Start-up and operation of the world’s most powerful hot strip mill at ATI

On 18 March, 2014, a new, fully integrated hot-rolling and processing facility (HRPF), supplied by Primetals Technologies on a process-turnkey basis, was started at the Brackenridge facility of Allegheny Technologies Incorporated (ATI) in Pennsylvania, USA. The mill is capable of rolling up to 3.5Mt/yr of a broad range of highly diversified stainless and carbon steels, speciality metals and electrical steel grades that find use in the aerospace, automotive, defence, petroleum, chemical, construction, mining and power industries, as well as in various medical, food-equipment, machine and cutting-tool applications. The rolling forces are the highest ever to be applied in a hot-strip rolling mill.

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The hot-rolling and processing facility (HRPF) project scope for Primetals Technologies (see Figure 1) included engineering, manufacture of special components, and the supply, installation and commissioning of mechanical equipment as well as electrical and automation systems. The supply scope covered transfer and handling equipment for slabs and ingots, heating/reheating furnaces, primary and secondary descalers, slab and rotary crop shears, a 4-high reversing roughing stand with integrated heavy edger, heat-retention Encopanels, a 7-stand, 4-high finishing train, a laminar-cooling section, two power coilers with integrated pinch-roll polishers and quick-exchange pinch-roll units, a coil-handling system, integrated sampling, inspection, marking and strapping machines, fume-exhaust systems and a water-treatment plant.

The electrical and automation systems comprised the main and auxiliary motors, drives, instrumentation, basic automation, process automation, the Siloc yard-management system and a manufacturing execution system (MES). The general layout of the HRPF is shown in Figure 2. Leading-edge technologies are built into the HRPF to ensure top-class performance and to control key parameters such as thickness, cooling and coiling temperatures through use of built-in process models and the associated automation-controlled actuators.

EQUIPMENT AND SYSTEMS

Roughing mill Following reheating and descaling, the slabs or ingots are initially rolled in the roughing mill (see Figure 3), which is equipped with an edger and state-of-the-art twin drives with a motor power of 9.5MW each. The roughing mill stand is capable of exerting a maximum load of 60MN. This immense power gives the HRPF the capability and versatility to process and roll the broadest ranges of speciality metals in the industry. Slabs can be processed up to thicknesses of 250mm (10in), at widths up to 2,083mm (82in) and at lengths up to 12,497mm (492in) – allowing a maximum coil weight of up to 40 tonnes to be produced. Ingots can be processed with thicknesses up to 660mm (26in), at widths up to 1,778mm (70in) and at lengths up to 5,080mm (200in).

Following roughing, the transfer bar passes on to the finishing mill through an Encopanel-covered section to minimise temperature loss and provide a more uniform finish-rolling temperature.

Finishing mill The finishing mill is designed with seven 4-high stands, each of which is powered by 10MW drives (see Figure 4) and is capable of exerting a mill-stand load of up to 55MN. Patented technological controls allow the application of long-stroke HAGC (hydraulic automatic gauge control) cylinders for improved operation and maintenance. All stands feature dynamic work-roll...
cooling that allows defined cooling patterns to be carried out across the work-roll barrel length. Additional systems include interstand cooling, work-roll lubrication, a fume-suppression system, strip cross sprays, entry-guide cooling, as well as looper cooling as the basis for optimum process parameters and equipment conditions.

In order to ensure that the highest technological demands are met for rolling ATI’s extremely sophisticated product mix, the mill is furnished with numerous state-of-the-art technological packages. This includes SmartCrown rolls installed in the finishing stands, which operate in conjunction with L-type bending blocks and the work-roll shifting system. This technology is a decisive factor for assuring excellent strip profile and flatness control.

Laminar cooling section The laminar cooling section comprises 54 top headers and 162 bottom headers that allow a maximum water flow rate of 20,000m³/h. The cooling headers are flow-controlled on the basis of calculations from a microstructure target-cooling model. Laminar cooling is split into a fast cooling zone (first 20 top headers) and a normal cooling zone (remaining 34 top headers). Each top header and each group of bottom headers is separately regulated by a flow-control valve. This increases the overall flexibility of the cooling system and allows a variety of cooling rates to be applied for exact control of phase transformation, depending on the desired steel grade to be produced.

