OPERATIONAL EXPERIENCES WITH THE SECONDARY COOLING MODIFICATION OF CONTINUOUS SLAB CASTING

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Abstract

The surface temperature on the small radius surface in positions of straightening is an important parameter that can influence the surface quality of continuously cast steel slabs. Based on the detailed analysis the replacement of cooling nozzles pertaining to the small radius surface in the secondary cooling was performed on the caster in Evraz Vitkovice Steel due to the requirement on the increase of surface temperatures on the small radius surface of cast slabs. The results and experiences obtained after the replacement of cooling nozzles are compared to long-time operational data for the preceding setup of cooling nozzles that are used on the caster since 1995. The comparison is performed with the use of data acquired from the dynamic solidification model and with the use of the statistical operational data. The optimization of cooling nozzles setup is also discussed in the paper.

Key Words: optimization, surface temperature, characteristics of nozzles, continuous casting, statistic

1. INTRODUCTION

The concasting machine (caster) for the casting of slabs (**Fig. 2**) has the secondary-cooling zone subdivided into thirteen sections, due to the convection of a greater amount of heat from the voluminous slab casting. The first section engages water nozzles from all sides of the slab. The remaining twelve sections engage air mist cooling nozzles, which are positioned only on the upper and underside of the concasting. It is therefore very important to determine the correct boundary conditions for the numerical model of the temperature field [1, 2]. Regarding the fact that on a real caster, where there are many types of nozzles with various settings positioned inside a closed cage. Real caster contains a total 8 types of nozzles and geometrical layouts [3]. The aim is to modify the secondary cooling zones 6, 8 and 10 so

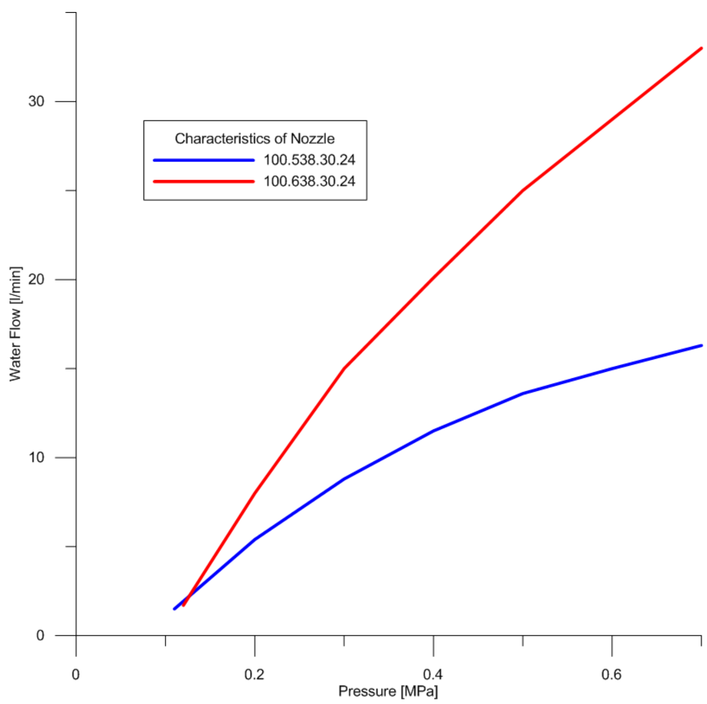

Fig. 1 Characteristics of nozzles Lechler 100.638.30.24 and 100.528.30.24

as to increase the surface temperature of the slab in a small radius at point of straightening. Currently in cooling zones 6, 8 and 10 nozzles installed air mist nozzles Lechler 100.638.30.24 (**Fig. 2**). Since the cooling nozzle 100.638.30.24 for minimum water flow appears to be too intensive and measurements were made for such a small nozzle 100.528.30.24 (**Fig. 3**) [4]. In the last part of the year have been installed on the caster new smaller nozzles (100.528.30.24) in the cooling circuit 6, 8 and 10, but the settings remained the same water flow and optimization flow to take place this year [5, 6].

