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SETTLEMENT POSSIBILITIES OF STEEL TEMPERATURE IN CRYSTALLIZE

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ABSTRACT
In work enters simulation of solidification continuous casting steel product using micro-coolers in crystallizes. The rated program is realized in the language C++ and functions under stackers Win32. The simulation did for cooling primary and secondary of blooms steel mark S 235 JRG2 with section 240x270mm.
The simulation realization manages to the aspects clarification with regard to the reduction superheating, respective steel a settlement of temperature in crystallize considering the fact as, the degree of superheating has was influencing important over quality continuous casting steel product.
Resulted plots analysis after simulation, it allows the information procurance with regard to the make-up mode of micro-coolers in crystallize and the quantity same respective effects to those over temperature variation in crystallize and over structure continuous casting steel product.
Keywords: simulation, continuous casting, micro-coolers

1. INTRODUCTION
One of the main load of current continue casting is to improve the quality of continue casting steel. For this we have to grant a distinct attention to subtraction measurements of areas and dendrites segregation, by reduction of fissure made and by growth of main part density of semi-manufactured good continuous casting.
The macrostructure steel product obtained from continuous casting is characterized through a three structural areas made: a surface area of little dendrites crystals, an area of column dendrites and a central area of echiaxes crystals. In function of crystallization conditions the structural areas are different after the extension of areas and crystals size. We know that at steel ingot solidification the extent area of echiaxes crystals encourage the bettering of ingot structure quality, in special subtraction of axial and dendrites segregation, dispersion of axial porosity and diminish the nonmetallic inclusions dimensions.
At casting steel with a little overheating degree, the steel crystallization starts quickly, and the occupied area by echiaxes crystals is bigger. At steel casting with a big degree of overheating, the column crystals germinate make that the occupied surface by echiaxes crystals to be reduced. Even in the casting with a bigger degree of overheating, in the middle of semi-manufactured good is making an echiaxes area. This is possible because the solidification speed is late to cause of limit heat change through the made crust [1].

In the column area made, in front of solidification front produce the elements segregation. If the column crystals growth until the middle of semi-manufactured good, than in the central area the semi-manufactured good will present a major segregation.
At the same time, because is overheating, the column crystals which growth on the opposite face, can unit and can make that deck. In the superior part of continue casting thread it form a crust. After the crust formed, the column crystals start to grow perpendicular on the semi-manufactured good area. Because of convection current and of the thermic temperature difference from liquid steel, the column crystals development became unstable making the possibility of deck make which isolate the rest of liquid steel from certain no solidification areas.

2. THE SIMULATE OF SEMI-FACTURED GOOD SOLIDIFICATION IN CONTINUOUS CASTING WITH MICRO-COOLERS ADITION

The semi-manufactured good solidification in continuous casting can be made with micro-coolers additions in crystallize like in steel casting ingot. In a first phase of research we make a mathematical model on its base, which was simulate semi-manufactured good solidification in continuous casting [2].
The computing program was realized in C++ and it runs under Win32 systems (that means Windows 95, 98, Me, NT4, 2000, XP – with Intel processor). For graphical interface the program uses MFC (Microsoft Foundation Classes), a classes library that include the functionality of Windows standard programming interface (API – Application Program Interface). The 3D graphs are realized with the Windows implementation of OpenGL specification (Open Graphics Library).
For configuration of specific dates for every steel grade, using the principal interface (figure 1) the program opens the dialog box. When the program is running it is opened a dialog box for calculus progress, as is presented in figure 2 and figure 3. The temperatures are indicated by the mean of a colored gradient, having the values: red for casting temperature, blue for ambient temperature and green for their average. Any intermediary temperature is a combination of these.
A first obtained dependence is represented by temperature variation of the half-finished product function of time (figure 4.). The distribution of the discredited points is also presented.
As regards the temperatures distribution in the crystallize (which take over the heat transferred by the half-finished product and transfer it to the cooling water), it is presented in figure 5. In this case to it is presented also the position of the discredited points.

