11th International Research/Expert Conference
”Trends in the Development of Machinery and Associated Technology”
TMT 2007, Hammamet, Tunisia, 05-09 September, 2007.

IMPROVING THE CONTINUOUS CAST BLANK STRUCTURE BY USING MICRO-COOLANTS

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ABSTRACT

Paper intended to clarify some problems regarding the accomplishment of an improved crystalline of the continuously cast blanks using the micro-coolant addition during the continuous casting of the steel.
The industrial experiments were made within a metallurgical plant having a continuous casting machine for blooms with a 240x270mm section. Micro-coolants as grains were added in the mould of the continuous casting machine, on a single thread.
The conclusions got from analyzing the casting structure of the experimental blanks (with addition of micro-coolants in the mould) in comparison with the common casting structure (witness blank) are presented.
Keywords: crystallize, steel, continuous casting, micro-coolants, structure.

1. INTRODUCTION

One of the main load of current continue casting is to improve the quality of continue casting steel. For this we have to grant a distinct attention to subtraction measurements of areas and dendrites segregation, by reduction of fissure made and by growth of main part density of semi-manufactured good continuous casting.
The macrostructure steel product obtained from continuous casting is characterized through a three structural areas made: a surface area of little dendrites crystals, a area of column dendrites and a central area of echiaxes crystals. In function of crystallization conditions the structural areas are different after the extension of areas and crystals size. We know that at steel ingot solidification the extent area of echiaxes crystals encourage the bettering of ingot structure quality, in special subtraction of axial and dendrites segregation, dispersion of axial porosity and diminish the nonmetallic inclusions dimensions.
The marginal crust make at a 140-200mm depth under the liquid steel level from crystallize, in direct concrete with cold walls from copper. Because of big tide of warm will be a fast grow of some echiaxis crystals very fine, uniform, making a solidify area with a thickness between 30-40mm and 60-70mm. After marginal crust make, with the temperature subtract, this is contract and take out from crystallizes wall making au interstice smaller than at classic casting when the temperature at out side surface of semi manufactured good is at almost 1200^0C, the semi manufactured good get out from crystallizes and follow to be fast cooler in secondary cooler, where temperature subtract until 900-1100^0C. The third area make of solidify start from crystallizes and continue in secondary cooler, this area thickness' is bigger than in classic casting. In the middle of semi manufactured good is making an area with echiaxis crystals, area which depends very much by overheating degree, by semi manufactured good section, by secondary coolers force, and by chemical compos ion of steel from contain or carbon.
To ensure the solidify conditions impose by chemical composition of steel must correlation a big number of technological factors, the main ore: the steel chemical composition, the casting temperature and pulling speed.

The blank structure is determined by the chemical composition of the steel, by the temperature gradient at the respective crystallization front, by the advancing speed of this front and by the presence of the supplementary crystallization centers in the molten steel volume. The steel solidification process is accompanied by complex phenomena not only by the crystal formation and growth, but also by their convective and gravitational movement, by the emerging of some complex phenomena of heat transfer and by the mass in the marginal stratum. By introducing micro-coolants it was expected to create a very great number of crystallization centers, having as a base the statement of the Russian academician Efimov, who uttered that one of the processes of size reduction of the structure in the axial zone is its intense mixing under the action of some external factors or by introducing of artificial crystallization germs.
The basic problem that has to be solved consists in obtaining quality continuous cast blanks that means homogenous from the chemical, structural points of view and of the physical proprieties.
In order to attenuate the deficiencies regarding the temperature adjustment in the mould it is necessary to adopt an efficient method of removing the heat from the steel during the solidification.
The steel crystallization process with exogenous germs introduced by those differs substantially from that of the continuously cast steels without micro-coolant additions.
As micro-coolants are usually used iron powder or different other alloy one, with the grain size between 50microns-3mm, respectively metallic powders from the same chemical composition with that of the steel being cast and they are introduced in quantities of 0.5-2% [1].

