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POSSIBILITIES REGARDING USING OF MICRO-COOLERS IN STEEL CONTINUOUS CASTING TUNDISH

Erika Ardelean,
University Politehnica Timisoara,
Revolutiei, no.5, 331128, Hunedoara,
Romania

Marius Ardelean,
University Politehnica Timisoara,
Revolutiei, no.5, 331128, Hunedoara,
Romania

Cristian Abrudean,
University Politehnica Timisoara,
Revolutiei, no.5, 331128, Hunedoara,
Romania

ABSTRACT
A frequent case in industrial practice at continuous casting is liquid steel overgrown temperature, that requirement change of cooling program in order to obtain adequate qualitative semi-finished products.
The paper presents a few simulation experiments of using micro-coolers in continuous steel casting tundish, micro-coolers used only for steel temperature decrease. Based on experimental data, they obtained dependence between meal micro-cooler and steel casting temperature, correlations which they allow the optimal areas establishment variation for temperature of casting, the quantity of micro-cooler dealt respective affected volume percent of cooling to the administration micro-coolers.
Keywords: steel temperature, tundish, micro-coolers.

1. INTRODUCTION

Customary, the temperature setting with a high degree of precision is made in two ways: the cooling of the added steel and the heating by induction or by voltaic arc. These have the disadvantage that, because of the heat losses along the ulterior operations, none of the procedures can assure a constant temperature of the casting.
During the continuous casting, the temperature of the steel in the tundish oscillates because of the continual modification of the steel temperature in the casting pot as well as due to the changeable thermic conditions in the tundish. At the beginning of the casting, the steel temperature decreases (it takes place the heating of the tundish wall), the temperature becomes stabilized, but at the end of the casting sequence, the steel temperature in the tundish decreases again. As a consequence, to assure a constant casting temperature, the temperature of the steel in the tundish must be set through its heating or its cooling [1].
In order to diminishing the overheating of the metal we introducing the steel powder in the tundish of the continuous casting machine. To prevent the solidification of the steel in the critical points of the tundish it is essential to have a higher degree of the steel overheating at the beginning of the casting. On the other hand, a strong overheating of the steel negatively influences the forming of the internal structure of the semi-finished product, as well as of the internal imperfections: the lower the degree of overheating is, the more homogenous the structure of the semi-finished cast product is and as a consequence the probability of the appearance of the segregation decreases. Theoretically, it was established that a quantity of 1% metallic powder determines a decrease of about 18^0C in the steel temperature.
The used micro-coolers for controlling the temperature process shall fulfil the following conditions:

- to have a high purity regarding the oxide inclusion content;
- the micro-cooler humidity maximum 0.25%;
- the surface shall not be oxidized;
- it shall have a certain grading composition. [2]

2. EXPERIMENTS AND RESULTS

For obtaining of materials in order to make the industrial experiments we have made our option to use the micro-coolers as grains made out of rolled wire, having a chemical composition close to that of the continuous cast steel. The wire with 3 mm diameter was cut off at lengths of 2-3 mm. After cutting off, the grains were weighed and packed for transport to the industrial unit where the experiments take place.

In the first faze, we made a computer simulation of process in tundish in micro-coolers adding case.

The mathematic model was made based on finite differential method, resulting a three-dimensional discretisation network. It was obtain a heterogenous network, much dense in case of casting wire, in order to obtain a reasonable calculus time but without to interfered on accuracy of the calculus. The mathematic model is used in simulation of two distinct but interdependent phenomena: mass transfer (flow) and heat transfer.

The computing program was realized in C++, in Visual Studio 6 medium, a MFC (Microsoft Foundation Classes), a class's library that include the functionality of Windows standard programming interface (API – Application Program Interface) and OpenGL API for 3D graphs. Because these types of calculus are intensive, we use a multithreading run.

Based on experimental conditions the simulation it was made in terms of work installation (dimensions, technological parameters, temperature, speed casting and materials characteristics).

The mathematical model is obtained based on the fallowing simplifying assumptions:

- the steel flowing in the tundish is considered laminar;
- the steel has constant mass density and incompressible (from Navier-Stokes equations result that speed is an laplace vectorial field);
- the admission speed, respectively the outgo speed of steel in tundish, in normal operating conditions, was uniform and constant;
- the heat losses by tundish cover and brickwork was experimental established;
- it is consider that at zero moment the temperature of steel mass is uniform;
- the evolving of fusion latent heat it is produced in liquidus-solidus interval, direct proportional with the temperature;
- the micro-coolers behavior, mechanically, is like an metallic molten. [1]

Even in minimal accuracy precisions, the number of nodes of discretisation network was 500.000, that conduct to a long time of run.

TURNCON_2 program allow obtaining some graphical dependences like the next charts. Also, in figure no.1 is presented variation of steel speed field in tundish (simulated area) and in figure no.2 in presented a variation of steel temperature gradient at micro-coolers adding in tundish.

