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THE TECHNOLOGICAL PARAMETERS OPTIMIZING TO CONTINUES CAST OF SEMI FINISHED Φ150mm, IN ORDER TO REDUCTION FAULTS APPEARANCE

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ABSTRACT

For the procurance to some qualitatively better continuous cast semi-finished products, it is necessary to correlate the technological parameters: temperature, time and the casting speed with the constructive characteristics of the continuous cast machine and with the tip dimensions of the semi-finished products, which are casted.
The optimizing of those parameters can tend the procurance to some superior qualitative semi finished product. From this motive, is needed their observation and the working behavior adjustment of machine for each section in part.
The experiments were done on an installation of continuous casting machines with five wire, on semi finished product with Φ 150mm section, this paper presenting a principal results and also their effects in industrial practice. We mentions as it obtained a reduction with 18-75% of reject due casting faults.
Keywords: continuous casting, technological parameters, semi-finished products.

1. GENERAL CONSIDERATION

When starting the continuous casting, the steel is cast until the mould is filled up. After that, without stopping the steel casting, the dummy bar, that was previously mounted on the bottom of the mould, together with the semi-finished product that is already developed, comes out from the mould and continues its line in the continuous casting installation up to the secondary cooling area. Before the semi-finished product leaves the mould, a high heat exchange between the outer surface of the semi-finished product and the inner walls of the mould takes place. These walls are strongly water-cooled. The cooling that takes place inside the mould as a result of the heat exchange has to ensure the building up of a steel scum, thick enough to resist to the longitudinal tensile stresses (when the semi-finished product moves relating to the mould walls).
The necessary thickness of the solidified scum when the semi-finished product comes out from the mould highly depends on the product section. For the small billets, a thin scum is sufficient, while the big sections require a thicker and more resistant crust, due to the higher ferrostatic pressure that acts on the semi-finished product when this comes out from the mould. For this reason, the cast speed decreases together with the increasing of the cross section of the semi-finished product [1,2].
When cooling the semi-finished product in the mould, the secondary cooling takes place. During this, the solidification has to be performed on the entire cross section of the strand. In order to achieve this, beside a proper primary cooling, the factors that influence the secondary cooling have to be also

correlated: the water flow on the three areas of the installation, the water pressure in the secondary line, etc.
All these have in view a proper solidification length; an intense cooling can generate cracks due to the thermal stresses, while a too slow cooling can generate a partial solidification of the strand up to the cutting machine area.

2. EXPERIMENTS AND RESULTS

In order to study the correlation of technological parameters with the constructive characteristics of the continuous cast machine, we have tested a number of 52 heats, OLT 45k grade, elaborate into an electric arc furnaces (EBT) by 100 t capacity and continuous casting as Ø 150mm billets.
A very important factor in what concerns the continuous casting and the quality of the obtained semi-finished products is the casting temperature of the steel. The ideal solution would be that the steel to arrive in the crystallizing apparatus at a constant temperature in time, a little bit higher that the solidification temperature of the respective steel. This thing can't be completely done because the thermal losses during the casting reach important values, which imposes an overheating of the steel at melting, ensuring a sufficient temperature of the period of continuous casting. For the studied cases we distinguish an increase of temperature gradient with about 40°C over the recommended temperatures - figure 1. An explanation of this fact should be a noncorrelation suitable of all processes to continuous casting machine, fact that tended necessity to increase steel temperature still from the secondary treatment unit. The issues of this increases temperature influence the other technological parameters: cast speed, primary and secondary cooling conditions (generally for increase values of these parameters) [3].

