The steel melt shop is getting smarter

Steel melt shops can boost productivity, safety and energy efficiency using smart factory solutions powered by digital technologies, taking a step towards autonomous and safer operations, writes ABB’s Tarun Mathur*

STEEL manufacturers face three key challenges. First, there is the need to improve productivity while also keeping workers safe in melt shops, where there is a lot of manual co-ordination of hot metal.

Second, melt shops are under pressure to produce the same tonnage of metal with fewer operating costs. An increasing number of technology projects in the steel industry now focus on optimising process efficiency through the application of digital and automation solutions.

Finally, sustainability is a major driver. Along with the aluminium and cement, steelmaking produces the largest quantity of emissions of any industrial process worldwide, and the onus is on companies to reduce carbon emissions; this is especially true in Europe, which has strict environmental targets.

Steelmakers can take advantage of grants and subsidies available from governments to incentivise them to reduce their carbon footprint. Partnering with a trusted technology provider with a portfolio of digital and automation solutions and proven domain expertise is key in helping them to do so.

**ABB Ability™ Smart Melt Shop**

By synchronizing the movement of ladles using digital and automation solutions, melt shops can detect and eliminate equipment or process bottlenecks to maximize throughput, while at the same time minimizing energy use per tonne of production.

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ABB ABILITY™ SMART MELT SHOP: KEY BENEFITS

• Increased caster speeds by ensuring the correct superheat at the caster.
• Improved people safety by reducing exposure to hazardous hot metal zones and allowing for decision-making based on information dashboards.
• Energy savings and quality improvements by predicting the ladle’s thermal loss during transfer and calculating the right temperature to avoid excess overheating.
• Improved service planning by tracking the history of ladle maintenance and contact with metal.
• Reduced tapping ladle delays for EAFs due to efficient crane scheduling for ladle movement.
• Detailed time motion analysis of work orders and overall system effectiveness with reports and KPIs.
• Backed by knowledge built up during ABB’s more than 100 years in the steel industry.

Ladle tracking by itself is not enough to optimise melt shop operations, yet many vendors only offer ladle tracking solutions. ABB Ability™ Smart Melt Shop additionally offers how to pace the heats and ladles optimally while eliminating delays caused by either processes or cranes. This ensures the correct superheat at the caster and that there are no tapping delays at the arc furnace or converter; this additional functionality is a key differentiator for the company and customers.

Thermal loss prediction based on ladle conditions and forecasted delays in operations provide ladle furnace operators with the right lifting temperature prediction to ensure heats reach the right superheat at the caster, hence the opportunity for the steelmakers to increase caster speeds and higher production from melt shops.

ABB Ability™ Smart Melt Shop displays many attributes of an Internet of Things (IoT) solution in that it connects all the processes, cranes and ladles, and tracks all these different objects uniquely in the melt shop and applies algorithms to improve the production ecosystem.

**Ladle and crane tracking engine: visibility and safety**

What do we mean by a ‘smart’ melt shop? Take Uber cabs as an example. Customers are demanding a taxi to a certain location, with multiple users making the same request to a central server via an app. Uber looks at the availability in that area and then allocates a specific cab for a specific user.

Transfer this model to the steel melt shop, where you have multiple people requesting a crane to pick up the material at the right time. ABB Ability™ Smart Melt Shop makes the entire ladle and heat movement automated by tracking the cranes using radar technology, ladle transfer cars by laser and augmenting this data with an image-based system to track the real time position of ladles/heats. This data is then fed into the scheduling engine, which automatically generates and schedules crane jobs based on real time visibility, with pick up and drop location information made available to the operator on a screen.

Instead of only ladle tracking, ABB’s solution extends to derive real values by scheduling crane operations, heat pacing and thermal model predictions to optimise melt shop operations with the preferred heats and speeds, and less arcing in ladle furnaces.

The ABB tracking engine has no sensors on the ladle itself, and instead radar-based technology for crane positioning and laser-based technology for transfer car positioning allow to logically and uniquely track the ladles in the steel melt shop. This alternative approach reduces the hardware footprint, and saves melt shop
clients having to spend time and money on additional hardware maintenance.