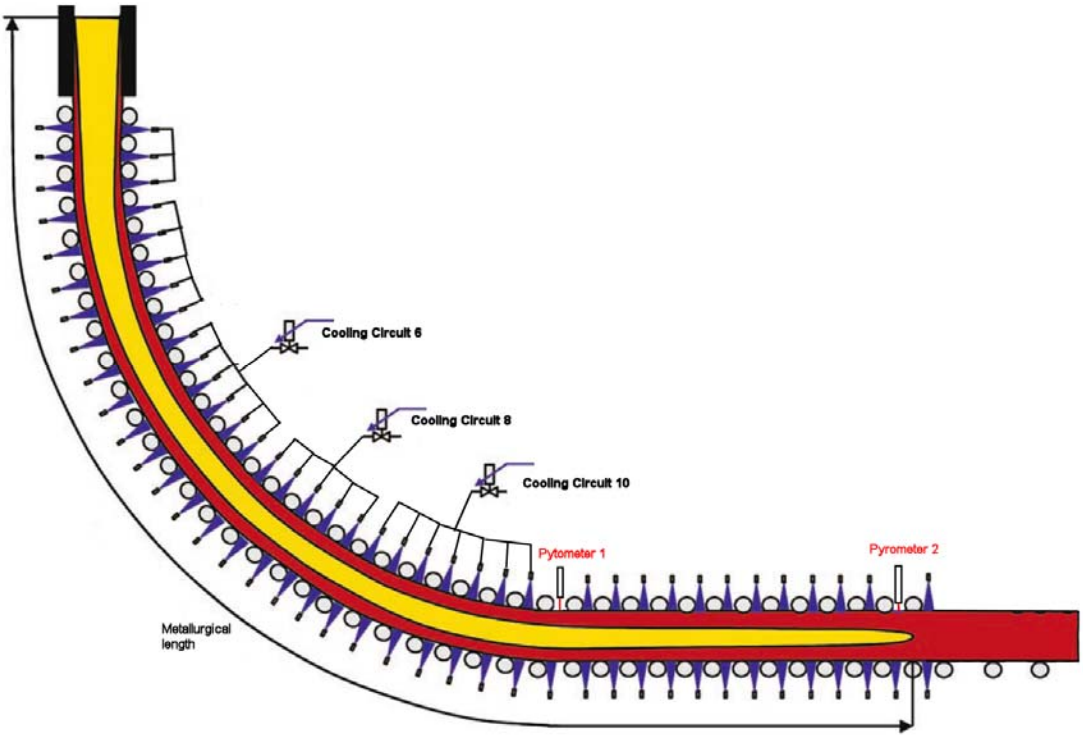

Fig. 1 Radial caster with cooling circuit and position of pyrometers

2. STATISTICAL PROCESSING OF DATA FROM THE ON-LINE MODEL

For each "heat", the following statistical quantities are calculated for all measured and calculated values: the arithmetic mean, the minimal value, the maximal value and the standard deviation.

The basic statistical quantities are evaluated only from so-called "clean" data – the statistics does not include the transition sections of the first and last heats in the sequence and also the data from any unexpected interruptions in casting. In the evaluation of the statistical data, it is necessary to compare the data for the same slab profile and also for the same class or group of steel. This paper presents the graphs of the statistical quantities for basic slab profile 1530x250 and two one class of carbon steel with an average carbon content of 0.16 % and 0.10 % within a period of 12 months of operation of the caster at EVRAZ VITKOVICE STEEL. The main part of the year in operation original cooling nozzles, the last part of the year are already installed a new smaller cooling nozzles.

Fig. 3 compares the average values of the measured surface temperatures in two points with the average calculated temperatures in the same points. The graphs indicate that the measured and calculated values are practically identical in terms of their trends. Comparing the absolute values, it is possible to see that there are long intervals where the deviation is significant and, on the other hand, there are intervals where the values are identical. Furthermore, there are sequences of heats where one pyrometer is out of operation.

The conclusion here is that the calculated values of the temperatures are much more reliable and give values that are much more suitable for the prediction system or the secondary-cooling regulation. Another reason why there can be a difference between the measured and calculated temperatures is the state of the secondary cooling. The magenta dividing line is marked heat with replace nozzles.

