

## Technological aspects at continuous casting of semi-finished products with $\phi 270\text{mm}$

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**Abstract.** Continuous casting installation especially appreciated because steel can be poured in a more varied assortment. The flexibility of the system is not sufficient if the casting parameters are not properly adopted and adapted to the specific brand of steel. This paper presents some technical aspects relative to continuous casting of semi-finished products with  $\phi 270\text{mm}$  section. Graphical dependencies obtained in Excel and analytical equations of this allows to specialists from industry to adopt values for the addicted parameters according to the independent ones, already known.

### 1. Introduction

Continuous casting of steel, originally developed for casting of non-ferrous metals and alloys, has been adapted for casting of steel, gradually replacing ingots casting. With the changes in installation design and technology, were replacement vertical installations with installations which have curved wire in different zones – Figure 1. [1]

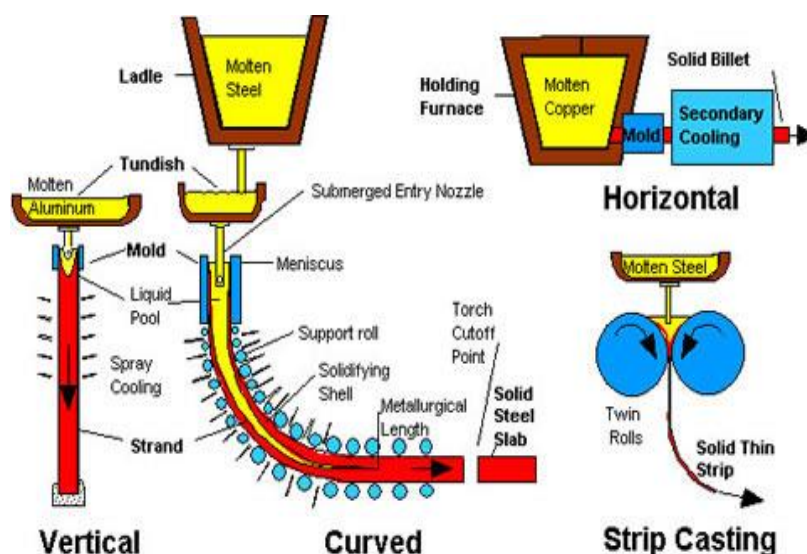


Figure 1. Types of continuous casting machines



Also, by the changes made to casting machines, range assortment has grown both in section and in shape – Figure 2. [2]

In extending of the continuous casting process in detriment of conventional casting has contributed improvements both the facility and the casting process: use immersion tubes [3], the coatings powders in tundish [4] and casting powders in crystallizer [5], [6], the electromagnetic stirring [7], properly designed tundish and crystallizer design [8], the possibility of casting simultaneously through the same system several sizes section or shape.



