10th International Research/Expert Conference
”Trends in the Development of Machinery and Associated Technology”
TMT 2006, Barcelona-Lloret de Mar, Spain, 11-15 September, 2006

STUDY REGARDING THE STEEL TEMPERATURE ADJUSTMENT POSSIBILITIES AT CONTINUOUS CASTING

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ABSTRACT

The temperature of molten steel is the main parameter on which it can be operated before the steel arrives in the continuous cast machine and during the continuous cast process. It is a known fact that, the temperature of the continuous cast steel has to be situated between much more restrained limits, recommending as optimal values for the temperature of the steel into the casting pot values higher than the liquid temperature with 30-60^{o}C, respectivly15 to 40^{o}C over the liquid temperature in the tundish.

An adequate conduct of the furnace and a secondary treatment properly managed can insure these values. But if this thing is not possible, must found different technological method to frame the temperature in requested limits.

A first settlement can be realized in the tundish of continuous casting machine, either through using cover dusts (for a lower temperature), either through the usage of micro-coolers (to bigger temperatures than one admitted). Also, a big temperature can tune in crystallizer, through the micro-coolers introduction. The paper introduces some researches with regard to the temperature settlement in the tundish of continuous casting machine.

Keywords: steel temperature, continuous casting, wastes.

1. GENERAL CONSIDERATION

The temperature of the steel in different phases of the technological process of continuous casting depends on the following elements: the quality of the steel, (the liquids and solids temperature), the size of the charge and the conditions of emplacement of the continuous cast hall in the technological flux (which determines the heat losses of the metal from the melting pot, up to positioning this above the continuous casting installation).

The liquids temperature at any steel brand is the basis of calculating the adequate casting temperature. All the other temperatures that are necessary in certain phases of elaborating and treating of the steel must be based on the liquids temperature.

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 55 heats, OLT 45k marks, elaborate into an electric arc furnaces (EBT) by 100 t capacity and continuous casting as Ø 150mm billets.

The temperature of the steel at the beginning of the evacuation from the evacuation furnace or from the secondary treatment unit may vary in large limits (1600–1700^{0}C), depending on the above-mentioned elements; at the majority of the modern installations, this temperature is situated between 1620–1650^{0}C.

The temperature in the casting pot of the steel during the continuous casting must be between 1570 and 1620^{0}C, and the temperature from the tundish must be 15–40^{0}C over the melting temperature, generally speaking being between 1550–1580^{0}C (the cooling speed in the tundish varying in the high capacity installations between 2 and 5^{0}C/min, the stationary time being of some minutes and the

lowering of the temperature in the tundish is small (10–20^{0}C). For the carbon un-allied steels, the temperature of the steel in the tundish is set as low as possible. The reasons are the higher functional safety and the quality of the profiles (the elimination of the perforations, improving the internal structure and preventing the internal cleaving).
The casting time of a charge results from pot capacity and from speed casting. The maximum time of casting depends first of all by maximum subtraction of temperature, because after what we saw, the metallurgical reason impose maintain of casting temperature between certain limits, with a view to obtain a correspond quality of products and of a sure working of installation. [1,2].
In this way, in figure 1 is presented the casting time variation in function of steel temperature tundish for snapshots made from two charges. We'll see the casting time growing after 180min of bigger temperatures than 1562°C, in conditions of a constant casting speed. If we'll see the subtraction of casting time we can enlarge the casting speed of semi-manufactured good, altered the smelting programme (in the way of primary and secondary smelting intensify of the semi-manufactured good). We can consider, for this case, a best casting time by 150-165min for steel temperature of 1550-1560^{o}C.

