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Knowledge about temperature development in vacuum degassing batch process

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PU	public	☒
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CO	Confidential, only for members of the consortium (incl. the Commission Services)	☐

CONTENT

1 Monitoring of melt temperature evolution during vacuum degassing

1.1 Fibre optical measurements

In Task 3.5 a demonstrator for fibre optical measurements of the melt temperature was developed. Results of this development were reported in D 3.7. This novel sensor was now used to measure for the first time the melt temperature evolution in the ladle during vacuum degassing with high dynamics and accuracy. It was installed at the RH degassing plant of tkSE (**figure 1**), and electricity and inert gas was supplied. A hand lance was adapted to the geometrical requirements at the plant, for temperature measurement of the steel melt inside the ladle. For long term measurements a novel probe was developed especially designed for high durability during vacuum treatment (**figure 2**).

Figure 1: Photograph of the demonstrator for fibre optical temperature measurements installed at the vacuum degassing plant

Figure 2: Photograph of the novel probe and the adapted hand lance for temperature measurements in front of the vacuum degassing plant

1.2 Industrial trials

When the nozzles of the degassing vessel were submerged into the melt, the hand lance was dipped into the liquid steel (**figure 3**). The measurements were repeated three times during the course of the vacuum treatment after chemical heating, alloying and cooling scrap additions (**figure 4**). Thermocouple and fibre optical measurements are in excellent agreement with each other.

At the beginning of the vacuum treatment, the pressure is reduced in the vessel, the lift gas is injected and the melt starts to circulate through the vacuum vessel. Since the refractory material of the vessel is colder than the melt, the temperature of the melt leaving the vessel decreases. This can be seen as a sudden drop in the temperature evolution (**figure 5**) as measured during the first five minutes of vacuum treatment. The melt temperature drops by 5K within 30 s.

Figure 3: Photograph of the hand lance for long term temperature measurements in the ladle during vacuum degassing.