**Figure 2.** Typo dimensions of continuously cast semi-finished product

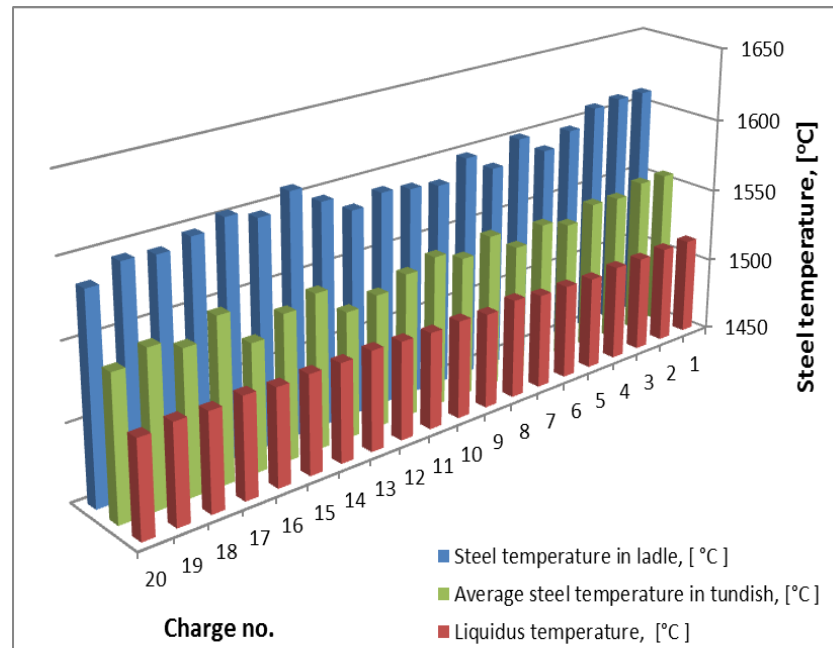
## 2. Experimental data's

To a specifically analyse of the steel continuous casting technology, were analysed a total of 20 charges of steel S235JR brand (according to EN 10025). It is noted that the charges have been produced in an electric arc furnace, treated in the LF secondary treatment installation (Ladle Furnace) and then continuously cast, on the 5-wire system as a billet section  $\phi 270$ mm (three-wire) and section  $\phi 310$ mm (two-wire). It is noted that on the continuous casting facility has been cast to the present billet section  $\phi 150$ mm,  $\phi 180$ mm,  $\phi 310$ mm bloom section and  $240 \times 270$ mm.

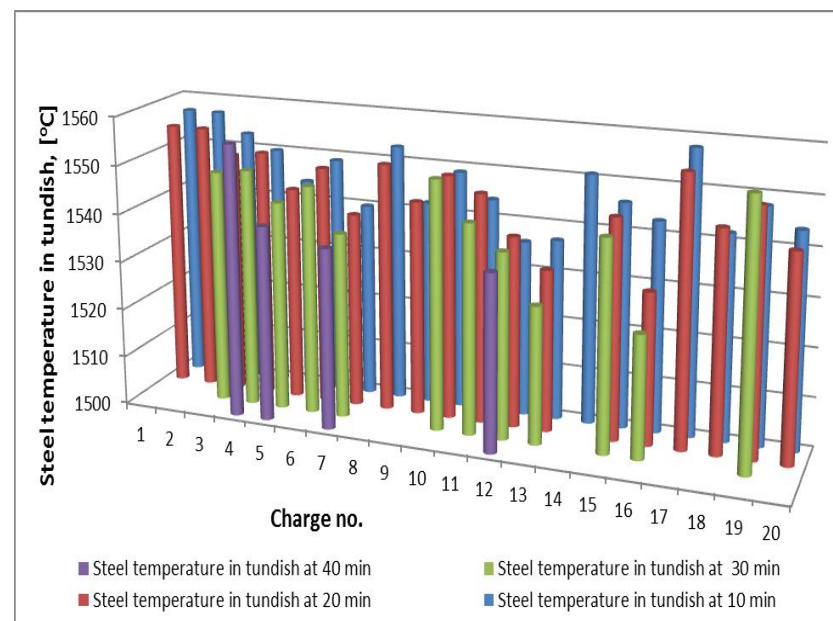
From the point of view of steel making process has been not found problems, at steel discharge from the LF that matching in terms of chemical composition [9].

At discharge of liquid steel from LF secondary treatment facility, steel temperature was within the limits  $1586$ - $1610^{\circ}\text{C}$ , noticing it an overheating compared to liquidus temperature with  $64$ - $94^{\circ}\text{C}$  – Figure 3. Overheating was necessary taking into account the time (and the route) to go ladle with liquid steel from steelmaking and secondary treatment hall to continuous casting plant hall.

During the continuous casting steel temperature is a technological parameter that is monitored continuously; as evidence, measurements made from 10 to 10 min relative to the temperature of the steel distributor, where continuously steel is in constant movement, being casted from the casting ladle and then in installation crystallizer. In most cases studied (Figure 4) there was a slight decrease of this parameter, which is normal because the tundish has no possibility of heating the steel. In one case there is a high temperature after 40-45min, but can be justified by entering into tundish of hot steel quantities of steel, brought by next charge of the casting sequence.