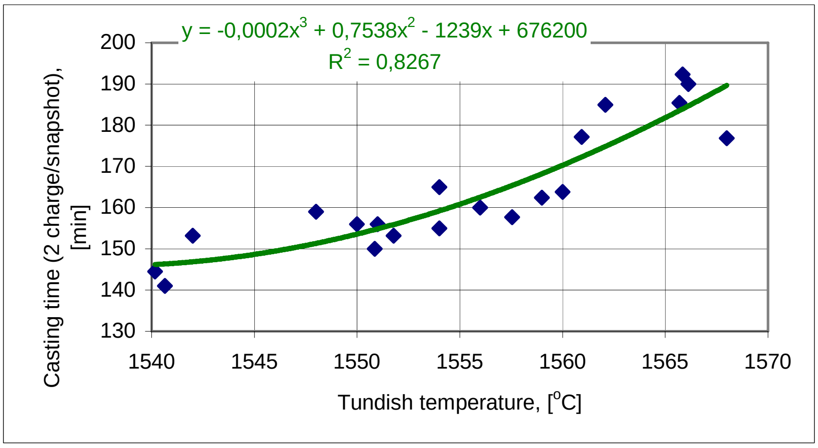

Figure 1. The casting time variation in function of initial steel temperature from the tundish, for snapshots made from two charges

The casting speed in the main factor for continuous casting installation size, because it influence the productivity, the number of necessary thread (to can empty in maximum time the casting pot by certain capacity at semi-finished products casting on a know section) and the minimum section of a casting semi-finished products.
For an ensemble image about the temperature influence over the speed casting, we'll implement programme Matlab, obtained both regress surface and the equation, which describe these surfaces.
For the billets with 150mm section, at 10 min after casting start, between casting speed (c_{speed}), the steel temperature in tundish ($T_{tundish}$) and difference between tundish temperature and liquids temperature (ΔT) is the variation presented in figure 2 (the regress surface and level curves of surface). The equation which describes the surface is:

$$c_{speed} = -1{,}72\cdot10^3 - 2{,}28\cdot T_{tundish} - 2{,}71\cdot\Delta T - 1{,}85\cdot10^{-3}\cdot T_{tundish}\cdot\Delta T - 0{,}75\cdot10^{-3}\cdot T_{tundish}{}^2 - 2{,}89\cdot10^{-3}\cdot\Delta T^2 \qquad (1)$$

and the global correlation coefficient are: $r_{yx1x2} = 0{,}8586$.
The obtain regress surface admit a maximum point appeared around the technological area: casting speed by 2,1-2,1m/min for a biggest variation of steel temperature in tundish but an difference temperature (reported at liquids temperature) of maximum 32°C.
The same dependence is presented in figure 3 at 40min from the casting start. We remark a subtraction of casting speed at high temperatures in tundish and a high difference temperature.
The equation which describes the surface is:

$$c_{speed} = 1{,}93\cdot10^3 - 2{,}45\cdot T_{tundish} - 1{,}31\cdot\Delta T + 0{,}94\cdot10^{-3}\cdot T_{tundish}\cdot\Delta T + 0{,}775\cdot10^{-3}\cdot T_{tundish}{}^2 - 2{,}14\cdot10^{-3}\cdot\Delta T^2 \qquad (2)$$

and the global correlation coefficient are: $r_{yx1x2} = 0{,}8799$.
For the correct functioning of the continuous casting installation, a severe control must be assured on the steel temperature and forward, in the technological flux. Thus, the necessary precision regarding

the prescribed temperature at the crystallizing apparatus entrance must be of ±5-10^0 C.