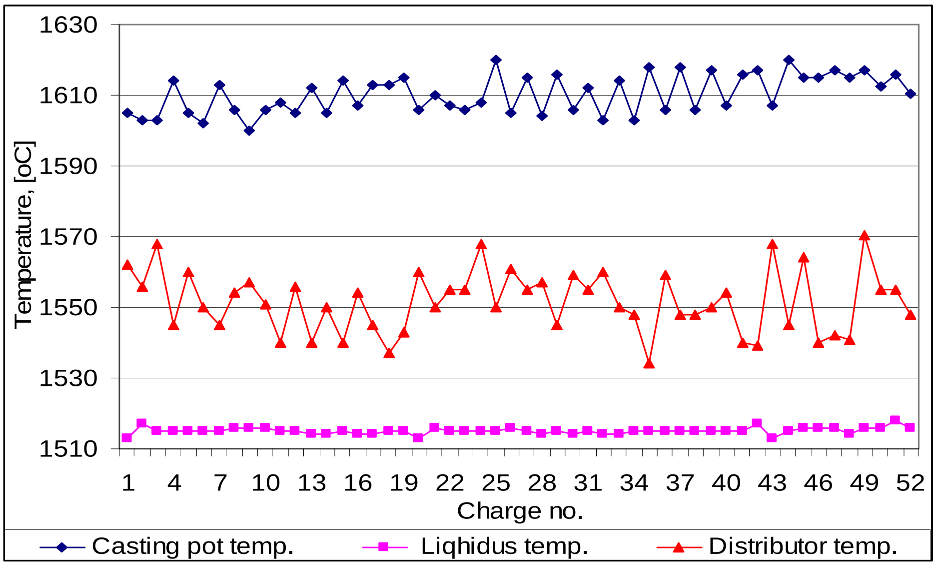


Figure 1. Steel temperature variation.

Speed casting is the governing factor for the installation dimensioning of continuous cast because it influences the sensible productivity, the needed number of wares and the minimum section of semi-finished products.
To billet with Ø150mm section, speed cast has varied between 1,5-2,7m/min in ordinary working behaviors conditions, considering as original casting speed is much smaller (of 1,2m/min). In this case, casting speed average speed is described of this time under un polynomial function of III degree – figure 2, resulting an global correlation coefficient of 0,89.
The casting time of one charge results from the ladle capacity and speed cast. The maximum cast time depends of the admitted temperature decrease, because, metallurgical considerations impose framing casting temperature between precise limits, for obtaining a suitable qualities of products and of a sure operation of installation.
With reference to primary cooling for the study profile, between the casting speed and the flow and pressure of the cooling water, we obtained the dependence presented in figure 3. The surface admits a minimum point outside the technological domain and has the fallow equation:

$$c_{speed} = 2{,}23 \cdot 10^3 - 4{,}9 \cdot f_{water} + 23{,}7 \cdot p_{water} - 0{,}5 \cdot p_{water}^2 \quad (1)$$

The global correlation coefficient for this regression surface is: $r_{yx1x2} = 0{,}8430$.

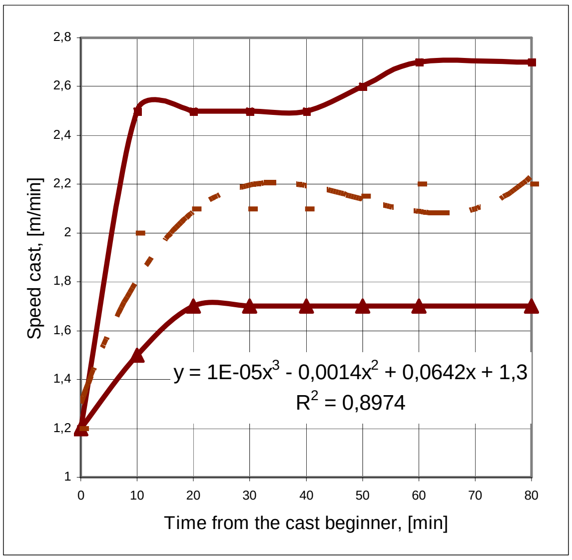


Figure 2. Speed casting variation in time.

