2 at 1-sigma"for target coating weight of 49g/m^2 instead of the previous deviation of 6~8g/m^2.
Dramatic improvement of zinc coating uniformity and reduced zinc consumption are possible in accordance with this function.

PTJ SIDE TRIMMER

Turret Side trimmer

FEATURES

High Accuracy

- High-stiffness trimmer housing and knife support
- Trimmer entry dual steering rolls
- Precision knife lap and clearance setting

High Quality Production

- Automatic knife lap and clearance setting
  (Pre-set by Level-2)

Ease and safe of Maintenance

- Quick knife changing operation at non-trimming side

FWC (Flying width change) Side trimmer

FEATURES

In addition to the Basic Features of Turret Head Side Trimmers, Flying Width Change Function

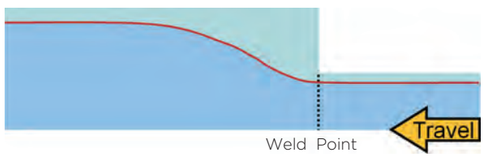
- Automatically changes trimmed width while line is running

Line Stop for Width Change is NOT required!

Circular knives trim strip of different widths smoothly as the trimmer housings rotate and traverse to the new trimmed width.
Thus FWC Side Trimmer can change the trimming width without line stop.

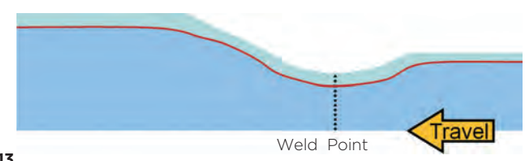
Pattern1

Typical Change of Trimming Width



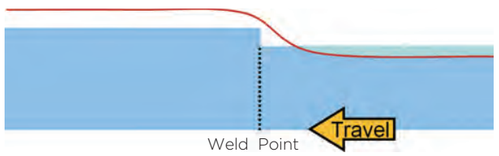
Pattern2

Trimming along Notched Portion



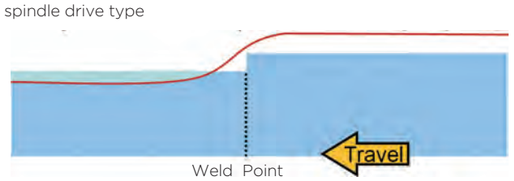
Pattern3

Change from Untrimmed Strip to Trimmed Strip only for spindle drive type



Pattern4

Change from Trimmed Strip to Untrimmed Strip only for spindle drive type

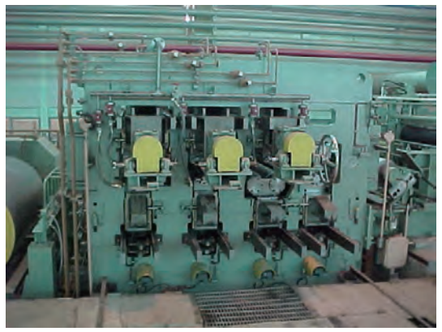


PTJ TENSION LEVELLER

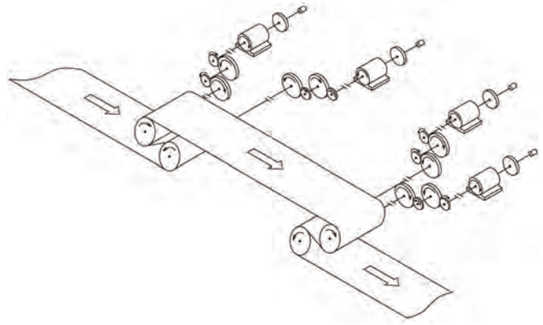
Tension Leveller

Typical PTJ tension levellers have the capability for shape correction and improvement of strip surface condition after hot-dipped galvanizing, and PTJ scale break levellers have the capability of sufficient scale breaking for accelerating pickling time in addition to shape correction for hot rolled strip in the pickling process.

Tension Leveller (Scale Breaker) for PL

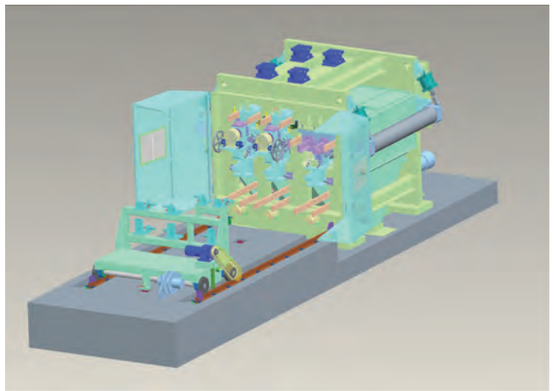


Tension Leveller for CGL



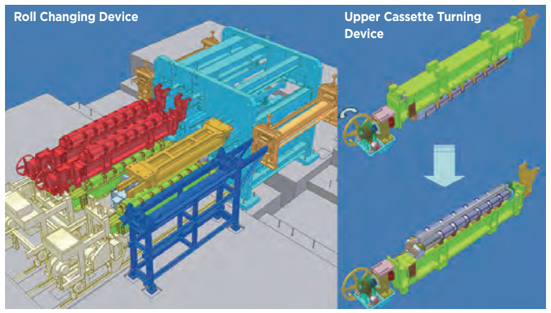
Individual Driving System

PTJ provides excellent elongation control accuracy by using an individual driving system for the bridle rolls, resulting in reduction of running costs and improvement of maintainability by means of the developed electrical equipment and elongation control.



Tension Leveller Typical Configuration

PTJ tension leveller upper roll cassettes have unique function to rotate the upper cassette using the lever for roll changing.
After pulling upper cassette by roll changing car, operator can rotate any upper cassette using the lever and change work rolls easily and safely without other tools.



Tension Leveller Roll Cassette Change

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