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EXPERIMENTS REGARDING THE STEEL TEMPERATURE ADJUSTMENT IN THE MOULD OF THE CONTINUOUS CASTING MACHINE

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ABSTRACT
The paper analyses the results got from simulating the micro-coolants addition in the mould of the continuous casting machine in comparison with those got at the industrial experiments. Temperature measurements were made during the experiments both for the steel and the continuous cast blank.
The purpose is to provide a datum basis and conclusions for the use of micro-coolants at the steel continuous casting and their effects upon the temperature variation in the mould.
Keywords: steel, continuous casting, micro-coolants, temperature.

1. INTRODUCTION
By analysing the specialty literature on the micro-coolant addition as iron chips at the continuous casting there was established that 1% of metallic powder quantity determines a decrease of the steel temperature with about 18^{o}C [1].
The metallic particles having the role of micro-coolants have to accomplish a series of conditions: they shall have a high purity concerning the oxide inclusion content (the oxygen quantity under 0.5%), they shall not have oxidized surface, they shall have a certain granulometry composition, the humidity shall not be greater than 0.25%, spherical shape or close, density greater in bulk and relatively low cost in comparison with that of the steel.
The grains are in suspension for a period of time in the steel melt and they can provoke several effects at the steel cooling and solidification: effects of quenching, crystallization, alloying, obtaining some special physical proprieties, etc.
From the cooling point of view the micro-coolants can determine four types of steel solidification [2]:
I – in this case the grains of micro-coolants melt before the beginning of the steel solidification, the micro-groups of the element atoms from the micro-coolants also disappear (by diffusion);
II – when the micro-coolants melt, but the atom micro-groups remain till the beginning of the steel crystallization, situation when they play the role of exogenous germs too;
III – represents the case when the micro-coolants melt till the end of the steel solidification, these also accumulate the latent crystallization heat, determines the steel crystallization and solidification in volume, respectively the change of heat flow direction, because the exterior flow does not coincide in terms of direction with the interior flow at the level of each micro-volume;
IV – the micro-coolants do not melt at all or they melt only partially till the end of the steel solidification and there appear the splitting surfaces between them and the steel mass. In this way there are obtained the composite pieces and the micro-coolants appear like components in the wall of the steel piece.
The maximum effect is got in the type III of solidification, when the micro-coolants melt completely, while they accumulate the overheating of the steel.

The temperature regulate can be made through the casting parameters correlation (speed and time casting) with technological parameters (debit, pressure, temperature cooling agent). A regulate quality made of a temperature with effect on quality is represented by micro-coolers in crystallize.

2. EXPERIMENTAL RESEARCHES

In order to make the industrial experiments, namely the feeding of micro-coolants as grains in the mould of the continuous casting machine, a conveying unit was designed and carried out.

Taking into account that a 1% addition of micro-coolants in the mould at the continuous casting leads to the temperature decrease with 20-25^{0}C, respectively an addition of 2% micro-coolants to a temperature decrease of 40-50^{0}C, fact correlated with the simulations made with our own calculation program TURNCON (fig.1 and 2) [3].

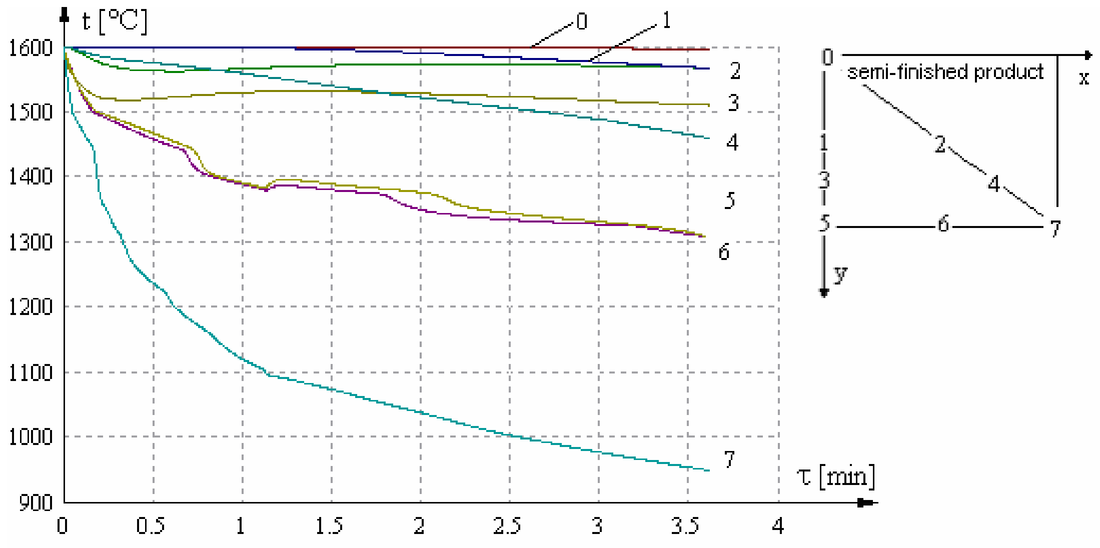

Figure 1. Temperature variation function of time in the wire

We made the option for an addition of 1% and 2% micro-coolants with 3mm sizes for the industrial experiments having in view the continuous cast blank sizes (270x240mm bloom). Fig.3 presents the micro-coolant addition mode in the mould of the continuous casting machine. The micro-coolant addition id adjusted function of the work recipe by the burdening system of the micro-coolant addition unit, this thing being done continuously during the steel casting, the micro-coolants having a haphazard distribution (fig.4). We made the option for an addition of 1% and 2% micro-coolants with 3mm sizes for the industrial experiments having in view the continuous cast blank sizes (270x240mm bloom). The blank surface temperature was measured with an optical radiation pyrometer in 11 points on the thread length. In the zone 0 (immediately at coming out from the mould), the temperature measurement could not be made because of the way of placing the cooling nozzles and rolls. In fig. 5 the way of placing the points where the measurements were made, calculated since the thread coming out from the mould.

