Products and solutions: Planning under consideration of capacity and temperature with PSI*metals*

Temperature-controlled planning for energy optimisation in steel plants

With regard to the holistic optimisation of production processes in steel production, PSI cooperates closely with leading technological partners such as the applied research institute VDEh-Betriebsforschungsinstitut (BFI) in Dusseldorf and has integrated the latter's analytical-mathematical online process models in its production management system, PSI*metals*. Current collaborations are aimed at energy-optimised facility planning under consideration of available capacity and the heat temperatures required during the production process. The main focus is on integrating the BFI temperature model in PSI*metals* to enable temperature-controlled scheduling for steel plants. The system ensures that the heat is handed over for continuous casting on time and with the right temperature, depending on the aim of optimisation (maximum throughput or minimum energy costs).

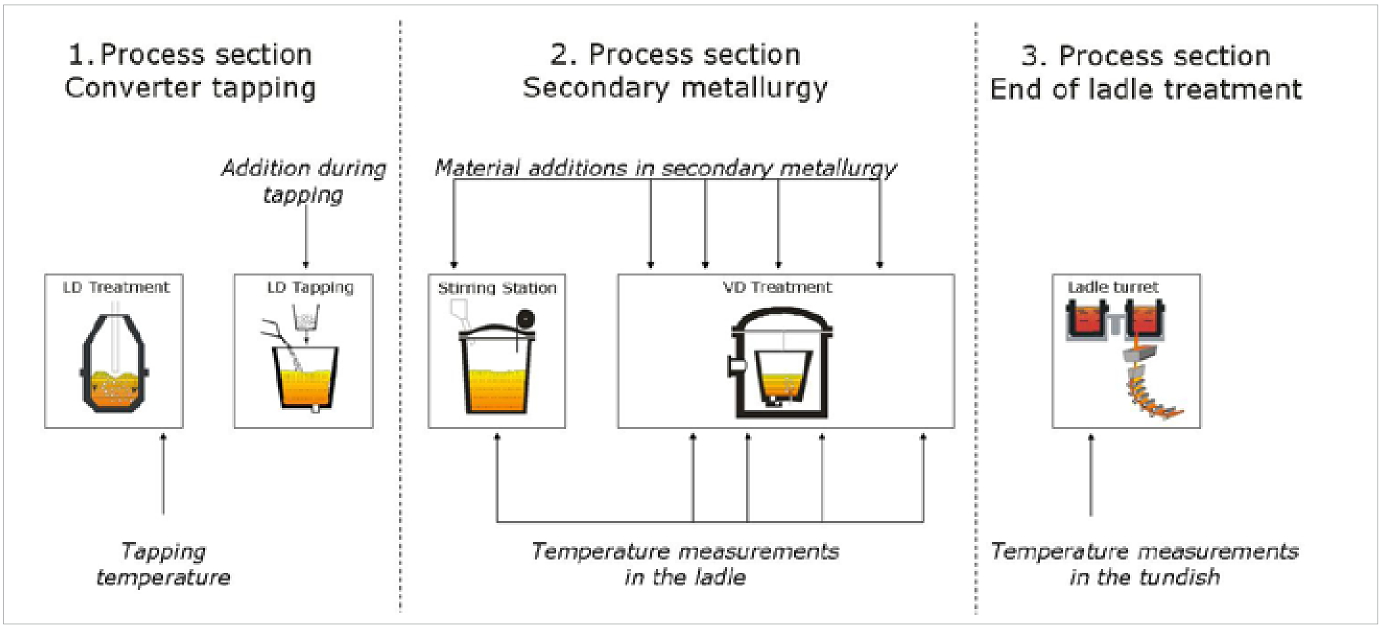
The problems concerning energy buffers for process control

The steel production process (from manufacturing crude steel in a converter or electric arc furnace to complex treatment in secondary metallurgy to casting the steel in continuous casting machines) is very energy-intensive. Starting from the target temperature required at the continuous casting machine, production processes usually incorporate energy buffers for every upstream facility to compensate for the temperature losses occurring between tapping and treatment including waiting time and to cover unforeseen production interruptions.