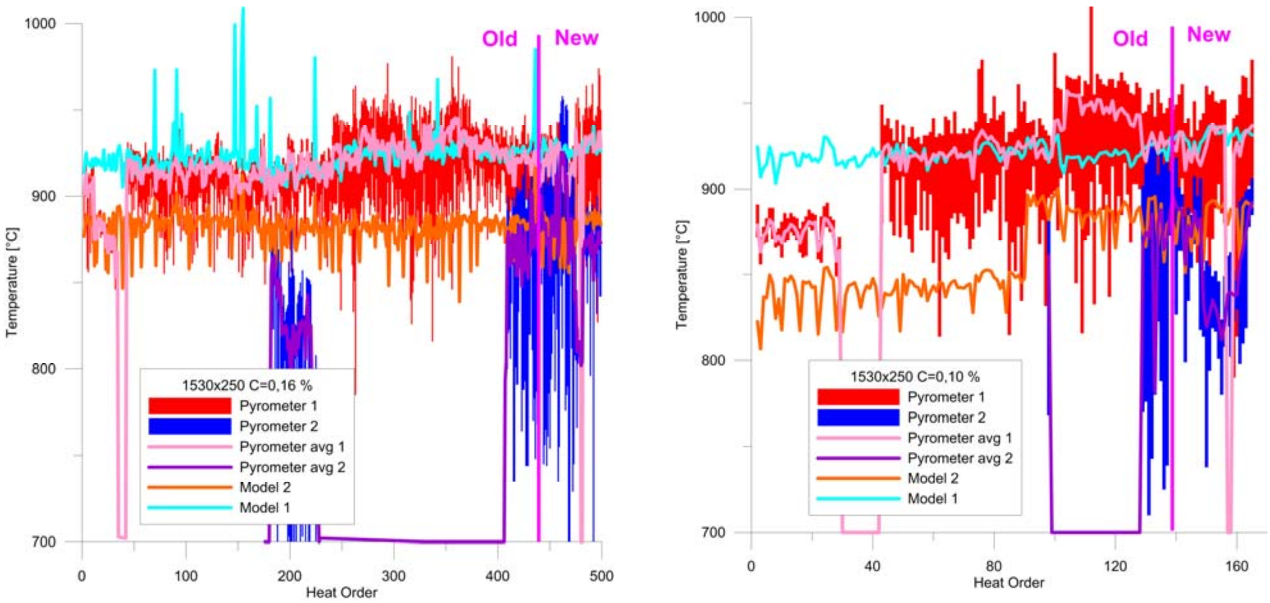

Fig. 3 The measured and calculated temperatures of a 1530×250 mm slab

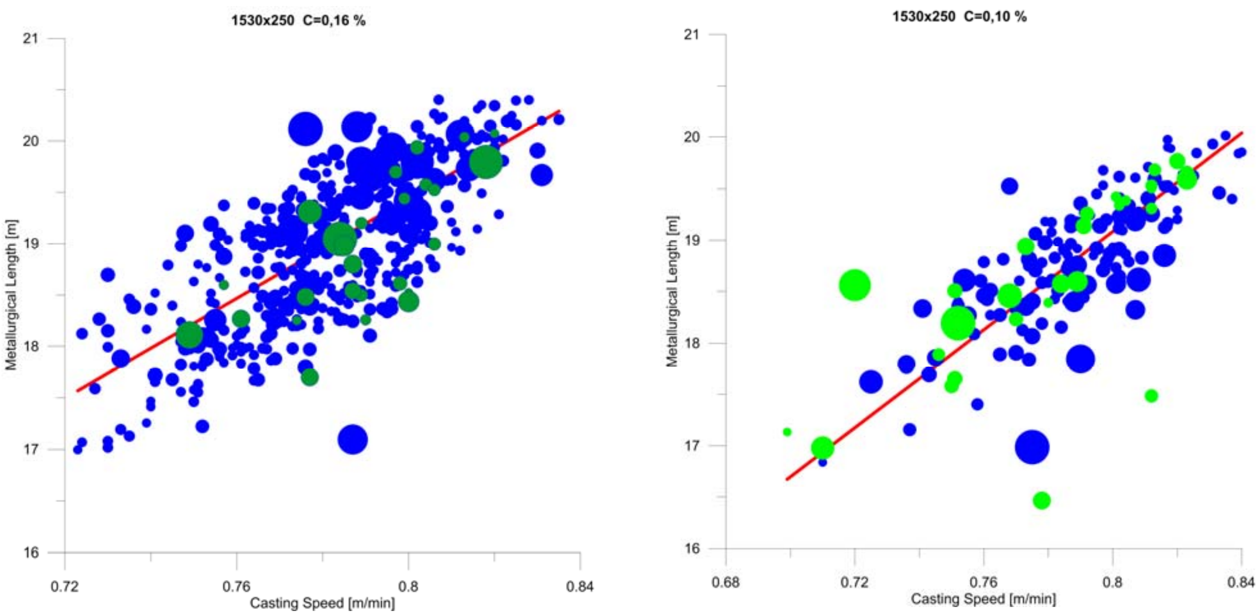

Fig. 4 Metallurgical length in dependence on casting speed

The graphs in **Fig. 4** show dependence between metallurgical length and casting speed. The solidification constant for steel C=0.16 % is K=24.3 mm^2/min and for steel C=0.10 % is K=23.9 mm^2/min. The graphs indicate a similar dependence for both steels. Blue bubbles are melting with the original nozzle and green bubbles represent a new cast of smaller nozzle in the circuit is 6, 8 and 10 The size of bubbles is the standard deviation calculated metallurgical length. Replace the nozzles did not bring any change in the average constant solidification.