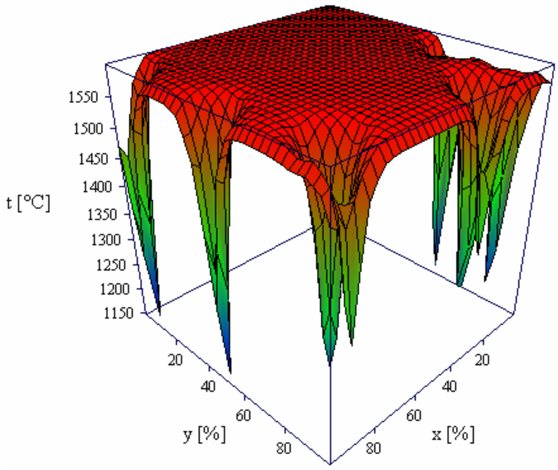

Figure 2. Temperature distribution in the continuous cast blank at 3s after the micro-coolers adding.

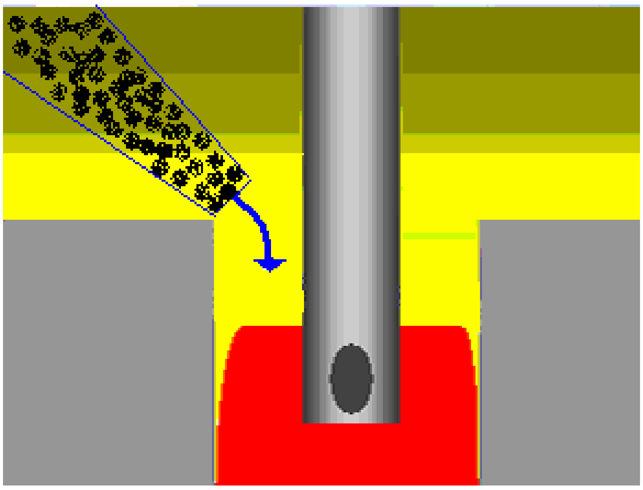

Figure 3. Mode of adding the micro-coolants in the mould of the continuous casting machine.

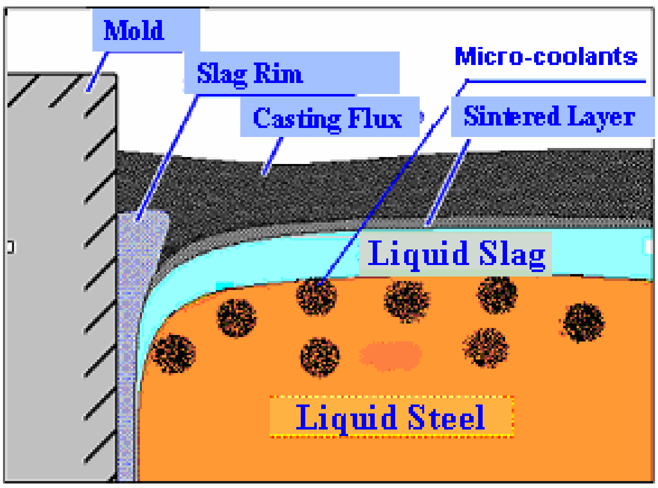

Figure 4. Micro-coolant distribution in the hot steel

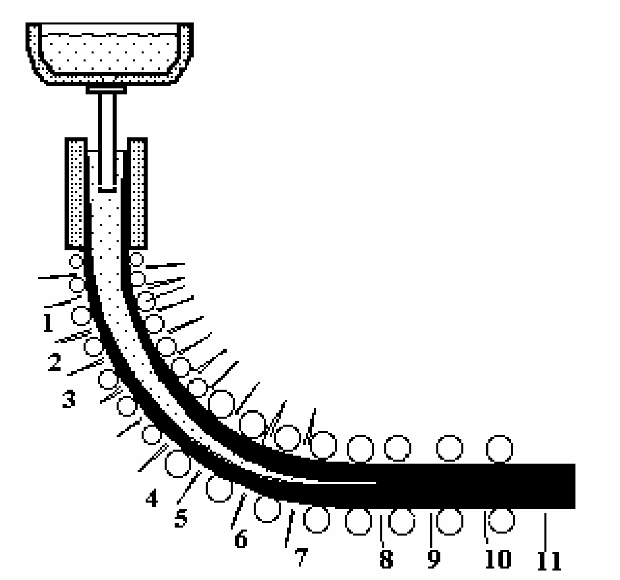

Figure 5. Placing the points where the measurements where made

3.CONCLUSIONS

Analyzing the graphical dependences from the performed researches, based on literature review data and from own experimental work it results the fallowing conclusions:

- Addition of micro-coolers induction of fact local fall at steel temperature;
- Additions of micro-coolers determine the conduct of solidification as a result of local fall steel temperature;
- 1% addition of micro-coolants in the mould at the continuous casting leads to the temperature decrease with 22^0C;
- 2% addition of micro-coolants in the mould at the continuous casting leads to the temperature decrease with 45^0C.

The researches accomplishment leads to clear up the aspects regarding the reduction of the steel overheating, respectively a temperature adjustment in the mould taking into account that the overheating degree has an important influence on the quality of the continuously cast blanks. Thus, reducing the overheating temperature up to 15^oC contributes to the considerable reduction of the internal flaw number, the narrowing of the dendrite crystal zone, the decrease of the axial segregation degree and of the internal porosity.

4. ACKNOWLEDGEMENTS

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5. REFERENCES

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