EC's Framework Programme for Research and Innovation Horizon 2020 (2014-2020)
Grant agreement no. 636820

Cross-sectorial real-time sensing, advanced control and optimisation of batch processes saving energy and raw materials (RECOBA)

Start of the project: Jan 1st, 2015
Duration: 36 month

Detailed dynamic process model for both (RH degassing and Ar stirring) processes

Due date: June 30, 2017
Actual submission date: June 30, 2017

Lead contractor for this deliverable: BFI

Author:

Company	Name
BASF	
TKSE	S. Will, M. Skorianz
ELKEM	
UCAM	
RWTH	
VSCHT	
PMAT	
BFI	B. Kleimt , T. Kordel
CYB	
MINKON	

Dissemination level

PU	public	☒
PP	restricted to other programme participants (incl. the Commission Services)	☐
RE	restricted to a group specified by the consortium (incl. the Commission Services)	☐
CO	Confidential, only for members of the consortium (incl. the Commission Services)	☐

CONTENT

1 Detailed dynamic process model for both (RH degassing and Ar stirring) processes

The dynamic process model for the evolution of the steel melt temperature covers the complete process chain from tapping of the BOF converter up to the delivery of the melt to the continuous casting plant. Thus it also includes the liquid steel treatment within the RH degassing and the Ar Stirring plant, where trials with the fibre optical temperature measurement system were performed at the tkSE Beeckerwerth plant.

For evaluation of these measurement trials the dynamic model calculations were applied for the corresponding trial heats. This has been done for two purposes:

- to confirm the reliability and accuracy of the fibre optical temperature measurement
- to perform a more detailed validation and adaptation of the model calculations and parameters on the basis of the continuously acquired information on the melt temperature evolution

1.1 Evaluation of fibre optical temperature measurements at the RH plant

Measurement campaigns were performed for in total three heats treated at the RH degassing plant. Two of them belonged to the group of decarburised heats, one to the group of alloyed heats. **Figures 1 and 2** show the measurement results together with the results of the dynamic model calculations for one exemplary heat of each of these two steel grade groups.

