



MULPIC® PLATE COOLING TECHNOLOGY
PROFIT MAXIMIZATION IN PLATE
PRODUCTION

FAST UNIFORM COOLING FOR THE MOST VALUABLE PRODUCTS

THE CHALLENGE

Plate and plate Steckel mill operators need to produce plate and coil with higher quality and at lower costs. The challenges that underpin these two key factors are different for producers with and without powerful Accelerated Cooling (ACC) & Direct Quench (DQ) equipment.

Without:

- Limited product range
- High alloy costs
- Additional processing in a heat treatment line for all abrasion resistant and high strength grades
- Low production rates for temperature controlled rolling

With:

- Cost of re-work for flatness defects
- Yield losses
- Material downgrades
- Maintenance costs
- Product development costs
- Adapting to Industry 4.0 and the drive for digitalization

THE SOLUTION

MULPIC® is an advanced online plate ACC & DQ system designed specifically for the challenges of online plate cooling. Its fundamental strength lies in its powerful, yet very uniform cooling, and its precise flow control over the large product range required by a plate producer. With over 20 reference projects, MULPIC® is the market leading plate cooling technology.

The fundamental design principles of MULPIC® have not changed, with the technology evolving to enable:

- Its application to coil production on plate Steckel mills
- Further increases in temperature accuracy and uniformity
- Intermediate / transfer bar cooling
- Further alloy and operational cost savings through digitalization and precise cooling
- Low CAPEX hybrid machines integrating with existing laminar cooling sections
- Low maintenance requirements
- Short delivery times



The 4.2m mill made a profit in March 2017 for the first time since 2010 when the mill was put into operation. The new MULPIC® played a very big role in this."

Mr He
Baosteel Zhanjiang
Iron and Steel Co., Ltd.



KEY FEATURES

MAXIMIZING PROFIT THROUGH COST REDUCTION AND ADDED VALUE



LARGE FLOW CONTROL RANGE WITHIN A SINGLE HEADER DESIGN

The header design is consistent throughout the machine. This allows any header to be potentially used for a wide range of cooling duties, from Direct Quenching (DQ) to ultra low flow.

Compared to other cooling technologies with separate designs for DQ, MULPIC® has several advantages:

- Spare parts reduced
- Less complicated maintenance
- Uniform heat transfer mechanism
- Consistent use of water crown and edge masking
- Shorter machine

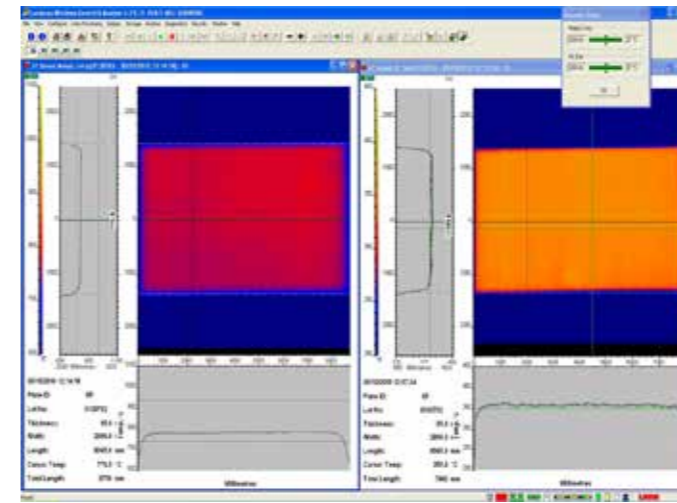
These lead to reduced operating costs, improved product quality and an increased range of products that can be produced online.

ADVANCED FLOW CONTROL VALVES

Primetals Technologies' advanced flow control valves are assembled and tested in-house providing position accuracy and responsiveness not available from standard valve assemblies.

The advanced flow control valves allow precise control during the large flow adjustments needed for head and tail masking on plate production, as well as feed forward control at high product speeds during coil production on plate Steckel mills. This results in increased temperature and mechanical property uniformity, and improved product yield.

The design has been optimized to simplify maintenance, with "one-click" calibration via the HMI.



HIGH NOZZLE DENSITY & DYNAMIC WATER CROWN CONTROL

With over 1000 nozzles in a single MULPIC® header for a 5m wide mill, and heat transfer highest in the impingement zone around each cooling jet, cooling rates and therefore alloy cost savings are maximized.

