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THE INFLUENCE OF THE TECHNOLOGICAL PARAMETERS ON THE PRIMARY COOLING AT THE CONTINUOUS CASTING

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Abstract

The primary cooling – inside the mould – has a high importance in what concerns the thickness of the solidified steel scum. If the scum is too thin when coming out of the mould, under the action of the ferro-static pressure generated by the liquid steel from inside and due to the own weight of the strand, the scum can force through, thus resulting the strand breaking.

The paper presents a series of correlation between the different technological parameters (the steel temperature inside the tundish, the casting speed, etc.) and the cooling conditions inside the mould for the section 240x270 mm and for the 150 mm round.

Keywords

Continuous casting, primary cooling, steel temperature, parameters

1. INTRODUCTION

When starting the continuous casting, the steel is cast until the mould is filled up (Figure 1). 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. From here, the line continues further, through the drawing and straightening rolls, towards the cutting equipment and cooling bed.

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). After the semi-finished product comes out from the mould, the scum has to resist also to the transversal tensile stresses (generated by the pressure inside the steel).

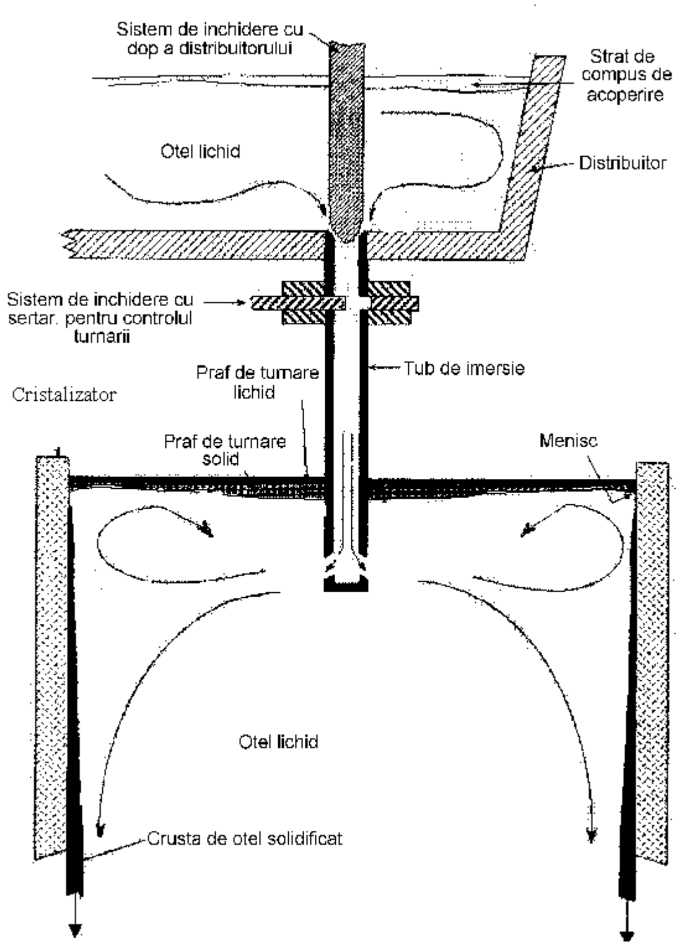

Fig.1 Continuous casting of the steel true the mould

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 scum, due to the higher ferro-static 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.

2. EXPERIMENTS AND RESULTS

In order to study the solidification of the steel when continuously casting, we have tested a number of 55 heats, OL 37-2k grade, cast as 240x270 mm bloom and 55 heats, OLT 35 grade, cast as Ø 150 mm billets.

We have analyzed a series of parameters that influence the primary solidification, as follows: the steel temperature inside the tundish, the casting speed and also the parameters of the cooling water inside the mould (temperature, pressure, flow), all measured at certain time periods. The data were processed in the Matlab programme and the results are shown both graphically and analytically.

Figure 2 presents the casting speed depending on the steell temperature in the tundish and respectively the water temperature in the mould for 150 mm round, all these being measured initially and then at different time periods since beginning the casting. We have considered the sequential cast heats as being individual cast heats, taking into consideration the fact that only the temperatures and the casting speeds at beginning the casting are different. It can be noticed that at low steel temperatures in the tundish the casting speed is higher and the temperature of the water in the tundish has higher values.

