Parametric Study of Continuously Cast Steel Billet 150 × 150 mm

Parametrická studie plynule litého ocelového sochoru 150 × 150 mm

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An application of the numerical model for computer simulations of the temperature field of continuously cast billet requires systematic experimentation and measurement of operational parameters on a real caster as well as in the laboratory. The measurement results, especially temperatures, serve not only for the verification of the exactness of the model, but mainly for optimization of the process procedure: real process → input data → numerical analysis → optimization → correction of real process. The most important part of the investigation is the measurement of temperatures in walls of the mould and surface temperatures of the billet in the zones of secondary and tertiary cooling. It is necessary to process the data before it is used, i.e. it is necessary to find a suitable method of filtering. The off-line model of the temperature distribution allows for comprehensive parametric studies into the influence of chemical composition, casting speed, temperature of overheating and cooling conditions in the secondary cooling on the temperature distribution of the cast billet.

***Key words**: model tuning; temperature field; experimental measurement; parametric study; chemical composition; secondary cooling; casting speed; steel overheating; metallurgical length*

Aplikace numerického modelu teplotního pole kontinuálně litého sochoru vyžaduje systematický experimentální výzkum a měření provozních parametrů na reálném ZPO i v laboratoři. Výsledky měření, především teplot, slouží nejen k ověření přesnosti modelu, ale především k zajištění provázanosti těchto kroků: reálný proces → získaní vstupních dat → provedení numerické analýzy → optimalizace technologických parametrů → korekce reálného procesu. Stěžejní je měření teplot ve stěně trubkového krystalizátoru pomocí termočlánků a na povrchu sochoru v zóně sekundárního a terciárního chlazení pomocí pyrometrů. Při ověřování a upřesňování modelu bylo vhodné provést experimentální měření povrchových teplot sochoru těsně pod krystalizátorem. Trvalé měření teplot pomocí tří pyrometrů se ukázalo jako nutné ve dvou zónách sekundárního chlazení a na výběhu za tažně-rovnací stolicí. Off-line model teplotního pole umožňuje provedení i rozsáhlých parametrických studií vlivu chemického složení oceli, licí rychlosti, rychlosti přehřátí a sekundárního chlazení na výsledné teplotní pole sochoru. Výsledky studií slouží k ověření správnosti numerického modelu, k ověření používaných empirických vztahů, k nastavení technologických předpisů pro dané sochorové ZPO i při přípravě komplexní optimalizace výroby. Ke srovnání vlivu různých vstupních parametrů je nejvhodnější zvolit grafické vyhodnocení metalurgické délky, maximální délky tekuté fáze, nárůst ztuhlé licí kůry, teploty povrchu sochoru v místě rovnání a teploty jeho povrchu těsně před výstupem z klece ZPO. Je připojena úvodní studie vlivu elektromagnetického míchání na teplotní pole sochoru. Ukazuje se, že vliv míchání je při použité hustotě výpočtové sítě zanedbatelný.

***Klíčová slova**: ladění modelu; teplotní pole; experimentální měření; parametrická studie; chemické složení; sekundární chlazení; rychlost lití; přehřátí oceli; metalurgická délka*

1. Model tuning and its verification

The research of thermo-kinetics of solidification and cooling of continuously cast billets requires a systematic experimental research on a real continuous casting machine (CCM). Its results were used not only for tuning of the numerical model of the temperature field but also for its verification. Long-term experimental measurement provided a continuous correction of numerical analysis of the real process. Experimental investigation in the steelworks would be very costly and they would be complicated from the organization point of view because it is not allowed to endanger or to influence the production. For tuning of the model, it was therefore necessary to use quantities that were already measured by the existing CCM control system.

The usually measured quantities are the steel temperature in the tundish, the water flow through the mould including its temperature and the billet surface temperature measured by pyrometers at different places. For tuning of the model and for verification of the submodel for the mould temperature field it was advisable to perform experimental measurement of surface temperatures just below the mould.

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1.1 Experimental measurement for model verification

On the basis of the analysis and spatial possibilities of the CCM2 in the steelworks Třinecké železárny [1] and with regard to the possibility of placing the measuring device in the process plant, the following measuring points were chosen (Fig. 1):

a) measuring point No. 1 – 3 (under the mould – zone II.A), Fig. 2
b) measuring point No. 4 (zone III.A), Fig. 3
c) measuring point No. 5 (at the outlet, behind the drawing-straightening stand), Fig. 4

All the measuring points are on the billet eighth utmost strand as it is shown in Fig. 4. Dimensions in the diagrams of the measuring points or of the plane of the nozzles in the right part of Figs. 2 to 4 represent the distances from the lower edge of the mould.