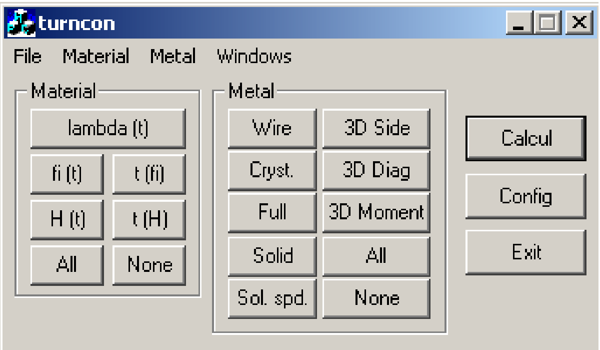


Figure 1. Program principal interface

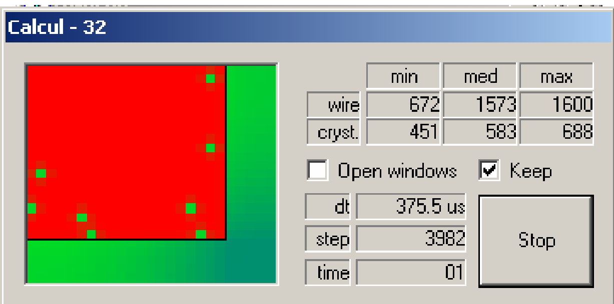


Figure 2. Dialog box for calculus progress (moment addition micro-coolers)

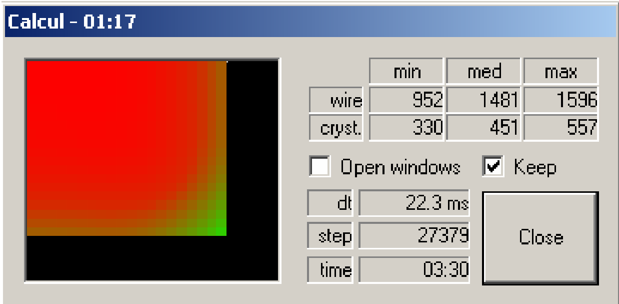


Figure 3. Dialog box for calculus progress (end program).