2. EXPERIMENTAL RESEARCHES

The industrial experiments consist in the following stages: making the device for adding the micro-coolants in the mould, preparing the micro-coolants in classes and exact quantities for the experiments, making the addition of micro-coolants in the mould during the continuous casting of the steel, preparing and sampling the specimens necessary to the analyses, the metallographical study, choosing the mathematical and statistical analysis method of the data obtained, conclusions.
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 (Fig. 1).

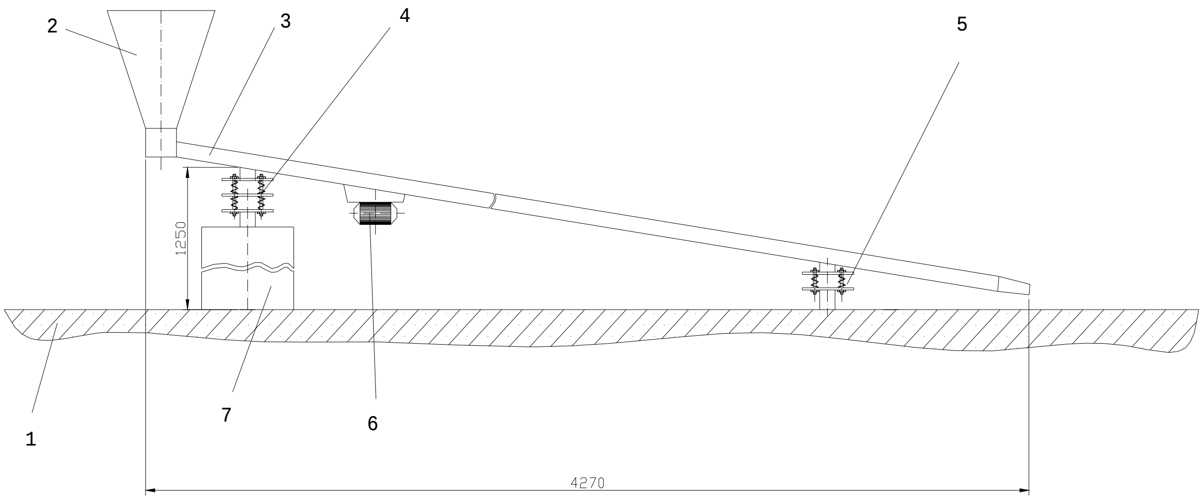

Figure 1. Unit components:
1 – foundation, 2 – hopper, 3 – metallic trough,
4,5 – spring support; 6 – vibrating device, 7 – support

The conveyer unit is made up of a trough made of sheet of 3mm, adjustably tilted. For advancing the material up to the zone of its entering into the mould of the continuous casting machine, the conveyor trough vibrates, the oscillation amplitude being of maximum 5-10mm.

Charging the mould with micro-coolants is made at the top end through a feed hopper, prismatic pyramidal, and the descharging is made at the opposite end through a discharging trough. Because this trough will be placed in the mould zone of the continuous casting machine where the temperature is about 1600^{o}C, it will be protected with refractory material. The movement transmission is made through a vibrator-motor.

For obtaining the materials in order to make the industrial experiments we have made our option to use the micro-coolants as grains made out of rolled wire, having a chemical composition close to that of the continuous cast steel.

The wire with 3mm diameter was cut off at lengths of 2-3mm [2]. After cutting off, the grains were weighed and packed for transport to the industrial unit where the experiments take place (fig.2).

Fig.3 presents the micro-coolant addition mode in the mould of the continuous casting machine.

