THE CONSTRUCTIVE AND TECHNOLOGICAL OPTIMIZATION OF CASTINGS BY MEANS OF THE SOLIDIFICATION DIRECTION GRAPH OBTAINED FROM NUMERICAL SIMULATIONS

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Abatract:

In this paper we present a new method on numerical simulation with reduced resolution and a possibility of technological interpretation of solidification process castings, effective for constructive and technological optimisation.

The physical phenomena are thermal phenomena, related to liberation of the latent heat of solidification, and volume contraction by the forming, the repartition of internal and open shrinkages in the solidification process.

The model is applied to casting-alloy (alloy in liquid phase, intermediate phase and solid phase), mould, feeder, internal chill, surface chill and chill in mould. The numerical method used is based on heat flow rate through the three faces of the cells. The temperature variation is determined from the total heat balance, in which the boundary conditions are also included.

At the level of every cell it is considered the liberation of the latent heat by the method of the variation of the solide fraction, using the lever rule case, determining the quantity of the solidified alloy, the position of the solidification front and the repartition of the shrinkages.

The algorithm and programme were conceived in TURBO-PASCAL, on a PC computer and the results have physical and technological importance for the reduced resolution for the big size castings and high geometrical complexity.

To persue the solidification process, we use numerical data which are turned to good account by the solidification direction graph, in which the solidification fine for each level of the discretization net on the height of the casting is presented.

The solidification graph presents three zones: growing zone, constant zone, decreasing zone. The growing zone is favourable to the directional solidification, because the solidification front advances constantly from the lower to the superior part, the zone being usually affected by an open macroshrinkage. The decreasing zone is inauspicious to the solidification process, because the solidified zone includes, under its level, unsolidified parts. This zone presents the possibility to form internal shrinkages. The constant zone presents the specific feature to solidify at the same time and this zone is affected by microporosities.

In this paper, the solidification direction graphs are used to project the constructive form and to optimize the technology of a body in gray cast iron, with a wall thickness of 30-40 mm and the size of 2455x1240x1400.

The simulation of the solidification process was made considering and analysing, by the solidification direction graph, the following possibilities:

- the isolate guide path, without taking into account the other constructive elements of the casting;
- the guide path, taking into account the vertical walls;
- the guide path, taking into account the horizontal walls;
- the guide path, taking into account the vertical and orizontal walls;
- the guide path, taking into account the technological thickenings;
- the guide path, taking into account the chills;

From the numerical analysis we have the following conclusions:

- the variant without the isolations of the external surface of the alloy at the level of the feeder presents an inappropriate graph of the solidification direction, in the sens that it presents at its superior part a decreasing slope;
- the utilisation of the variant of the isolation of the external surface at the level of the feeder has favourable effects on the graph of the solidification direction;
- the heat transfer coefficient in the external surface at the level of the feeder has not an important influence on the forming of the constante zone;
- the utilisation of the variant with chill has favourable effects on shape of the graph of the solidification direction;
- the vertical walls do not amend essentially the shape of the graph of the solidification direction;
- the horizontal walls amend inauspiciously the shape of the graps of the solidification direction.

By analysis and simulation made on the solidification process, the paper presents the explanations on the following constructive and technological elements:

- the size, position and number of the technological thickenings on height of the casting;
- the form, size and position of the chills;
- the form, size and position of the feeder;
- the size and position of the vertical walls;
- the size and position of the horizontal walls.

Key word: solidification, numerical method, casting, simulation, constructive and technological optimization, grey cast iron.