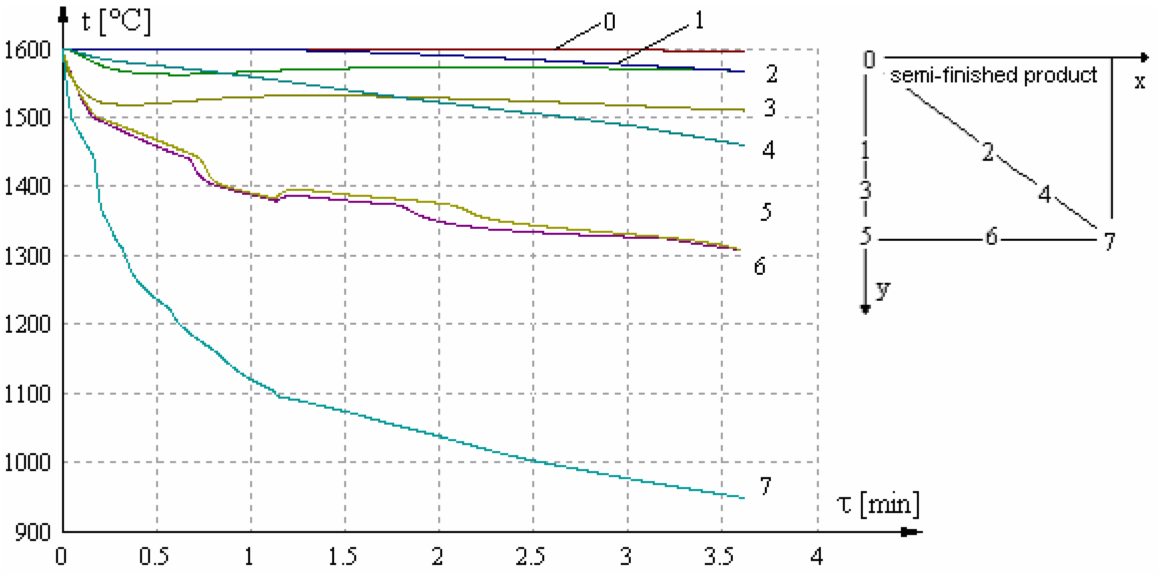


Figure 4. Temperature variation function of time

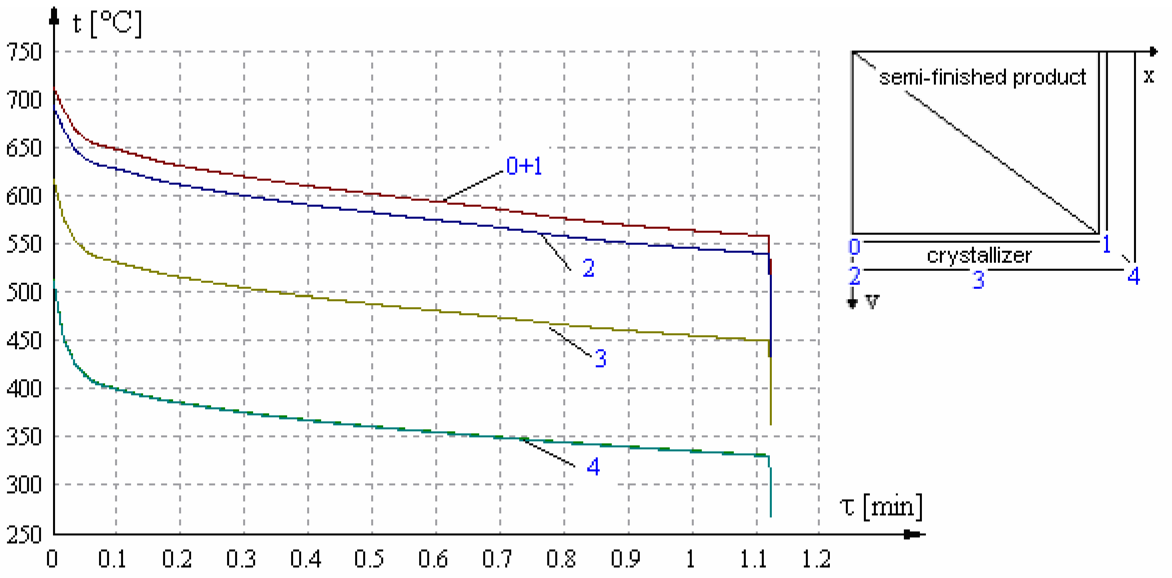
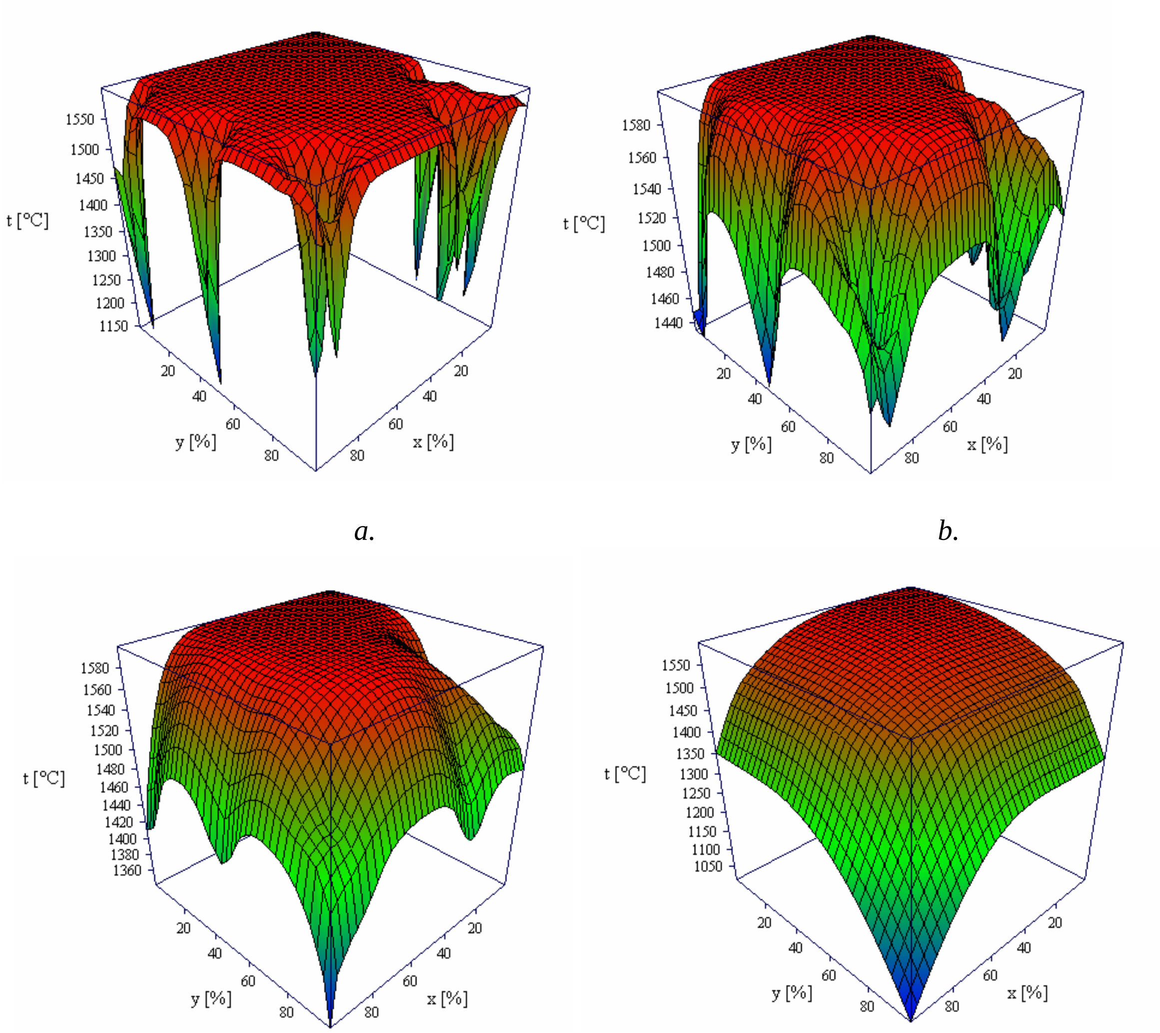