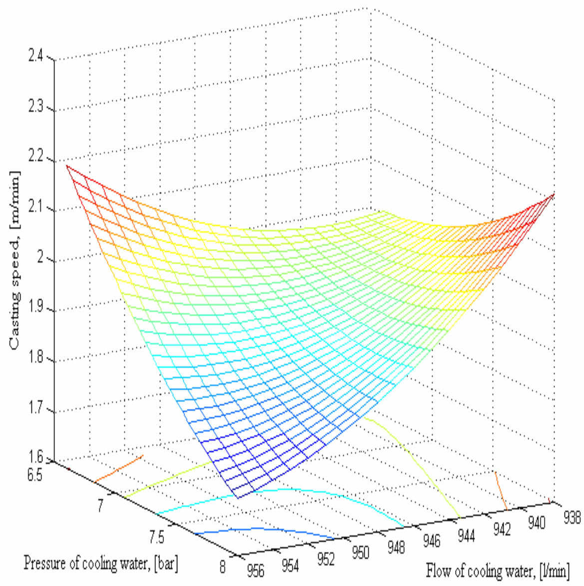
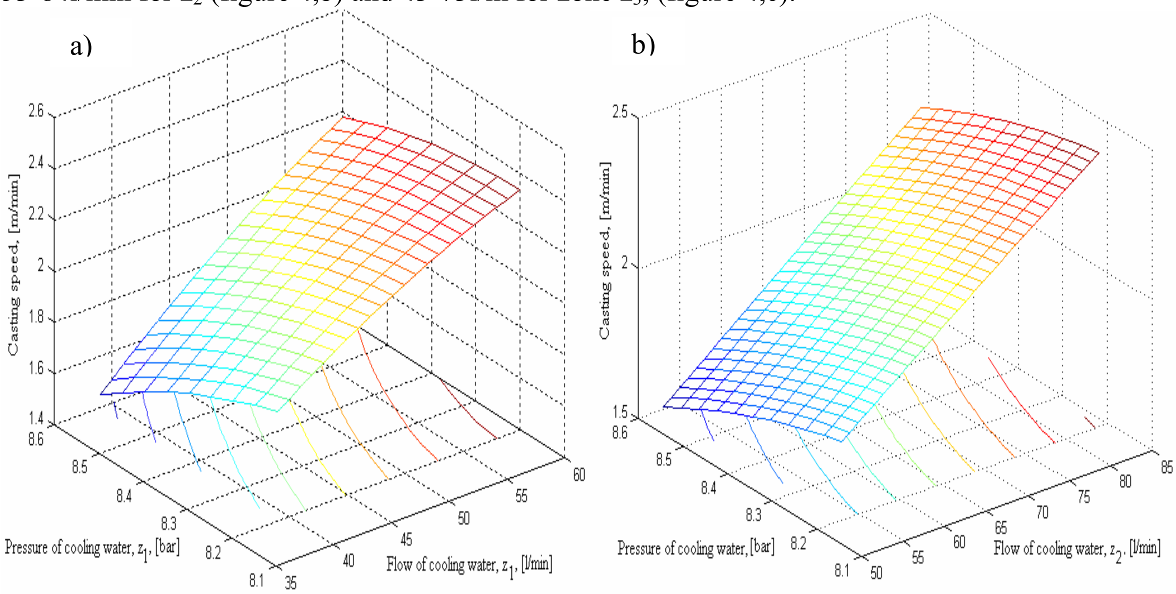


Figure 3. The variation of the casting speed depending on the pressure and the flow of the cooling water in crystallizing vessel

The aim of secondary cooling is to keep on removing heat in order to allow the semi-finished part to solidify up to the core. Secondary cooling is achieved by water spraying, under either cone or flat shaped jet. Instead of water, a mixture of air and water can be used, which leads to a more even and fine cooling, as well as to a lower water consumption (which actually varies with the quality of the steel).

