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# DEVELOPMENT OF OPTIMAL TEMPERATURE-SPEED REGIMES FOR COOLING OF PROFILED PURVEYANCES IN THE CONDITIONS OF CC MASHINE OAJ «F.E. DZERDZHINSKY DNEPRO METALLURGICAL COMBINE»

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The method of calculation for the optimal temperature-speed regimes of cooling for profiled purveyances by means of search of multicriterion global extremum is presented. There are results of calculus to concrete CC mashine offered.

Keywords: CC mashine, temperature-speed mode, tensions, liquation, global optimum

On this stage of development of science and technique definition of optimal parameters of cooling for steel bars taking into account all factors so far is impossible [1-6]. Therefore mostly the state task of multicriterion optimization is taken to determination of the optimal regimes of cooling of bar with taking into account of a few factors, thus the found regimes are just for certain standard size of purveyance, as-assortment steel and concrete CC machine.

By the basic requirement at development of the regimes of second cooling of steel purveyance in the bunker of zone of second colling (ZSC) there is invariability or smooth decline of temperature of her surface on condition of absence of critical tensions. There are supposed mostly, that the law of change of temperature for surface in the limits bunkers of ZSC must have exponential character. In obedience to [6], the running temperature of surface of purveyance ($t_{sur}^{b}$) in the bunker of ZSC depends on the set temperature of surface of purveyance at the end of bunker of ZSC ($t_{sur}^{b.e}$), on an exit from crystallizer ($\tau_{sur}^{cr}$), speed of casting ($V_c$), length of bunker ZSC ($\ell_b^{zsc}$) and in every calculation moment of time for process of casting $\tau_p$ determined on a formula:

$$t_{sur}^{b} = t_{sur}^{b.e} + \left(t_{sur}^{cr} - t_{sur}^{b.e}\right)^{1-\frac{V_c \cdot \tau_c}{\ell_b^{zsc}}} . \qquad (1)$$

At definition of the optimal regimes of second cooling it is accepted, that by the first functional, influencing on the partition of temperature load to a purveyance within the limits of bunker of ZSC, are relative tensions, expected as attitude of actual tensions to maximum.

A next functional is accept the degree of liquation of chemical admixtures, for example sculptures ($L_S$). As well as in the previous case, a value of liquation degree must be on possibility less.

As parameters determinative the set functionals it is used the temperature of overheat ($\Delta T_{oh}$), speed of casting ($V_c$, m/minutes), temperature of surface of purveyances on an exit from the bunker of ZSC ($t_{sur}^{b.e}$) and concentration of carbon in the ladle test [*C*].

For the receipt of regressive dependences the second order and minimizations of quantity of numeral experiments the orthogonal central composition planning are used [7].

It is accepted, that the sought-for regressive equations for dependence of functionals $Y_i$ from the parameters of casting look like

$$Y_i = b_0 + b_1 \cdot \Delta T_{oh} + b_2 \cdot V_c + b_3 \cdot t_{sur}^{b.e} + b_4 \cdot [C] + b_{11} \cdot \Delta T_{oh}^2 + b_{22} \cdot V_c^2 + b_{44} \cdot [C]^2 \ . \qquad (2)$$

For realization of correct search of global extremum at multicriterion optimization it is necessary to execute the so-called operation of normalization. There are used the method of standardization of functional, foreseeing them re-calculation with the purpose of receipt of Gausses probabilistic distribution.

As among metallurgists objective information absents on joint gravimetric influence of stretching, squeezing tensions and degree of liquation on official descriptions of continuous cast purveyance it is used the formal method of determination of gravimetric coefficients.

Explanation of physical pattern of conduct the sought-for functional consists in its interdependence. Especially it behaves to dependence of tensions from chemical composition of metal, changing both in the process of crystallization and in the volume of purveyance. It, in turn, causes irregular motion of crystallization, which is accompanied by a sharp acceleration or, inside out, stop of moving of crystallization front. On occasion takes place even submitting of already crystallized local area. And such processes depend very difficult on the investigated parameters. So, decrease of concentration of admixtures in some local area of purveyance, caused by the stop of moving of crystallization front, results in a decline temperature of crystallization alloy, and, means, to primary consolidation of this area. If such area will be between isosolidus and isoliquidus after a layer with enhanceable content of admixtures (it has a subzero temperature liquidus, and, consequently, relatively long is in the liquid state), the feed of this area from a liquid phase will cease. An area with large maintenance of segregates and subzero strength properties with enhanceable probability of appearance of cracks is appears.

Confessedly, that hot cracks arise up near-by a two-phase zone. Our mathematical model allows to define time of origin of credible cracks and their place of location in the volume of purveyance on the basis of knowledge of law for moving of border «solidus» ($D_{sol}$, mm) and «liquidus» ($D_{liq}$, mm):

$$D_{sol} = 113.6344\text{-}112.461[\mathrm{C}] + 198.499[C]^2 - 31.979V_c + 3.812V_c^2 + 12.470X - $$
$$-1.037X^2 - 0.789\Delta T_{oh} + 0.006\Delta T_{oh}^2 - 0.046t_{sur}^{b.e} + 1.798H - 0.373H^2, \ R = 0{,}94 \ ; \qquad (3)$$

$$D_{liq} = 114.224\text{-}40.858\,[\mathrm{C}] + 121.790[C]^2 - 14.347V_c + 1.369V_c^2 + 17.700X -$$
$$-1.037X^2 - 0.617\Delta T_{oh} + 0.004\Delta T_{oh}^2 - 0.128\,t_{sur}^{b.e} + 1.008H - 0.821H^2,\ R = 0{,}95\ , \qquad (4)$$

where $H$ is a thickness of purveyance, m; $X$ is a distance of calculation section from a meniscus threw on the technological axis of CC machine, m; R is a coefficient of plural correlation.

By analogically it is possible to expect the optimal temperature-speed regimes for other CC machine with possibility of prognostication of high-quality descriptions of metal production.

*Conclusions.* With the use of numeral modeling of the thermal, concentration and tense state of continuous cast of steel profiled purveyance got quantitative intercommunication between optimal distribution for closeness of thermal stream, taken away in the process of crystallization, on a perimeter and length of purveyances at dependence on the conditions of casting, and also analytical dependences, allowing to forecast the macrostructure of continuous cast profiled purveyances.

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