**Figure 3.** Comparative analysis of steel temperatures (liquidus, ladle and tundish)

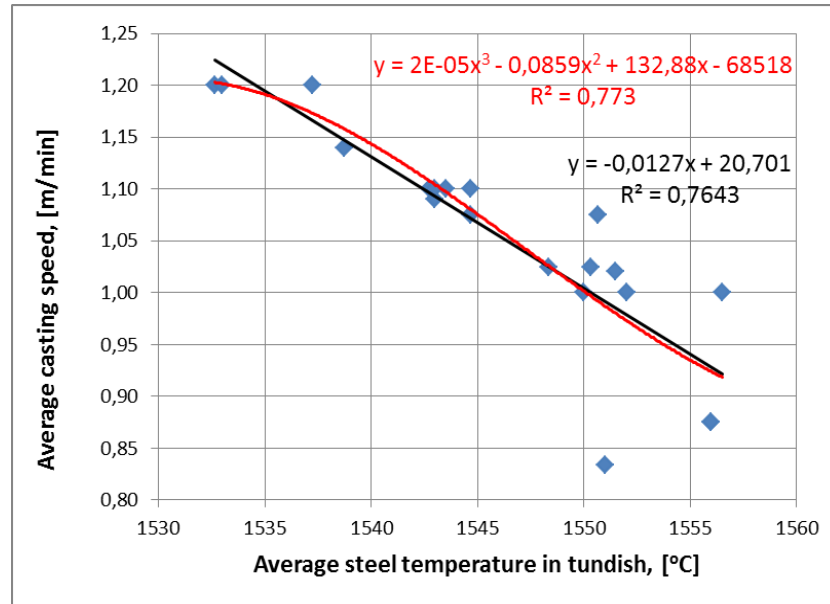


**Figure 4.** Changes in temperature of liquid steel in tundish during casting

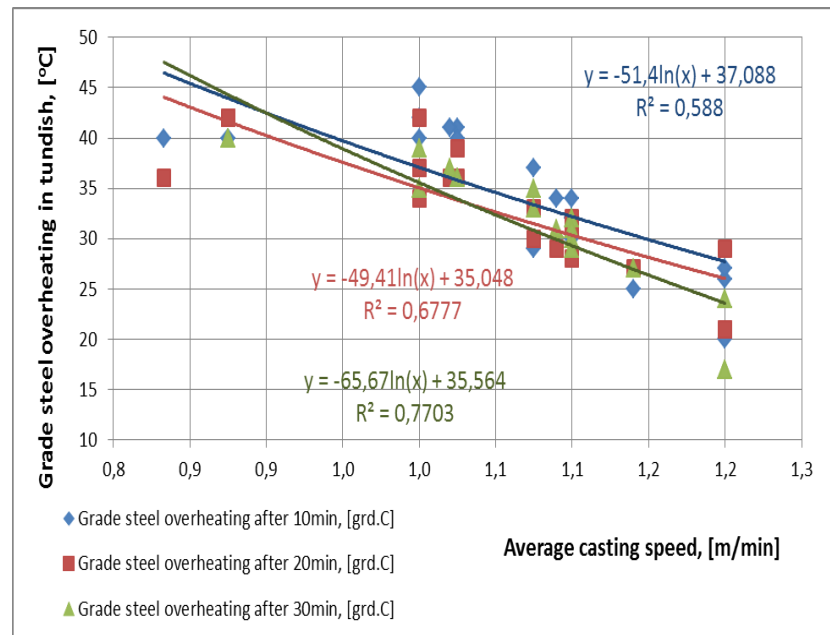
That, the casting temperature caused the variation of another important parameter: the casting speed Figure 5. It is noted that with increasing of temperature are reduced the speed of continuous casting, so that the cooling of the billets be adequate and their quality is not negatively affected.

Figure 6 presents the variation in overheating degree of the steel in the tundish according to the casting speed. It is noted that casting speed adjustment was made through the entire process of continuous casting, as evidenced by the inverse dependences: an increased temperature gradient, the

casting speed was slightly decreased in order to not induce additional thermal stress in the semi-finished product.