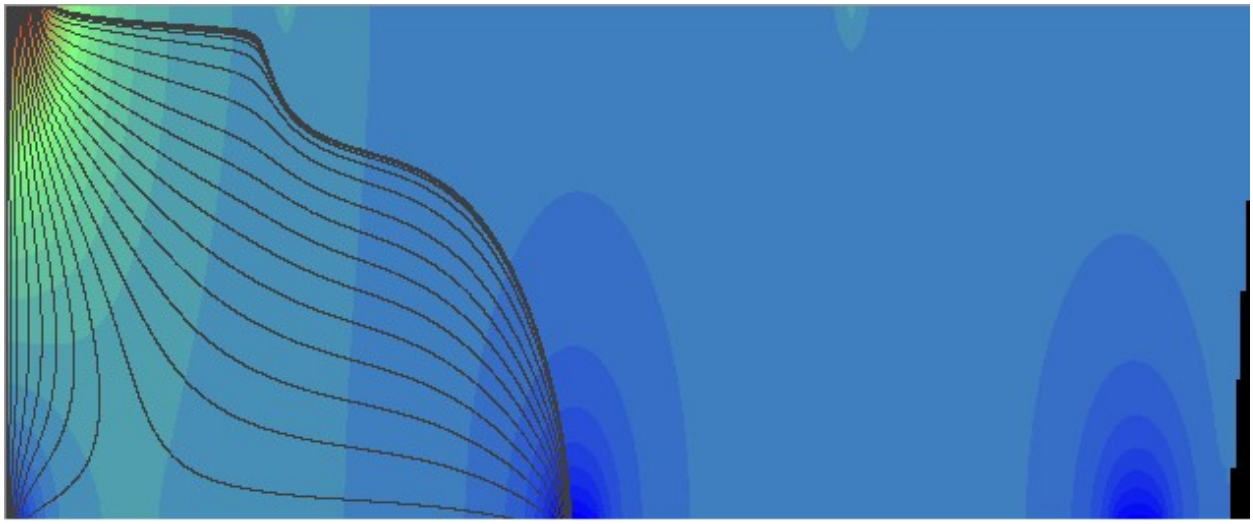

Figure 1. Variation of steel speed field in tundish (longitudinal section)

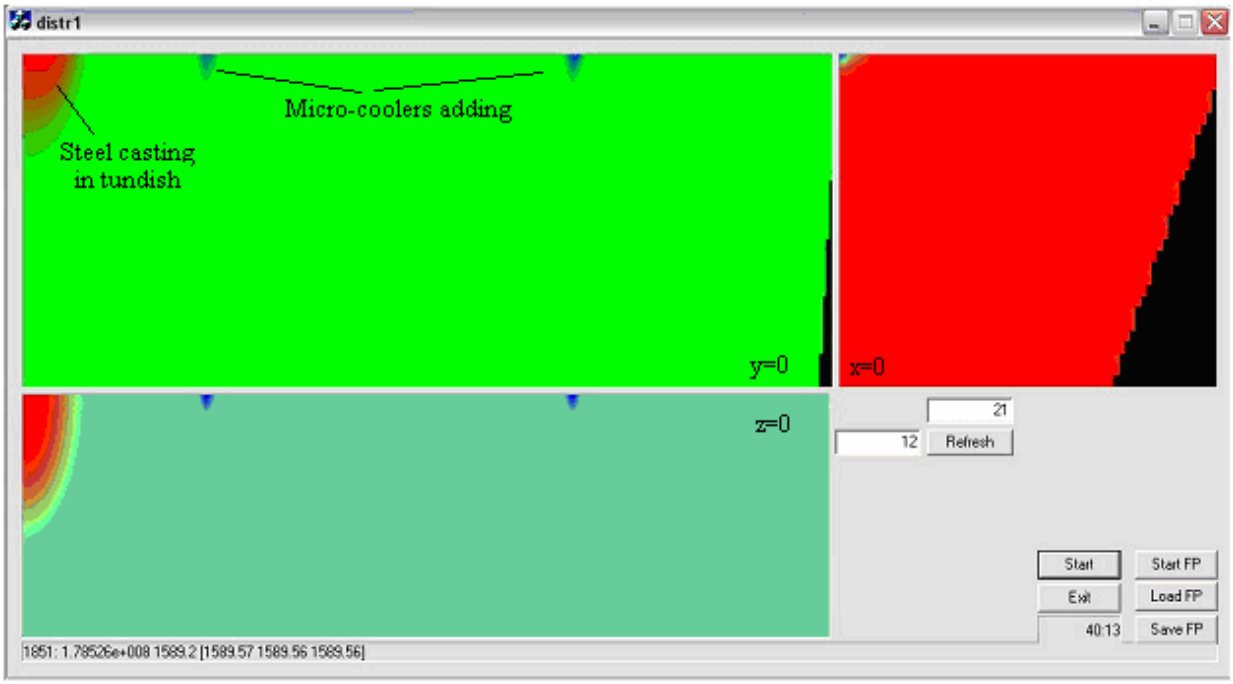

Figure 2. Variation of steel temperature gradient in tundish at micro-coolers adding

3. CONCLUSION

Simulations result conduct to conclusion that a addition of 1% micro-coolers in tundish decrease temperature of steel with 21°C, dates verifying with theoretical relation like:

$$m = \frac{1000 \cdot (T_t - T)}{T + 705}$$

were: T_t steel casting temperature, in °C;
T – steel temperature after micro-coolers melting, in °C;
m – specific consumption of micro-coolers, in kg/t. [3]

Because of the simplifying assumptions, the simulations conduct to approximate results of steel temperature variations. The next part of studies is practical verification of simulations results in real work conditions.

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4. REFERENCES

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