The global correlation coefficient: ryx1x2 = 0.7390

The equation of the regression surface are:

$$z = -630.6283 + 0.8531*u - 0.7280*v + 0.0006*u.*v - 0.0003*u.^{2} - 0.0038*v.^{2} \quad (1)$$

In comparison, Figure 3 shows the same relation for the 240x270 mm bloom. Excepting the different temperatures of the steel inside the tundish, there can be noticed more lower values for the casting speed. We must take into consideration the bigger section in the second case. The global correlation coefficient together with the equation of the regression surface is

- the global correlation coefficient: ryx1x2 = 0.5915
- the equation of the regression surface

$$z = -33.3665 + 0.0525*u + 0.0466*v - 0.0014*v.^{2} \quad (2)$$

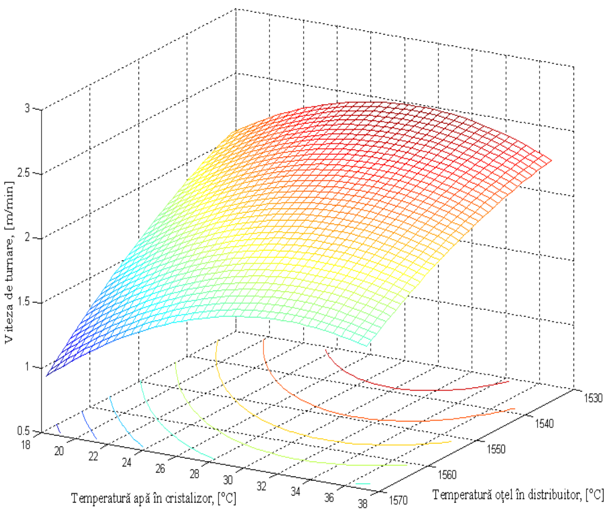

Fig.2 The dependence between casting speed, the steell temperature in the tundish and the water temperature in the mould for Φ150mm

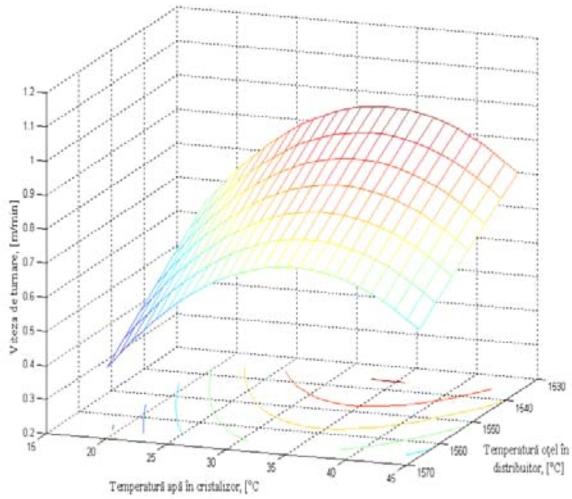

Fig.3 The dependence between casting speed, the steell temperature in the tundish and the water temperature in the mould for bloom 240x270mm

In what concerns the other parameters of the mould, as: water flow and respectively the water pressure in the mould, they have a high importance for the building of the semi-finished product scum. When coming out from the mould, the scum is thick enough in order to resist to the outer and inner stresses, without breaking.

From this point of view, in case of the Ø150 mm profile (Figure 4), for a certain casting speed, the pressure and the cooling water flow in the mould can be chosen. There is an inversely proportional dependence between these parameters.

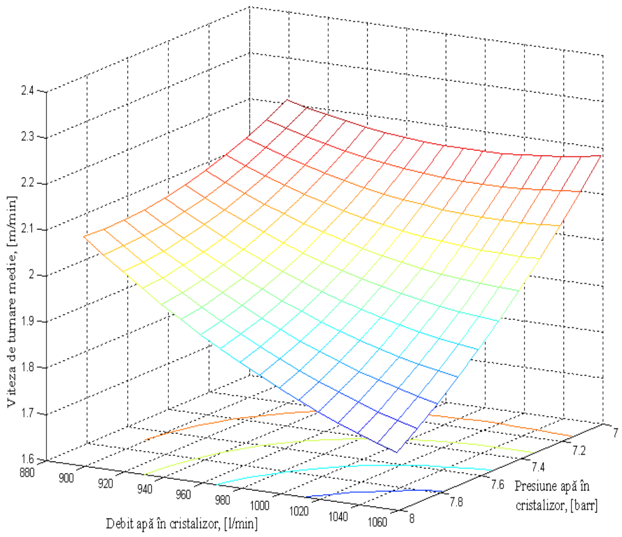

Fig.4 The dependence between the speed casting, pressure and the cooling water flow for the Ø150 mm profile