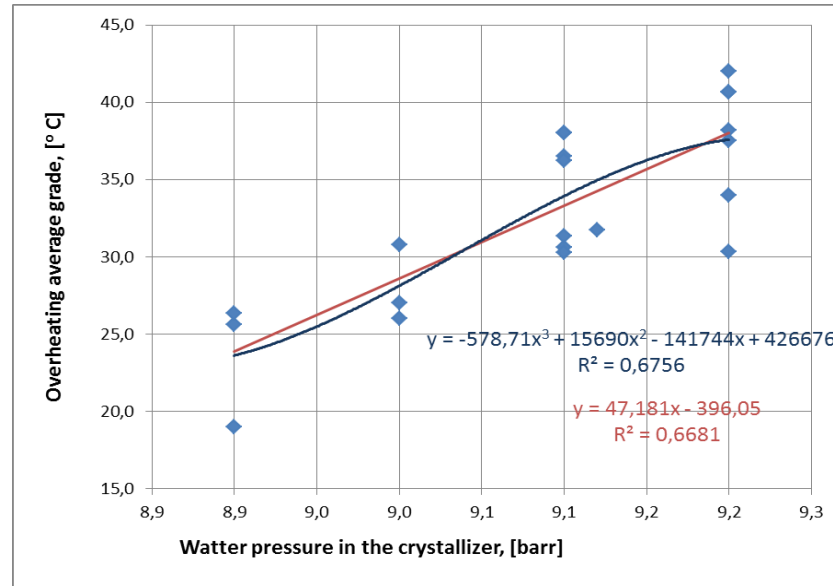
**Figure 5.** Dependence between casting speed and the average temperature of steel in tundish



**Figure 6.** The dependence between overheating degree and average speed casting

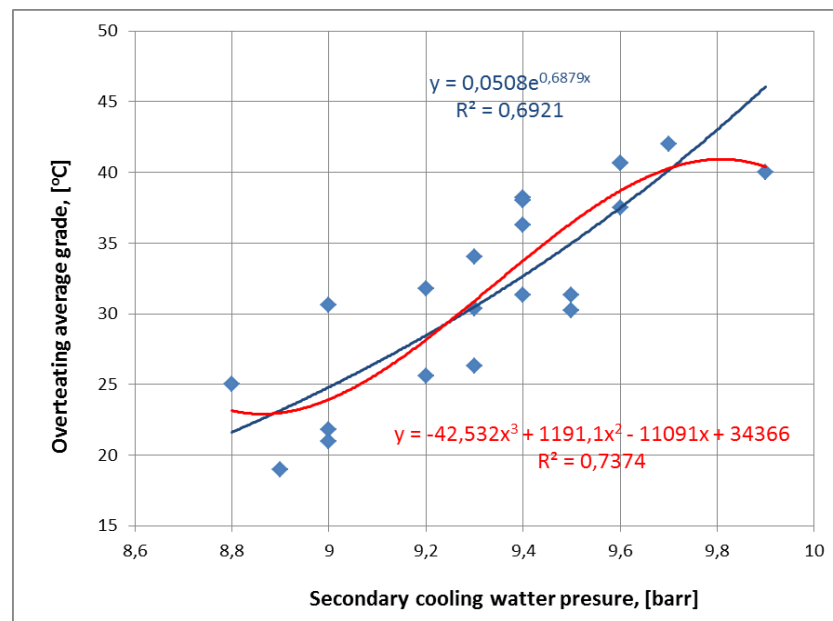
Primary cooling takes place in the crystallizer; at studied charges water cooling values were as follows: pressure 8.9 to 9.3 bar, flow rate of 1800 l / min. In Figure 7 is presented the dependence between the average degree of overheating of steel in tundish and cooling water pressure in crystallizer. It can be seen directly proportional interrelation between the two parameters: with

increases of steel temperature (the degree of overheating) increases also the water pressure in the crystallizer.