Figure 5. Temperature variation in the crystallize, function of time

Another type of temperature distribution, when the half-finished product is droved out from secondary cooling zone, it is presented in figure 6. The obtained regressing surface it correspond to a quarter of half-finished product section, being similar for the remained parts of the section. From temperature values point of view, the corner of the half-finished product is that one which is cooled more powerful, and the center is cooled slowly.



a. *b.*

c. *d.*

Figure 6. Temperature distribution in the continuous cast blank: at 3s (a), 10s (b), 30s (c) since the micro-coolers adding in the secondary cooling zone (d).

3. CONCLUSIONS

Analyzing the graphical dependences from the performed researches, based on literature review data and from own experimental work it results the fallowing conclusions:

- Addition of micro-coolers induction of fact local fall at steel temperature;
- Additions of micro-coolers determine the conduct of solidification as a result of local fall steel temperature;
- Modifying a series of parameters (number of discretised points, dissipated heat in crystallize and in secondary cooling, data of steel grade) it could be obtained more correct values, applicable to other steel grades.

4. ACKNOWLEDGEMENTS

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5. REFERENCES

[1] Butnariu, I.: Continuous casting of steel product, Editura Tehnică, Bucureşti, 2000.

[2] Ardelean, E.: Continuous casting of steel, Politehnica, Timişoara, 2001.