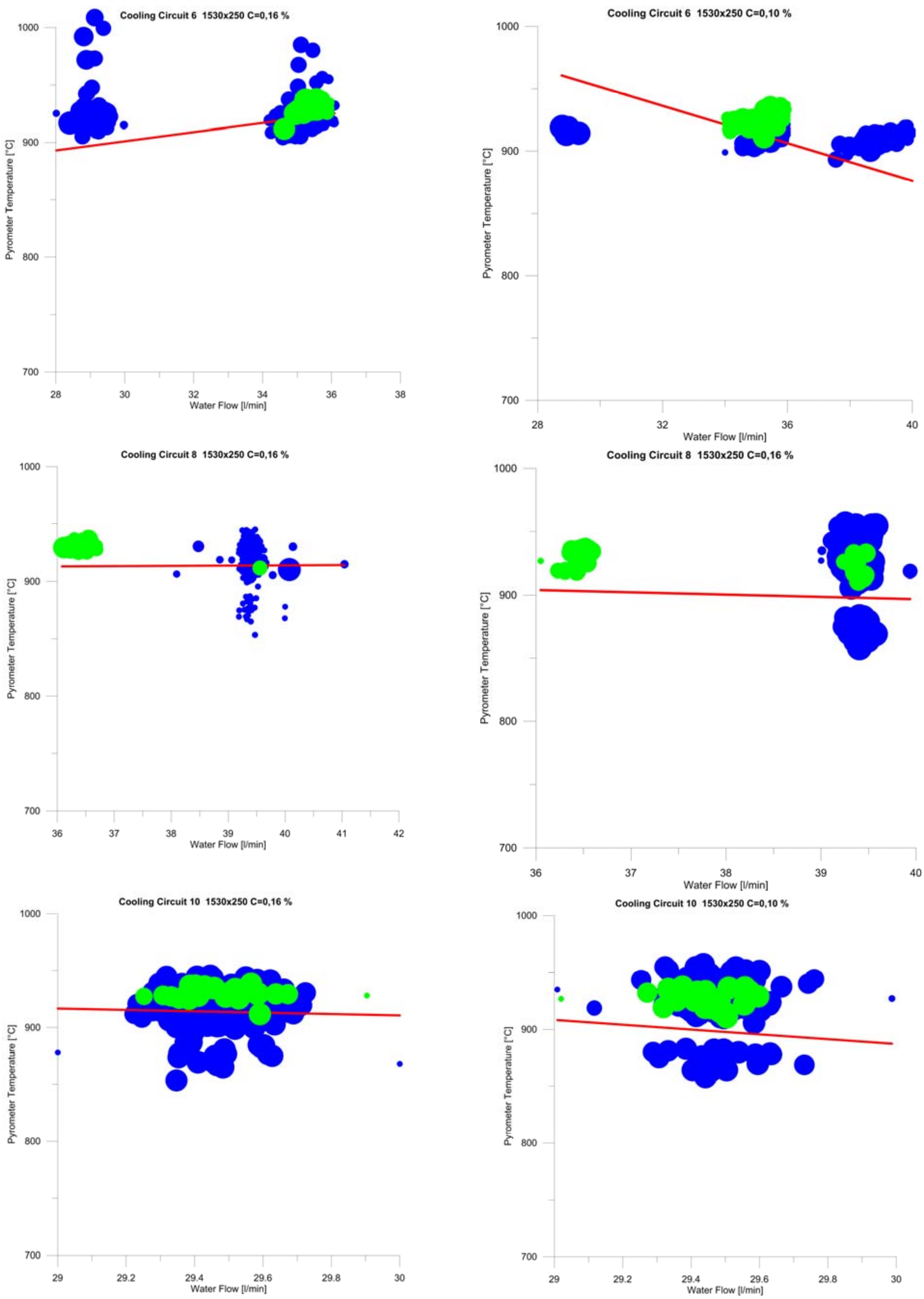

Fig. 5 Measured surface temperature at unbendig point in dependence on water flow in the cooling circuit