The global correlation coefficient: ryx1x2 = 0.6975

The equation of the regression surface

$$z = 3.3405 - 0.3328*u + 0.0032*v - 0.0022*u.*v + 0.1446*u.^{2} \quad (3)$$

In what concerns the bloom, by taking into consideration its section, the cooling is performed differently on the two sides, as follows:

- in Figure 5, the directly proportional variation of the average casting speed depending on the cooling water parameters for the small side of the mould (240 mm) with the global correlation coefficient:

ryx1x2 = 0.7589 and the equation of the regression surface

$$z = -212.6674 - 8.4313*u + 0.4495*v + 0.0113*u.*v - 0.2633*u.^{2} - 0.0002.*v.^{2} \quad (4)$$

- in Figure 6, the interdependence of the same characteristics for the big side of the mould (270 mm), with the global correlation coefficient: ryx1x2 = 0.850 and the equation of the regression surface

$$z = 804.8152-136.3525*u -0.6430*v + 0.1386*u.*v + 0.1582*u.^2 - 0.0002*v.^2 \quad (5)$$

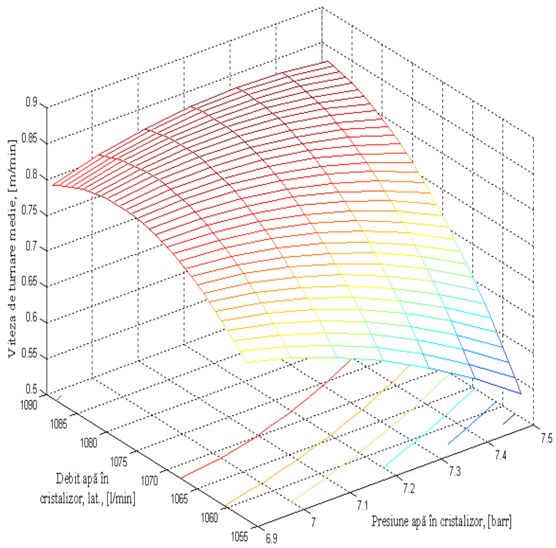

Fig.5 Variation of the average casting speed depending on the cooling water parameters for the small side of the mould (240 mm)

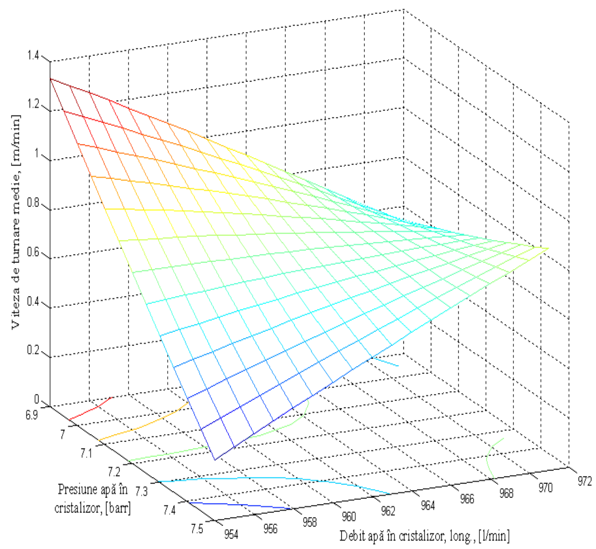

Fig.6 Variation of the average casting speed depending on the cooling water parameters for the big side of the mould (270 mm)

In this case there exists a variation that is similar to that of the round for low values of the casting speed, and respectively a directly proportional variation for higher values of the casting speed.

3. CONCLUSIONS

Based on the performed study and on the shown graphical and analytical dependence, a series of conclusions result, as follows:

- the solidification of the steel in the mould is very important. The thickness of the semi-finished scum when coming out from the mould and the integrity of the continuously cast strand depend on this;
- the steel temperature in the tundish 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;

- both the regression surfaces and the reached equations can be used in practice in order to reach a parameter, when the other two are already known.

4. REFERENCES

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