The data have been processed under Matlab calculation program in order to obtain both regression surfaces and the corresponding correlation equations and coefficients and the dependencies obtained are related to casting rate and pressure, respectively water flow rate for the three zones of the installation, 10 min from the beginning of the casting process. For the billet with cross section Φ150mm, are results a directly proportional dependency between the parameters is kept, the work magnitudes of parameters being: pressure 8,2-8,8bar, and the flow rates 39-60l/min for z_1 (figure 4,a), 53-84l/min for z_2 (figure 4,b) and 43-73l/m for zone z_3, (figure 4,c).



c)

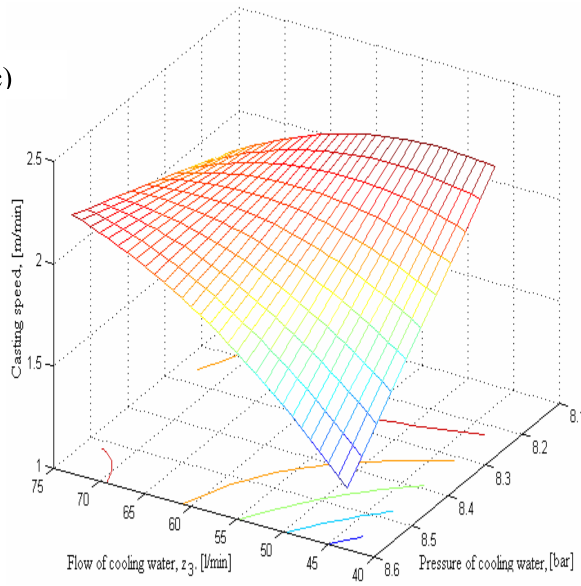


Figure 4. The interdependence between the average casting speed and the parameters of the secondary cooling water on all three areas

For the three surfaces the global correlation coefficients together with the equation of the regression surface are:

a) $c_{speed} = 111{,}34 - 1{,}31 \cdot f_{z1} - 17{,}29 \cdot p_{cw} + 0{,}21 \cdot f_{z1} \cdot p_{cw} - 4 \cdot 10^{-3} \cdot f_{z1}^{2} + 0{,}35 \cdot p_{cw}^{2}$; $r_{yx1x2} = 0{,}8224$ (2)

b) $c_{speed} = 82{,}09 - 0{,}12 \cdot f_{z2} - 17{,}35 \cdot p_{cw} + 0{,}049 \cdot f_{z2} \cdot p_{cw} - 2{,}1 \cdot 10^{-3} \cdot f_{z2}^{2} + 0{,}788 \cdot p_{cw}^{2}$; $r_{yx1x2} = 0{,}8127$ (3)

c) $c_{speed} = 194{,}17 - 1{,}27 \cdot f_{z3} - 35{,}28 \cdot p_{cw} + 0{,}18 \cdot f_{z3} \cdot p_{cw} - 2{,}6 \cdot 10^{-3} \cdot f_{z3}^{2} + 1{,}36 \cdot p_{cw}^{2}$; $r_{yx1x2} = 0{,}8786$ (4)

The dependence for the analyzed parameters is directly proportional: if the casting speed increases, the flow increases and the cooling water pressure also increases, but slowly [1].

3. CONCLUSIONS

From the researches made based on the data from the specialty literature and those of our own experiments their result the following conclusions:

- the steel temperature in distributor has to be within the technological limits required for the continuously steel grade, in order to perform a proper cooling;
- in order to obtain a thick enough scum when coming out from the mould, the cooling water parameters (temperature, flow, pressure) are to be correlated with the technological parameters, such as casting speed;
- the secondary cooling programme has to be chosen depending on the section of the profile that is to be cast, on the continuously cast steel grade and last, but not least, it has to be correlated with the technological parameters of the casting process. This fact requires in certain cases the correction and the using of another cooling programme, exactly during the casting process, fact that is performed by the process computer;
- the global correlation coefficients have relatively high values, that means a lower dispersion grade and thus the surface equations are possible to be applied with small errors in the industrial practice.

4. ACKNOWLEDGEMENTS

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