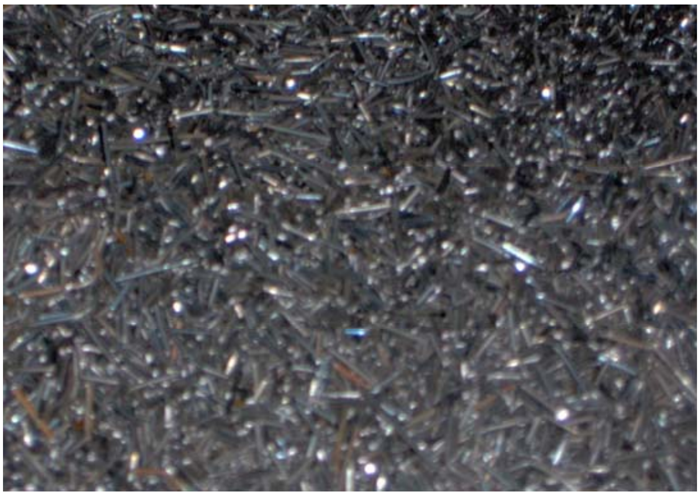

Figure 2. Micro-coolants

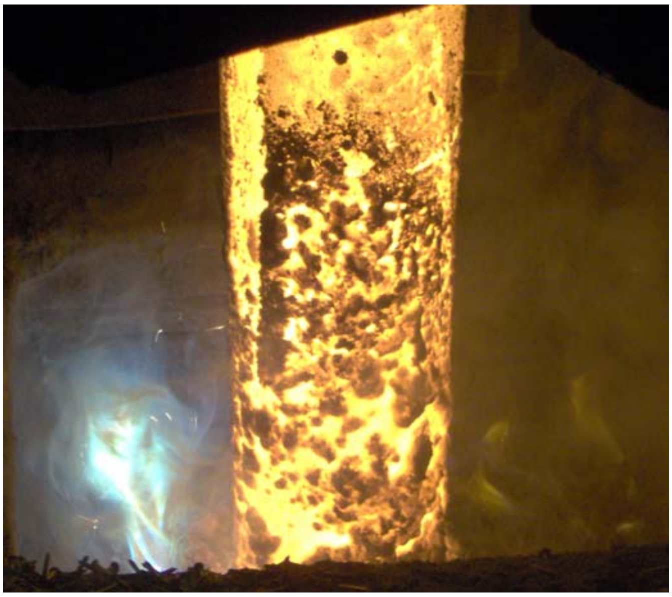

Figure 3. Mode of adding the micro-coolants in the mould of the continuous casting machine.

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 and we made the option for an addition of 2% micro-coolants with 3mm sizes for the industrial experiments having in view the continuous cast blank sizes (270x240mm bloom) [3]. The micro-coolant addition unit was mounted at a thread of the continuous casting machine.
The micro-coolant addition was made on a thread (line) of the continuous casting machine in an amount of 2%.
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. The experimental blanks, which were obtained, followed the technological processing flow of the heavy section rolling mill within the plant.

3.CONCLUSIONS

The researches and the experiments try to check the under-cooling effects of the central zone of the steel blank during the casting by using of the micro-coolants in the following hypotheses:

- By introducing the micro-coolants emerge new germination surfaces which produce an improvement of the macro and microscopic structure of the cast blank;
- There is a sensible relationship between the crystalline grain of the cast blank and the mechanical characteristics;
- The blanks obtained within the experiments present a growth and a significant homogeneity of the mechanical proprieties in comparison with the blanks obtained by the classical method, as a result of the structure modification.

The stimulation of the heterogenous germination produces:

- A significant growth of the mechanical characteristics concomitantly with the decrease of the diameter value of the real grain;
- The crystalline grain finishing during the solidification creates the premises for the mechanical characteristic improvement, especially those of plasticity;
- By improving the respective blank structure at a macro scale – a reduction of the dispersion of the mechanical characteristic values.

4. ACKNOWLEDGEMENTS

The authors gratefully acknowledge the support of the present research by the Grant CEEX nr. 3196/13.10.2005 of the Excellence Research Projects – Young Reserchers Romania.

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