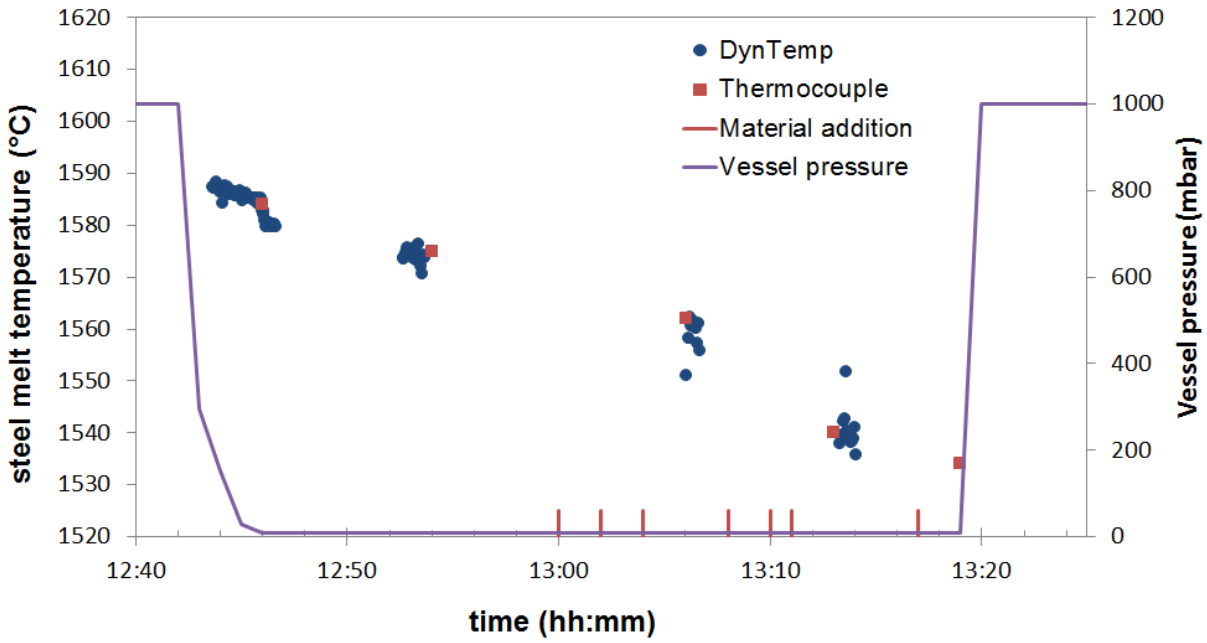

Figure 4: Graph of intermittent measurements of the liquid steel temperature evolution (left axis) together with other process data (right axis).

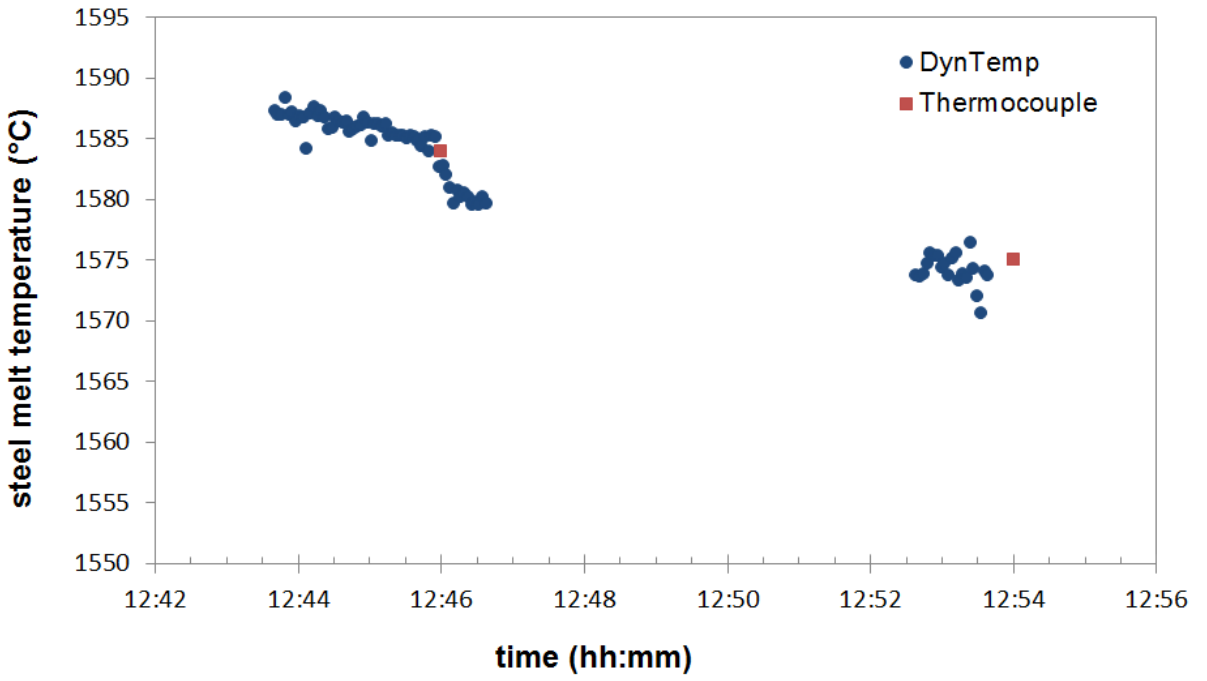

Figure 5: Detailed graph of the evolution of the liquid steel temperature during the start of vacuum degassing as measured by fibre optical and thermocouple measurements.

1.3 Conclusion

Using the adapted hand lance and a novel long durability probe, continuous liquid steel temperature measurements were performed for up to five minutes. Based on fibre optical measurements it can be studied in detail, how the vacuum process affects the melt temperature. Interesting aspects are the melt temperature decline based on the thermal state of the refractory vessel, alloying elements and cooling scrap additions, and the homogenisation duration until the material additions have been solved and are homogeneously distributed in the melt.