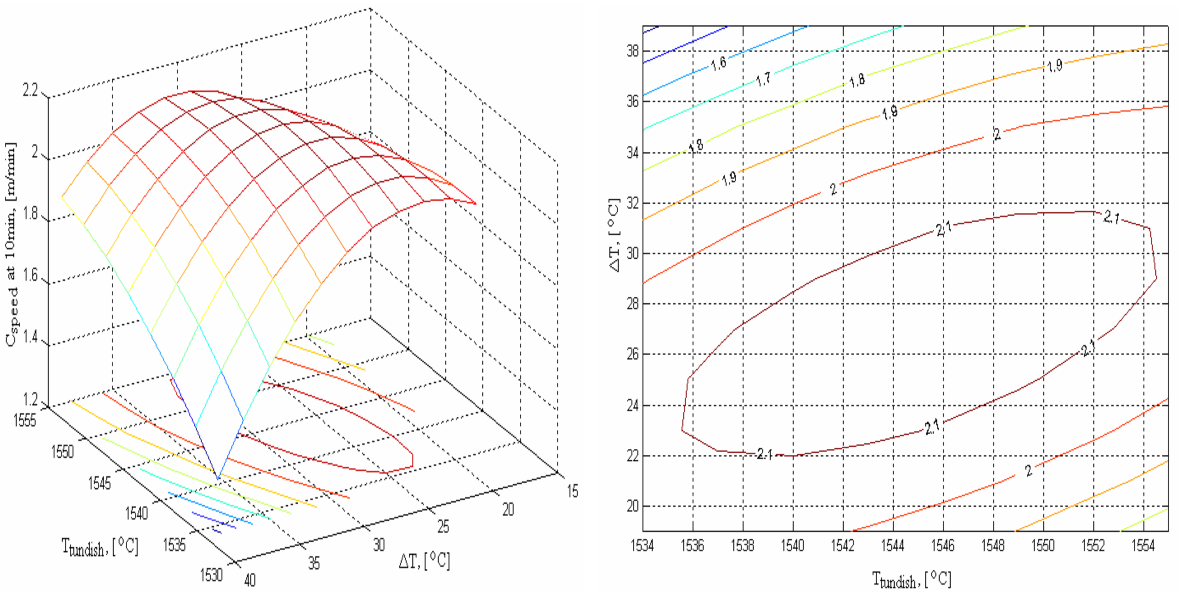

Figure 2. The casting speed variation in function of steel temperature in tundish and the difference temperature (reported at liquids temperature) for 150mm billets at 10 min from casting start

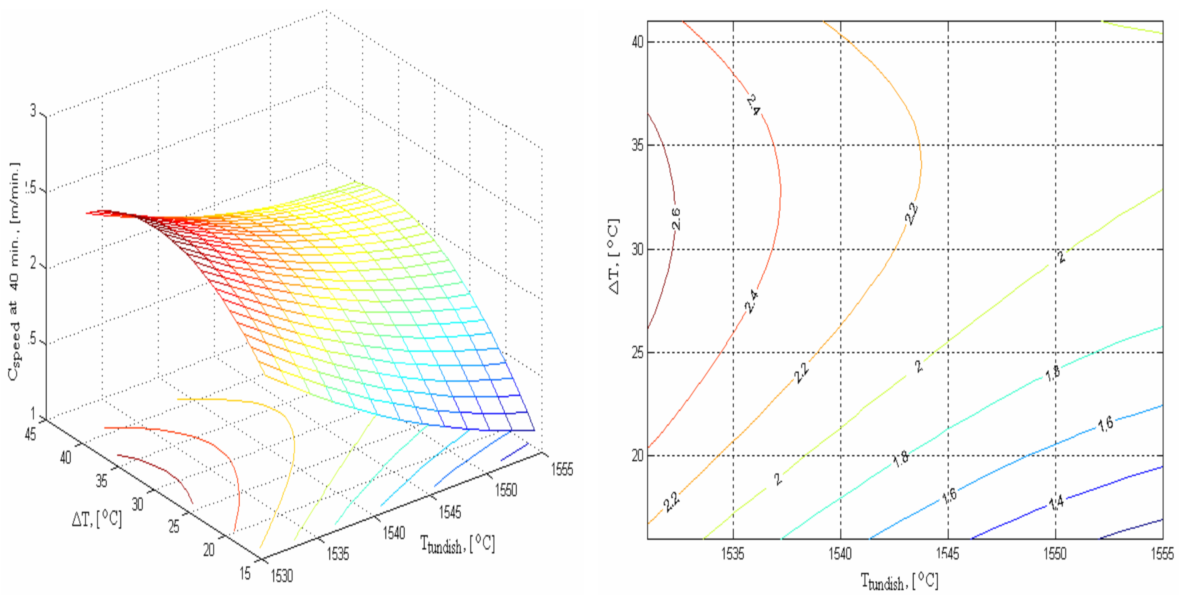

Figure 3. The casting speed variation in function of steel temperature in tundish and the difference temperature (reported at liquids temperature) for 150mm billets at 40 min from casting start

During the continuous casting, the temperature of the steel in the tundish oscillates because of the continual modification of the steel temperature in the casting pot as well as due to the changeable thermal conditions in the tundish. At the beginning of the casting, the steel temperature decreases (it takes place the heating of the tundish wall), the temperature becomes stabilized, but at the end of the casting sequence, the steel temperature in the tundish decreases again. As a consequence, to assure a constant casting temperature, the temperature of the steel in the tundish must be set through its heating or its cooling [3].