The energy buffers required to reach the target temperature, in particular in steel plants without a ladle furnace, are often over-dimensioned for precautionary reasons; this means taking longer stirring times and even the addition of cooling scrap to achieve the right target temperature into account when the process is running without interruption If delays in process flow lead to waiting times and thus to temperature losses (due to an insufficient energy buffer) the heat becomes too cold for casting and needs to be reheated in the ladle furnace under high energy expenditure, or even re-charge in the primary facility if there is no ladle furnace. The situation offers significant potential for energy cost reduction through optimised planning.

Temperature as a major planning variable

The planning solutions for steel plants available on the market focus on time schedules, capacity and sequence as restrictions for planning. However, the temperature as a major process variable and how it changes during production process in comparison to the required target temperature is left unconsidered. When steel is produced without a ladle



Interaction between material feed and temperature changes in the individual process stages of steel production Source: PSI/BFI furnace the assessment as to whether the casting temperature will be attained at the end of the process or if there is a danger of having to stop casting depends on the experience and competence of the operators and dispatchers; it also requires internal coordination to correctly evaluate the impact on follow-up production orders and facilities.

This gap in the market has now been closed by the integration of the BFI temperature model in PSI*metals* which takes the temperature into account as a significant basic restriction. All temperature-relevant variables are stored in the process instructions of PSI*metals*. Other factors influencing the temperature in addition to the temperature losses occurring during production flow, such allyoing and other material additions, are also calculated and taken into consideration. The logistic tracking of every single ladle in the steel plant by PSI*metals* enables the BFI model also to exactly consider its thermal condition and its impact on the temperature development.

Batching liquefied steel in an electric furnace Source: SMS Group

Dynamic online prediction of temperature development

The BFI temperature model calculates online the current temperature of the liquid steel in the facilities, considering all material additions and treatment steps. Furthermore, the model also ensures the heat reaches the target temperature required for continuous casting based on a given tap temperature The model's input variables are, on the one hand, specifications provided by PSI*metals* for treatment and transportation times as well as calculated target values for material additions, electrical energy input, etc., and on the other hand, the ladle temperature loss rate and losses through heat treatment and material additions. To achieve the target temperature, the model predicts the heat temperature for the remaining treatment steps on the basis of the current process condition determined via online monitoring. The prediction is updated cyclically and event-driven when laboratory analyses and new temperature measurements become available and when materials are added and treatment steps are finished.