Set of graphs in **Fig. 5** shows the effect of water flow in the circuit 6, 8 and 10 for two grads of steel on the surface temperature measured by the pyrometer (**Fig. 2** shows the positioning pyrometer) in place of unbending point. Blue bubbles represent individual heats for the original nozzle and green bubbles represent heat cast it with new smaller nozzles. Size of the bubbles represents the standard deviation of the water flow in the relevant cooling circuit. From the figure it is clear that the replace of nozzles without modifying the flow of water (cooling nozzles) does not change the fundamental change in surface temperature at unbending point [7].

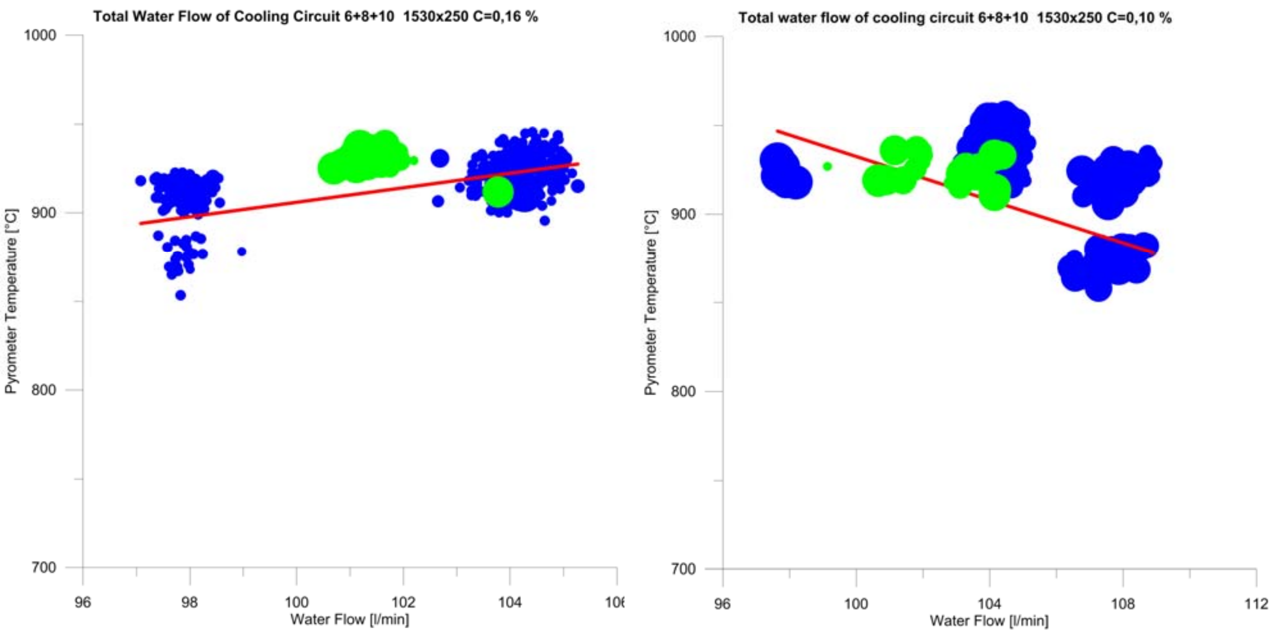

Fig. 6 Measured surface temperature at straightening in dependence on the total water flow in cooling circuits 6, 8 and 10

The graphs in **Fig. 6** summarize the dependence of **Fig. 5**. The graph is plotted the surface temperature dependence of the total water flow, were three cooling circuits 6, 8 and 10 on the top surface of concasting.

3. CONCLUSION

This paper introduces basic way of utilizing the results of the dynamic solidification model of the temperature field in a real caster operation. The operator or user of the computer network of the steelworks can monitor the current temperature field, including the information on the current metallurgical length and surface temperatures.

This article summarizes the first results obtained from the casting process after replacing the nozzle critical cooling circuits that affect surface quality of slab. These data are compared with results from the previous period. Obtained data confirm that the new smaller nozzles can achieve the same cooling effect as the original. Since, but the goal was to achieve a higher surface temperatures at unbending point, we can say that this can be achieved only by adjusting the overall cooling curves in the circuit 6, 8 and 10. This will be used in the optimization procedures [8, 9] and operational data that are presented here. The main reason for the exchange of the nozzles is just extending the control range in the lower water flows.

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