Water distribution across the width is controlled dynamically using water crown control valves, not by the physical distribution of nozzles. This allows any combination of thickness, width and flow to be produced with excellent temperature and flatness uniformity, even at maximum cooling rates used during direct quenching.

This reduces material downgrades and expands the product range to the point that abrasion resistant plate up to 500 Brinell hardness is now produced online, saving the additional energy and handling costs of processing in a separate heat treatment line.



ZONE SEPARATION SPRAYS

Cooling water is kept within the machine, and when needed, separated between cooling zones using variable pressure Zone Separation Sprays (ZSS).

A standard 24m long MULPIC® has 12 ZSS, with up to 8 in use at the same time.

The ZSS eliminate the need for damming or pinch rolls in Direct Quench sections:

- Reducing maintenance requirements
- Eliminating the risk of plate marking
- Improving uniform cooling along the plate length as no threading sequence is needed.

FLEXIBLE REVAMPS & UPGRADES

LOW COST SOLUTIONS TO FIT ANY MILL LINE

The modular, flexible design of the MULPIC® can be tailored to suit the demands and budgets of different users.

FLEXIBLE REVAMP SOLUTIONS

Revamp projects require a more innovative and adaptable approach in order to overcome existing physical or process constraints. The length of a MULPIC® machine can be customized to fit in existing mill lines depending on the available space and according to the target product mix.

Flexible Piping - Flexible hose or fixed piping in vertical or horizontal orientations can be adapted to suit the space limitations of the mill.

Flexible Cooling Water Supply - Depending upon the existing cooling water supply, an elevated tank or bespoke pumped system can be designed for a cost effective design solution.

The Return on Investment (ROI) can be less than 1 year, even considering the total project costs. Primetals Technologies works with plate producers to develop the business case and ROI.

HYBRID COOLING SOLUTION

MULPIC® technology can replace part of an existing cooling machine, creating a Hybrid Cooling Solution. The newly installed MULPIC® cooling banks can be used in conjunction with the existing cooling equipment, all controlled by the new automation system. The benefits of MULPIC® being realized with low investment costs.

Flexible Expansion - The modular design ensures easy future expansions. The laminar cooling headers of a hybrid installation can easily be replaced with additional MULPIC® headers at a later date, allowing modernization in phases.

Minimum Shutdown Time - The modular design of MULPIC® also allows for equipment to be installed without impacting production, ensuring minimum mill down time.

UPGRADE OF AN EXISTING MULPIC®

MULPIC® is continuously developing in-line with customer and end-user requirements. Various upgrades solutions are available for existing MULPIC® installations:

- Flow control valve upgrade
- Level 1 and Level 2 automation upgrades
- Condition monitoring system
- Digitalization package



Two very different cooling technologies were successfully integrated together by a rigorous design of automation system architecture. Cooling process capacity in terms of cooling rate and cooling uniformity is greatly increased after this revamping project... Wear-resistant plate with hardness level at HB500 is now being supplied to CSC's domestic customers."

Dr Wei Lo,
Senior Researcher, China Steel Corporation (CSC)



DIGITALIZATION

REDUCING COSTS, IMPROVING QUALITY & OPERATIONAL EFFICIENCY

SMART MULPIC® AND DIGITALIZATION

MULPIC® technology is continually being developed with the focus on smart plate production to reduce production costs, improve quality and increase operational efficiency. Fundamental to the digital revolution, Industry 4.0 and equivalent initiatives is the gathering and intelligent use of data. To achieve this, a number of additional system features and processes are employed using data gathered from newly developed sensors as well as utilizing existing data in new, smarter ways.

MECHANICAL PROPERTY PREDICTION WITH A DIGITAL TWIN

Machine learning is used to predict the final mechanical properties such as the yield stress, tensile strength and elongation of the cooled plates depending on the process parameters measured during cooling.

Additionally, simulations run with a digital twin of the system allow further process optimization and maximization of alloy cost savings, whilst also speeding up and lowering the cost of product development.

SCALE AND SURFACE MONITORING

Information regarding scale and surface quality is available from the scanning pyrometers located on the entry and exit sides of the MULPIC®. Quality issues are highlighted early in the process, reducing downgrades and increasing profitability.