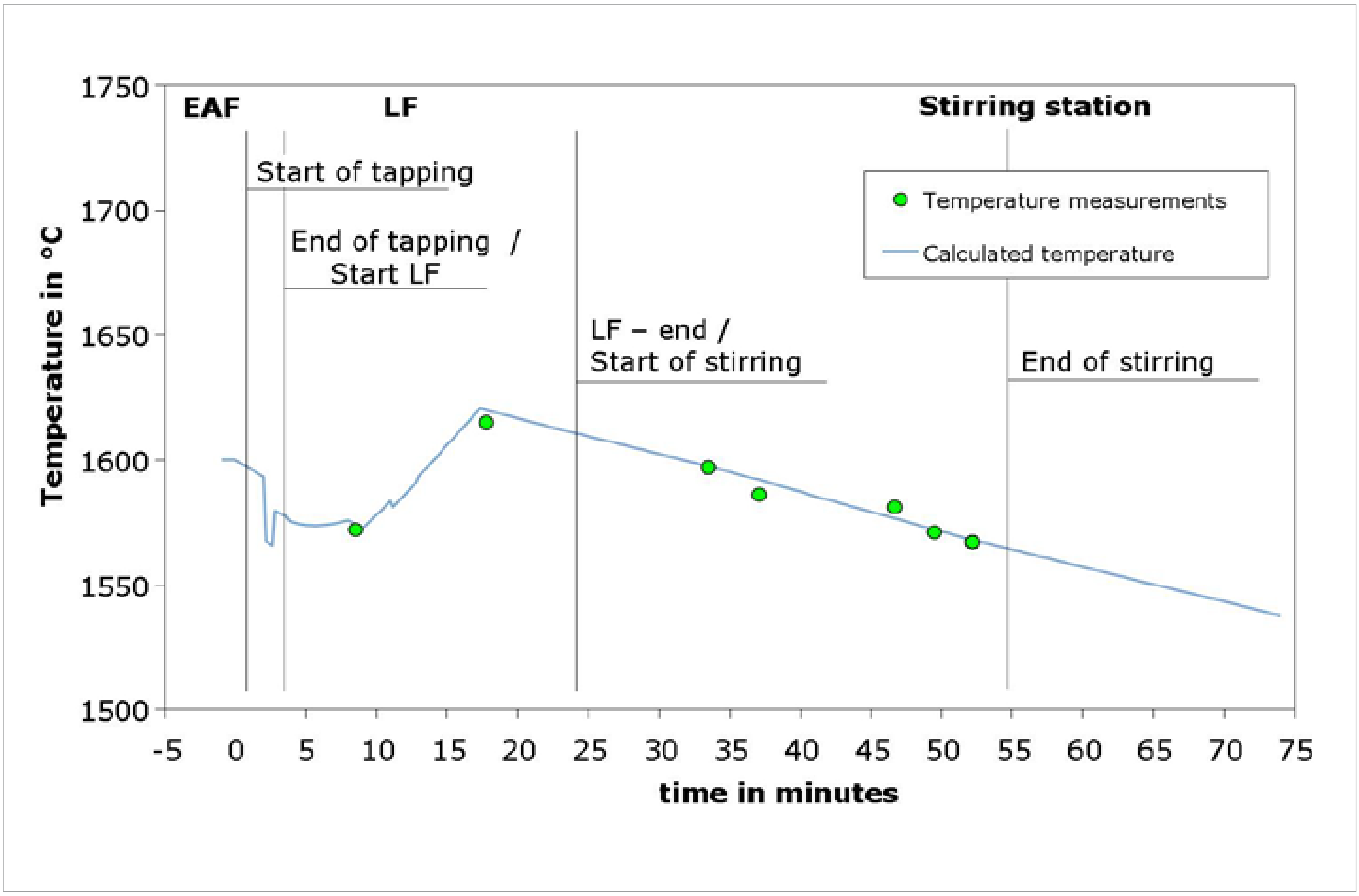
Temperature-guided planning with PSI*metals*

The planning process for the steel plants defines a sequential schedule for treating the heats with optimised temperature buffers for all facilities upstream from continuous casting on the basis of target treatment times and target temperatures. Changes in production flow lead to new predictions which are visualised in PSI*metals*. This is important to the extent that every chronological change in production flow has a direct impact on temperature. Temperature-guided planning allows temperature changes to be taken into consideration during planning to optimise the entire time frame of a heat production order.

Planning the ladle circulation also plays an important role as ladles that are empty for any significant amount of time not only cool down but also cause a higher temperature loss rate. PSI*metals* optimises ladle circulation with the aim of keeping every ladle in the cycle (taking ladle history into consideration) to reduce the average ladle re heating and circulation times.

Handling option for more efficiency

Depending on the processing route (converter steel plants, electric steel



Comparison of calculated temperature development and temperature measurements in process flow using the BFI temperature model Source: PSI/BFI

plants, ladle furnace yes/no) PSI*metals* enables the scheduler to optimise various targets with regard to quality, cost, time and productivity. For instance, throughput optimisation usually requires greater energy expenditure to treat as many heats as possible when the facilities are working to capacity. This can be expedient when the order books are full and profits are sufficient to cover the higher cost of energy. The response to a drop in demand is a continuous reduced facility output whilst maintaining throughput with a focus on energy cost minimisation.

PSI*metals* will make recommendations on what can be influenced by the dispatcher depending on the optimisation target. Can existing buffers be used up? Should the tapping temperature be reduced? Should casting speed be increased? PSI*metals* calculates the effects of changes to the speed of casting and how and when buffer times and temperatures can be utilised.

The direct integration of the BFI temperature model in PSI*metals* enables the temperature development in any production stage to be taken into consideration during scheduling. Energy buffers that "feel right" but are in fact too high can be reduced, treatment times cut and the overall energy costs of the treatment process lowered without increasing the risk of production downtimes.

► *Information*

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