Correlated with the heating of the steel the addition of some exothermic powders is made, powders that have the part of a covering compound. Such types of powders are used these days, and as a rule they are produced abroad, which implies a considerable financial effort.

From this reason, we are trying to realization such powders by using different wastes came from the siderurgic industry, energetic industry such as: thermo-central ashes, furnace slag, B.C.A. scraps,

limestone, calcinated soda, fluorine, raw dolomite, graphite powder.
After some preliminary operations (crushing, classing and measuring) the components are blending and get ready for experiments. Until this stage of experiments, we are using in laboratory experiment two recipes, with compositions presented in figure 4.

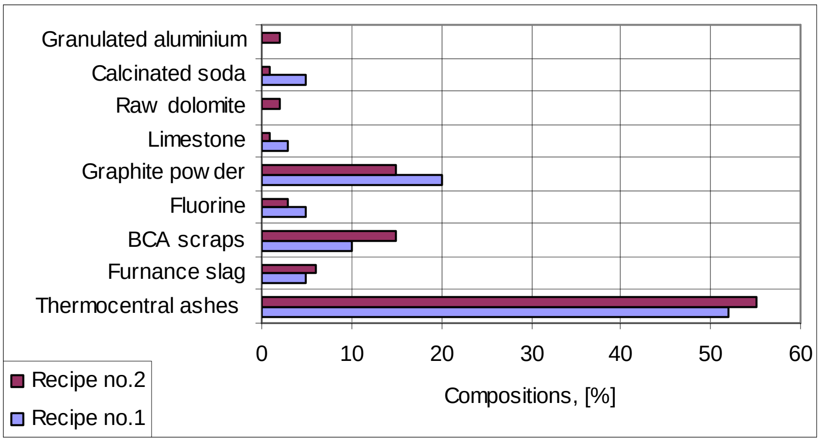

Figure 4. Recipes composition.

The trials made in the lab phase make us say that: the similar chemical composition with a powder that is successfully used in practice (which will be considered as standard powder), the relatively low melting-temperature and a big degree of spreading on a metal plate. There will be made more recipes, which, after an analysis of behaving in lab conditions will be industrially experimented.
Also, when the temperature of the steel from the tundish is too high, it is taken into consideration the realization of an addition of micro-coolers in the tundish. The base condition is that the used microcoolers mustn't impurify the liquid steel. As micro-coolers both metallic powder (under 1 mm) obtained through classical methods and grains from wires with a diameter of about 1 mm and cut to dimensions of 1-2mm can be used [3]. The shape of micro-coolers is not important in this case, considering the fact that only the cooling of the steel is the main objective and not the modification of its composition.

3. CONCLUSIONS

At the casting of the round profiles, usually the casting temperature in the tundish is set up to 15–30^{0}C above the lichidus temperature. Many factors of influence must be taken into account, such as the casting time and the casting flow (speed), the number of wires, the dimension of the wire, the capacity of the tundish, the steel brand, etc. The consequences of this temperature rising influence the ulterior parameters of influence: the casting speed, the primary and secondary cooling conditions (mainly in the way of increasing the values for these parameters).
If the casting temperature is too high, it is necessary to sensibly lower the casting speed and a very intense secondary cooling, having as a consequence internal and surface imperfections, due to the thermic tensions, and as well a too high temperature of the steel increases the danger of puncturing the wire under the crystallizing apparatus. A lower casting temperature may lead to the obstruction of the casting orifices of the tundish, especially in the case of thin sleb or of the small section billet, as well as to the surface imperfections.

4. ACKNOWLEDGEMENTS

The author gratefully acknowledges the support of the present research by the Grant CEEX nr.3194 / 13.10.2005 of the EXCELLENCE RESEARCH PREJECTS- YOUNG RESEARCHES Romania.

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