DIGITAL TWIN



MECHANICAL PROPERTY PREDICTION



SCALE AND SURFACE MONITORING



TRANSFORMATION MONITOR



KNOWLEDGE BASED QUALITY REPORTING



CONDITION MONITORING

TRANSFORMATION MONITOR

Transformation Monitor measures the transformation state of the passing steel online. It has been integrated in to the MULPIC® package providing the following features and benefits, with large potential for future developments:

- “Finger print” of the transformation state highlights any quality issues early to reduce downgrades and increase overall yield
- Comparison with offline metallurgical simulations can be made, reducing product development time and costs
- Feedback to the cooling model to improve the accuracy of microstructural prediction

KNOWLEDGE BASED QUALITY REPORTING

A web based reporting tool provides cooled product performance information such as the final temperature, cooling rate accuracy and statistical process control. The system highlights potential quality issues based on variances in process parameters, catching quality issues early, reducing downgrades and increasing profitability.

CONDITION MONITORING

The condition monitoring system records and analyzes key process parameters and cooling performance over time.

It also indicates when maintenance is required for individual parts of the equipment, helping to prevent unnecessary and unplanned machine downtime, reducing maintenance costs and increasing availability.

WORLD CLASS PROVEN TECHNOLOGY

Baosteel Zhanjiang had a very clear strategic intention to expand their product range to include more high strength structural steel grades.

They recognized that post-rolling cooling was critical to helping them achieve this and that their current cooling machine was not able to meet their precise quality requirements.



“The product mix is dramatically extended with the application of MULPIC® in the Zhanjiang heavy plate mill plant. By using MULPIC®, we successfully produced API X70 steel grades and high-strength structural steels.”

Mr Chen,
Chief Automation Engineer,
Baosteel Zhanjiang

MULPIC® REFERENCES A GLOBAL PRESENCE

Customer	Country	Product Thickness (mm)	Cooling Length (m)	Type	Project Details
SSAB (Axis) Mobile	USA	3.2-76.2	12+30	Hybrid	Plate Steckel Mill upgrade 12m MULPIC® + 30m existing laminar cooling
Shansteel (Jinan) Re-location	China	6-120	24	Modernization	MULPIC® upgrade - all banks
Dongkuk Steel	South Korea	10-100	24	Modernization	MULPIC® upgrade - bank A only
BaoSteel	China	10-100	24	New Machine	DQ MULPIC® in competitor's plate mill
China Steel Corporation	Taiwan	10-100	8 + 25	Hybrid	DQ MULPIC® + existing cooling machine
Kobe Steel Ltd	Japan	10-100	12	Hybrid	DQ MULPIC® + existing cooling machine
Gerdau Acominas SA/BR	Brazil	5-100	24	New Machine	New plate mill line
Xiangtan Iron & Steel	China	10-50	24	New Machine	New plate mill line
Jinan I&S Group	China	6-120	24	New Machine	New plate mill line
Sumitomo (NSSMC)	Japan	8-150	24	New Machine	Replace existing cooling machine
Jiangsu Shagang Group Co. Ltd.	China	10-50	24	New Machine	New plate mill line
Dongkuk Steel	South Korea	4.5-150	24	New Machine	New plate mill line
Wuhan Iron & Steel	China	5-100	24	New Machine	New plate mill line
POSCO #2 Phase 2	South Korea	10-150	8+20	Modernization	Replace the remaining 5 sections of existing cooling machine
Huta Czesochowa	Poland	8-120	24	New Machine	Replace existing cooling machine
Duferco Clabecq (NLMK)	Belgium	5-40	24	Modernization	Replace existing cooling machine
Jindal Steel & Power	India	6-120	24	New Machine	New plate mill line
Laigang	China	5-100	24	New Machine	New plate mill line
Wuyang Iron & Steel	China	6-120	24	New Machine	New plate mill line
POSCO #2 Phase 1	South Korea	15-120	8+20	Hybrid	Replace first 2 sections of an existing cooling machine
Jiangsu Shagang Group Co. Ltd.	China	10-120	24	New Machine	New plate mill line
POSCO #3	South Korea	10-120	24	New Machine	New cooling machine in an existing plate mill line

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