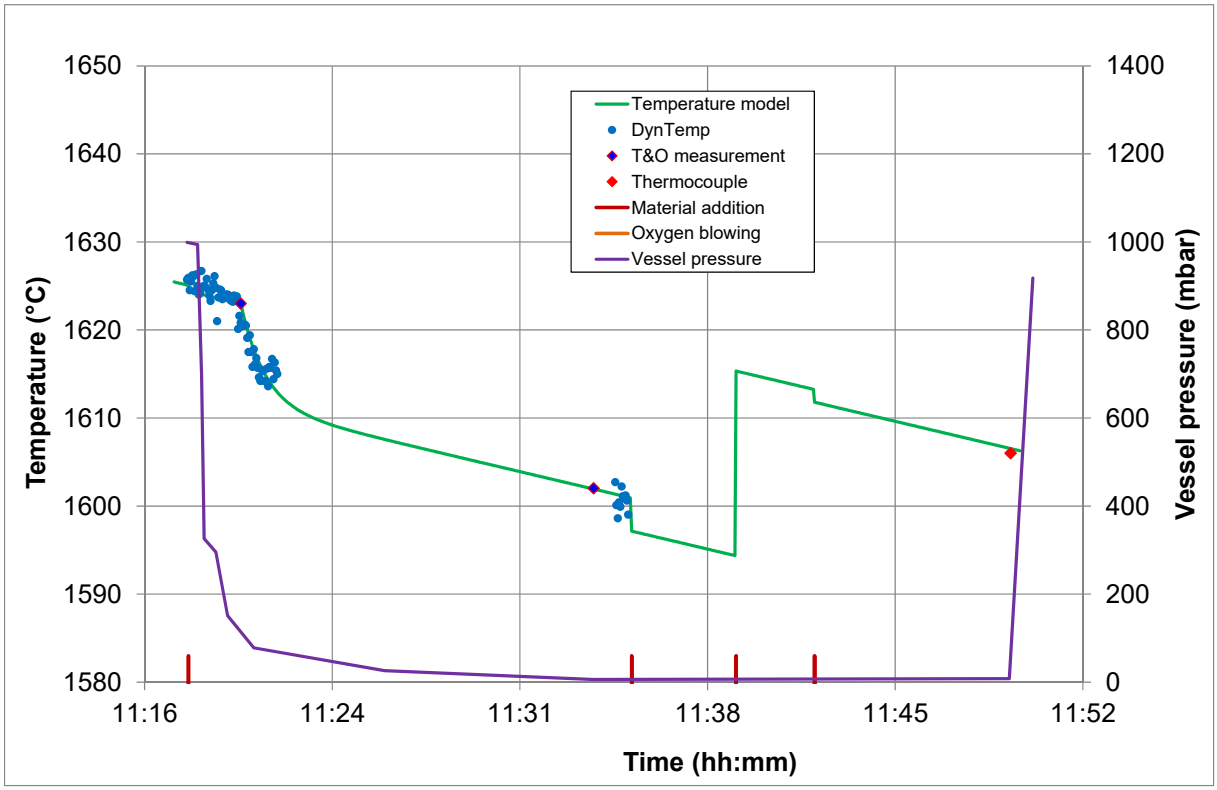

Figure 1: Fibre optical measurement and modelling results for liquid steel temperature evolution together with other process data for a decarburised trial heat

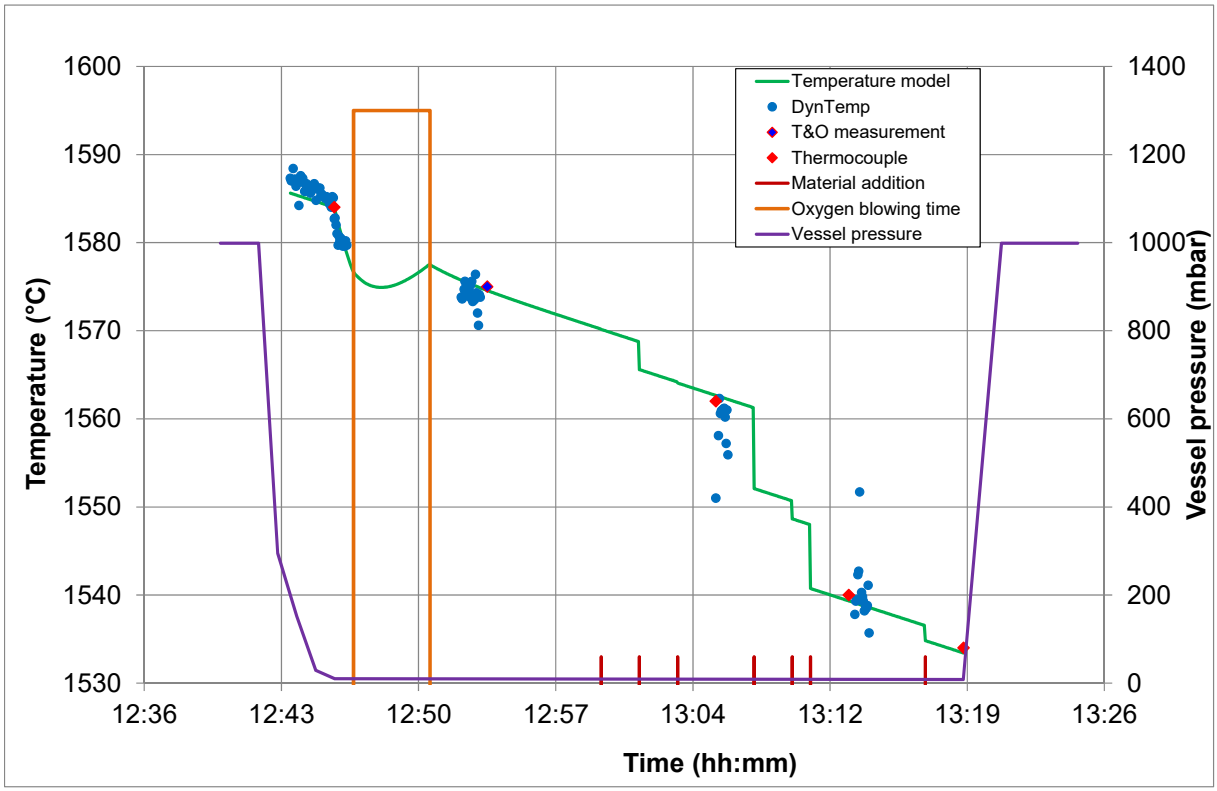

Figure 2: Fibre optical measurement and modelling results for liquid steel temperature evolution together with other process data for an alloyed trial heat

The evolution of the melt temperature calculated by the dynamic model fits very well to both the thermocouple measurements and the continuous fibre optical temperature measurement values. The steps in temperature evolution can be clearly explained by corresponding material additions. The continuous temperature decrease of the fibre optical measurement values directly after beginning of the vacuum treatment clearly indicates the higher temperature losses due to lifting and treatment of liquid steel in the refractory lined vacuum vessel, causing additional temperature losses by convection and radiation.