**Figure 7.** Changes in the overheating degree of steel according to the water pressure in the crystallizer

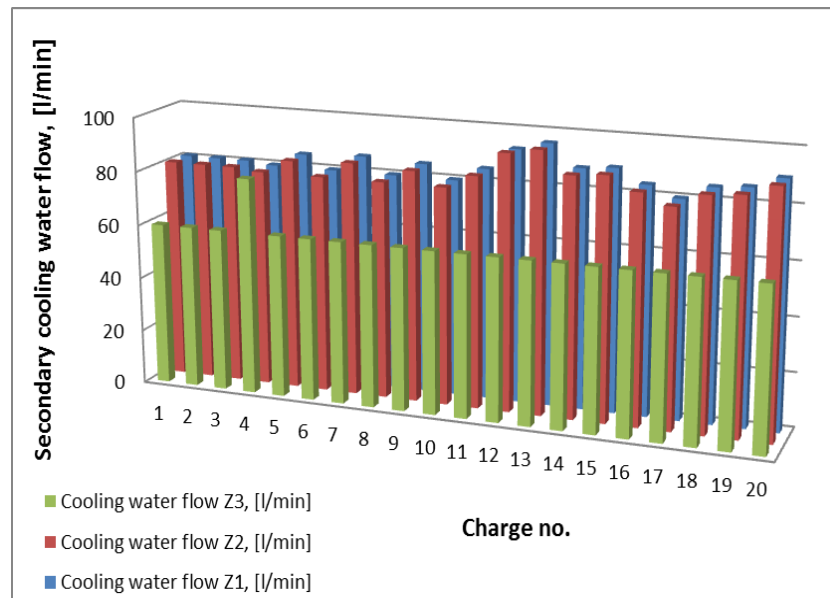
Cooling has continued later in the secondary cooling zones (divided into three zones according to the ratio 40:40:20), but even in this sector there is an adjustment of the cooling regime with liquid steel superheat degree – Figure 8. Secondary cooling water flow rates, presented in Figure 9, reveals identical values for  $Z_1$  and  $Z_2$  respectively slightly below the  $Z_3$ .



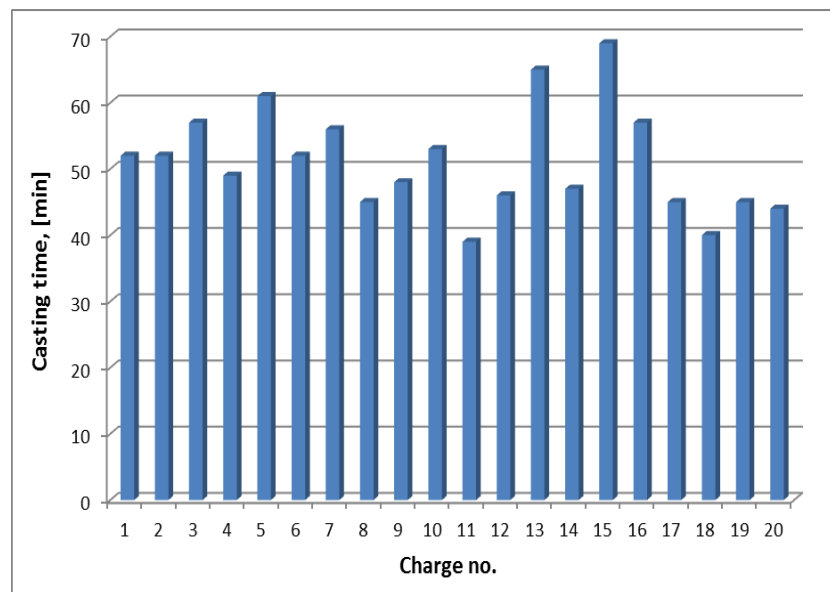
**Figure 8.** Changes in the degree of overheating depending on the secondary cooling water pressure

Finally it should be noted that the third parameter of influence to the continuous casting technology: casting time. At the studied charges it ranged between 39-69min, Figure 10. Both

extremes are atypical: in the first case the cast was interrupted and steel was evacuated emergency ladle; in the second case, it not was casted on the all 5 wires, which artificially increased casting time.



**Figure 9.** Changes in secondary cooling water flow



**Figure 10.** Changes in the casting time

### 3. Conclusions

From the above results the following conclusions:

- continuous casting of the profile with section  $\phi 270\text{mm}$  has no problems, any atypical values of some parameters are immediately remedied by changing the operating parameters of the facility;
- overheating degree of the steel in the casting ladle and then in tundish is slightly increased over the limits recommended by the literature (Mannesmann) -  $45\text{-}60^\circ\text{C}$  compared to liquidus temperature;

- casting speed allows an average value of 1,05m/min., casting speed adapted to the facility being studied. An increase in casting speed would have positive impacts on growth of the facility productivity, but must considered the effects to intensify of cooling on the quality of semifinished product;

- adaptation of the cooling parameters (flow and pressure in the crystallizer and in the secondary cooling zone) depending on the technological parameters is done by using cooling programs implemented at the studied facility.

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