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EXPERIMENTAL RESEARCHS REGARDING USING OF STEEL MICRO-COOLANTS AT CONTINUOUS CASTING

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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 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 and upon the continuous cast blank structure. The experiments aim to demonstrate the practice of improving the proprieties of the blanks continuously cast with micro-coolant additions, in comparison with those obtained without micro-coolant additions.

1. INTRODUCTION

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 [1], 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%. By analyzing 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 $18^{o}C$ [2].

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.

2. EXPERIMENTAL RESEARCHES

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. After cutting off, the grains were weighed and packed for transport to the industrial unit where the experiments take place (fig.1).

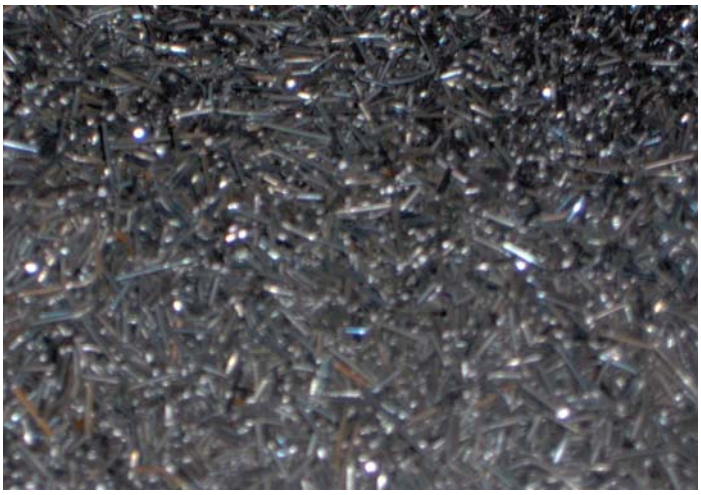

Fig.1. Micro-coolants

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 1% and 2% micro-coolants with 3mm sizes for the industrial experiments having in view the continuous cast blank sizes (270x240mm bloom).

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 1%, respectively 2%. Fig.2 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. 3). The blank surface temperature was measured with an optical radiation pyrometer (allowing a measurement error of $\pm$0.5% of the measured value) 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. The first measurements were made beginning with the zone 1 (the fog chamber) and it was continued on the length of the thread [4]. In fig. 4 the way of placing the points where the measurements were made, calculated since the thread coming out from the mould.

The experimental blanks which were obtained followed the technological processing flow of the heavy section rolling mill within the plant.

Fig.2. Mode of adding the micro-coolants in the mould of the continuous casting machine.

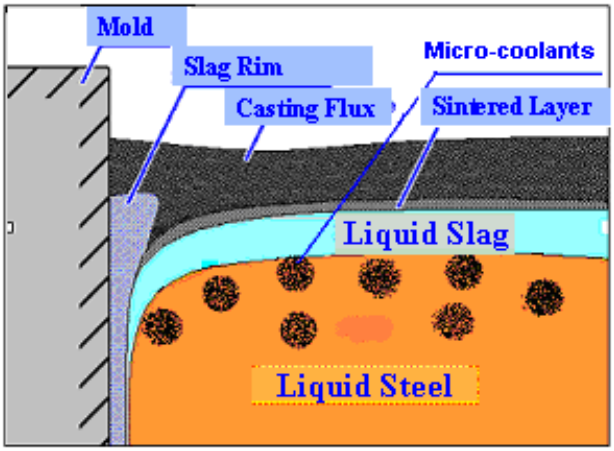

Fig.3. Micro-coolant distribution in the hot steel

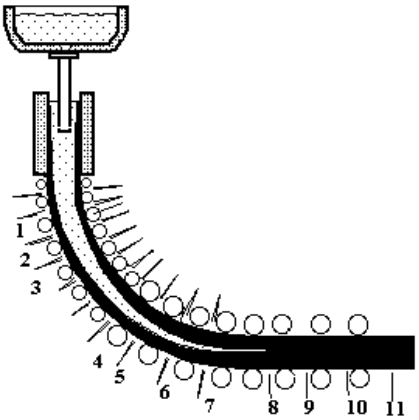

Fig.4. Placing the points where the measurements where made

3. CONCLUSION

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.

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