This confirms that both the model structure and also the model parameters are well suited to describe the evolution of the melt temperature during the RH degassing process. On the other hand, it clearly confirms the reproducibility and accuracy of the continuous temperature measurement.

1.2 Evaluation of fibre optical temperature measurements at the Ar stirring plant

Measurement campaigns were performed for in total five heats treated at the Ar stirring plant. All of them belonged to the group of alloyed heats. **Figure 3** shows the measurement results together with the results of the dynamic model calculations for one of these trial heats.

The evolution of the melt temperature calculated by the dynamic model fits very well to both the thermocouple measurements and the continuous fibre optical temperature measurement values. The steps in temperature evolution can be clearly explained by corresponding material additions, and the continuous temperature decrease of the fibre optical measurement values after a material addition clearly illustrates the melting and homogenisation procedure of the material.

This confirms that both the model structure and also the model parameters are well suited to describe the evolution of the melt temperature during the Ar stirring process. On the other hand, it clearly confirms the reproducibility and accuracy of the continuous temperature measurement via the Ar stirring lance.

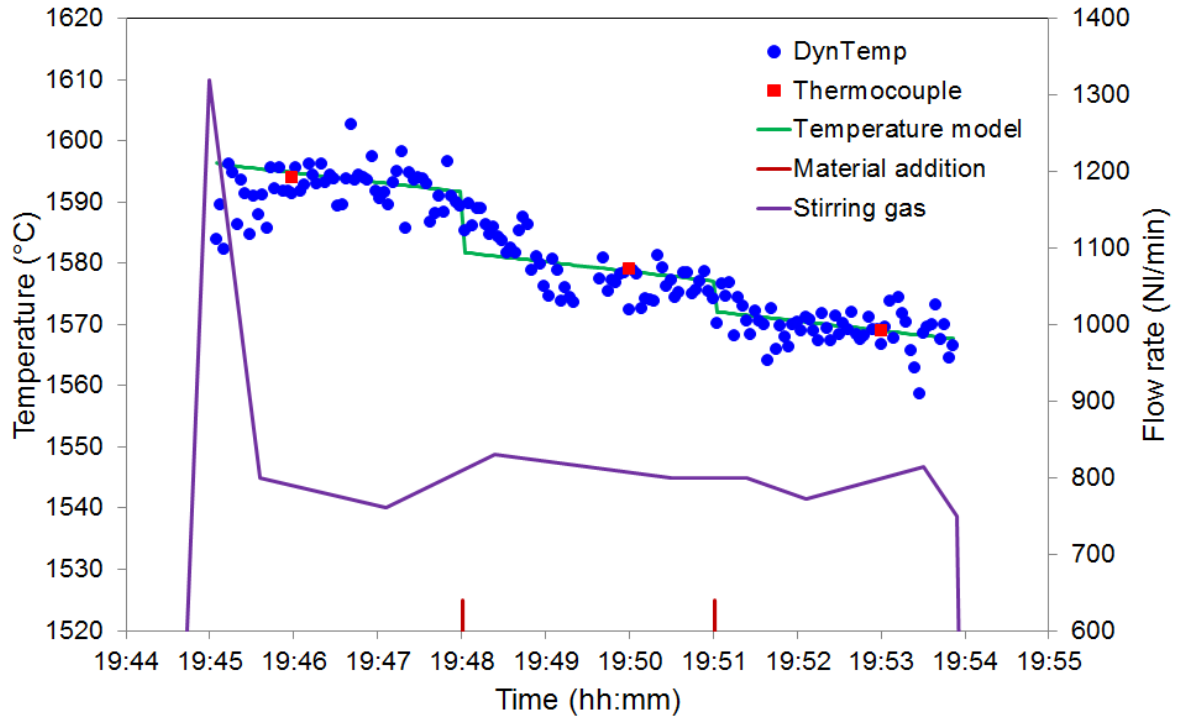

Figure 3: Liquid steel temperature evolution during gas stirring, as measured by fibre optical and thermocouple measurements and dynamic model calculations.

1.3 Conclusion

The fibre optical measurement was successfully applied at the RH degassing and the Ar stirring plant of tkSE. The good correspondence with the melt temperature evolution calculated by the dynamic process model on the one hand clearly demonstrates the reliability and accuracy of the continuous temperature measurement. On the other hand it confirms that structure and parameters of the dynamic process model are well defined to monitor and predict the temperature behavior during degassing and stirring treatment.