Crane scheduling engine: productivity
Currently, crane operations are manually co-ordinated. Typically, each process station speaks to the operator via walkie-talkie, with a manager overseeing the process to ensure each station gets the material it needs on time. Manual co-ordinations may result in inefficient operations leading to delays in tapping the ladle for EAF or delays in ladle transfer to the caster.

ABB automated crane scheduling, part of its smart melt shop model, encompasses job forecasting, route planning, automatic crane scheduling and automatic acknowledgement of jobs for optimal work allocation. For example, when arcing is complete, the system identifies that a crane is needed, creates a job list and dispatches the crane on time based on legacy and current production data.

By centrally visualising what is happening in the melt shop in this way, the tracking engine replaces inefficient manual crane management with synchronised operations that streamline production. A major reduction in tapping delays is observed after the implementation of the smart melt shop system. In addition, the crane operator’s job is made easier, more predictable and less stressful via the automated generation of job lists, rather than co-ordinating operations via walkie talkie. Safety is also improved by minimizing exposure to hazards via full visibility of ladle and crane movements.

Thermal engine: heat compliance
Effective superheat control for the heats at the caster is critical to running it at maximum speed. In addition to this, effective superheat control reduces the arcing requirement in ladle furnace processes, reducing the energy bill for melt shops. Lower superheat may lead to heat rejection at casters, while higher superheat requires casters to reduce speed, hence a loss in productivity.

The primary objective of ladle tracking and crane scheduling is to make the ladle transfer more certain, and hence calculation of thermal losses more accurate. Using forecast data from the tracking and scheduling engines, the system can predict the waiting and travel time for the ladle – and thus its thermal loss during transfer – and predicts the right lift temperature at the ladle furnace to avoid excess overheating so the caster can run at the highest possible speed. The thermal model takes into account the ladle’s recent tracking history for more accurate predictions.

An increase in caster speeds of 4–5% is observed after implementing the ladle tracking, crane scheduling and thermal model.

In addition to production optimisation, automated solutions such as those outlined above improve safety.

A melt shop is a dusty, hazardous environment, with hot metal temperatures exceeding 1,600°C. Now, personnel can visualise operations on a screen and tablet devices in an air-conditioned control room with much reduced footfall on the shop floor.

ABB digital and automated solutions for steel melt shops use standard industry protocols and are, therefore, easily incorporated with legacy and third-party supplier systems, resulting in more informed decision-making based on information dashboards, improved service planning, and better reaction time to work orders and overall system effectiveness through reports and KPIs.

Case study: JSW Steel
These benefits and others can be witnessed in India, where ABB has integrated ABB Ability™ Smart Melt Shop into a wider expansion at JSW Steel’s Dolvi Works. Completed in March 2021, the project has improved productivity and energy efficiency for the steel melt shop using a ladle and crane tracking system, crane scheduling system and thermal loss models to predict target temperature for ladle furnaces and ensure the correct superheat at the caster.

These innovations are expected to increase the company’s EBITDA profit by approximately $2 million a year through 4% higher casting speeds, time savings of one working day per month and additional output equating to 24kt/yr.

The Dolvi Works plant now benefits from real time ladle tracking for process synchronization and better maintenance planning. The lower energy consumption means fewer consumables are used per batch and, therefore, a lower carbon footprint thanks to less CO2 per tonne of steel produced.

In addition, ABB’s automatic tracking and scheduling solution increases the safety of JSW Steel personnel by removing them from the busy production area during crane and ladle movements.

The evolution of Industry 4.0
Innovations such as these are just the beginning. Industry 4.0 is transforming many key facets of steelmaking operations and manufacturers that do not adopt an ‘early mover’ strategy when it comes to embracing the digital and automation revolution risk losing their competitive advantage.

There are also potential wins in terms of predictive solutions that use advanced analytics, AI and machine learning to further improve temperature optimisation, maintenance and plant uptime.

As a leading technology provider with proven experience in the steelmaking industry, ABB’s portfolio of digital and automation solutions will adapt and evolve in response to the challenges facing steel manufacturers as they look to boost production and profitability, and reach their sustainability targets. n