Downcoiler section Two so-called Power Coilers (see Figure 5) are installed in the coiling section, which are dimensioned so that they are capable of coiling API X100 pipe-grade material at a thickness of 21.2mm/0.8in and a width of 1,956mm/77in or API X80 pipe-grade material with a thickness of 25.4mm/1in and a width of 2,083mm/82in (see Figure 6). The power coilers are equipped with servohydraulically controlled side guides, pinch-roll units and four wrapper arms. They are also outfitted with pinch-roll polishers, quick-exchange pinch-roll units and coil-springing prevention devices. The coils are subsequently strapped, weighed, marked and, if required, inspected before they are transferred to the coil yard for subsequent processing or dispatch.

Automation and logistics The entire facility is controlled from control pulpts positioned at the roughing mill, finishing mill and downcoiler. A complete suite of Level 1 automation systems and sophisticated Level 2 process-optimisation systems with integrated tailored process models ensure that nothing is left to chance. Level 2 rolling systems include models for the precise control of rolling parameters, models for monitoring and governing strip temperature, heat transfer and phase transformations,
and other models for profile and flatness control, roll bending, roll thermal crown and roll wear, material flow, roll flattening and roll shifting. The cooling section includes models for temperature monitoring and control, heat-transfer and phase transformations. The installed automation systems allow manpower requirements for the operation of the HRPF to be reduced compared to conventional hot strip mills (see Figure 7).

The application of an MES and a logistics system (Siloc) serve as the basis for record-breaking melting-to-shipping throughput times. This allows ATI to operate this exceptional facility at maximum output on a one-shift production basis without the need for a slab yard and coil yard specifically dedicated to the HRPF. This considerably enhances ATI’s capability to reduce its managed working capital.

**EXPANDED PRODUCT MIX AND ROLLING CAPABILITIES**

Completion and operation of the HRPF has enhanced ATI’s capability to offer its sheet and plate customers a wider range of grades and sizes. Following successful completion of all required performance tests, the final acceptance certificate (FAC) was issued on 3 February, 2016. ATI is now able to offer a significantly expanded range of speciality metals and product dimensions unique in the industry. Larger, longer, thicker and wider coils are produced with thinner gauges, superior tolerances, improved surface quality and more consistent mechanical properties. Overall hot rolling performance has been significantly augmented with the new HRPF as follows:

- Unprecedented short melt-to-shipping lead times
- Reduced manufacturing throughput time
- Production of an incomparably and highly diverse product mix (see Table 1 and Figure 8)
- Enhanced capacity to meet customers’ product design needs and increased range of product applications
- Unique capability to offer best-in-class coil geometry
- Rolling of 1,500-2,000mm wide coil and plate products at the thinnest and thickest gauges in the industry.
### FORMING AND FINISHING PROCESSES

**Strip produced from slabs**
- Stainless steels, including austenitic (200 and 300 series), super ferritic (400 series), martensitic (400 series) and duplex grades
- High strength/high temperature alloys, including nickel-based and cobalt-based grades; armour plates and other specialty metals
- Titanium and titanium alloys
- Zirconium

**Strip produced from ingots**
- Stainless steels (austenitic, ferritic and martensitic grades)
- High-temperature alloys
- Titanium
- Grain-oriented silicon steel grades

**Carbon steels**
- Dual phase steel (as hot rolled)
- API pipe-grade products
- Multi-phase steel (for cold rolling up to DP 1000)
- Steel for exposed automotive and other applications (for subsequent cold rolling and coating)
- Electrical steel grades

| Table 1 Product mix capability of the HRPF |

### OUTSTANDING COOPERATION

The HRPF project represents an outstanding example of a successful cooperation between a market-leading supplier of specialty metals and a metallurgical plant builder. The installed power, size and advanced technology of the mill, combined with decades of operational expertise, allow ATI to use this unparalleled capability to fully meet the most demanding customer requirements in a highly efficient and productive manner.

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