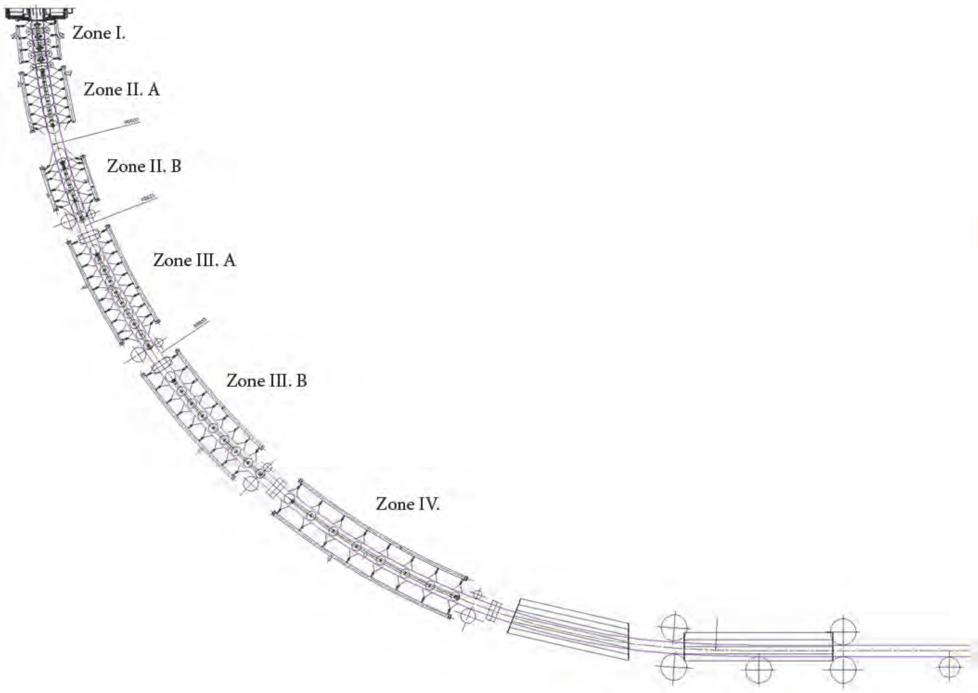

Fig. 1 Diagram of layout of the nozzles in the radial part of the caster and their assignment to the zones
Obr. 1 Schéma umístění trysek na oblouku stroje a jejich přiřazení do zón

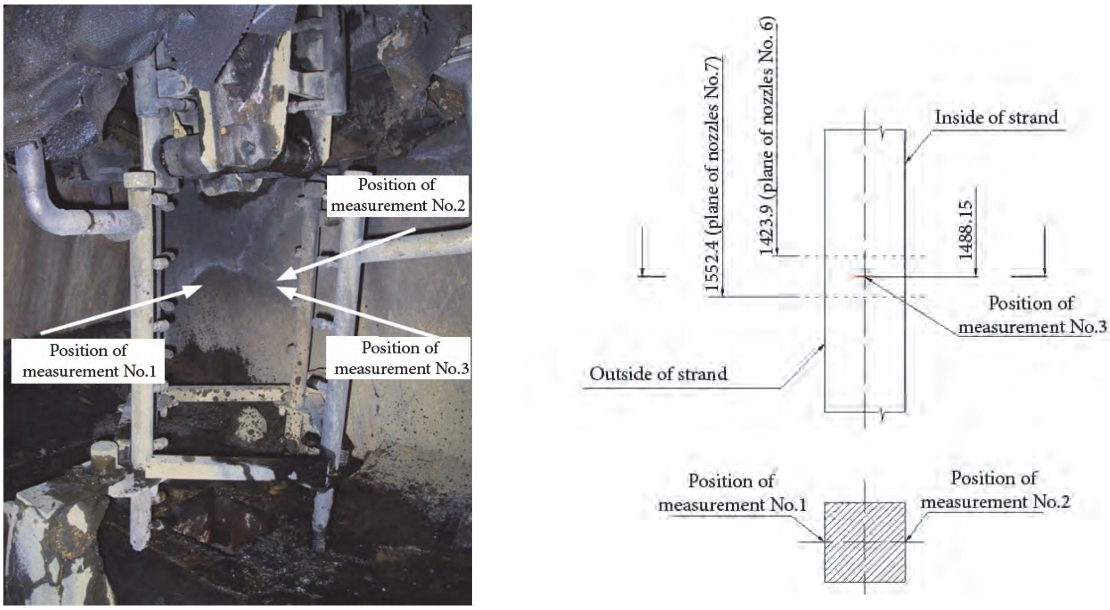

Fig. 2 Diagram of the layout of the pyrometers in the zone II. A (pyrometers Nos. 1 – 3)
Obr. 2 Schéma umístění pyrometrů v II. A zóně (pyrometr č. 1 – 3)

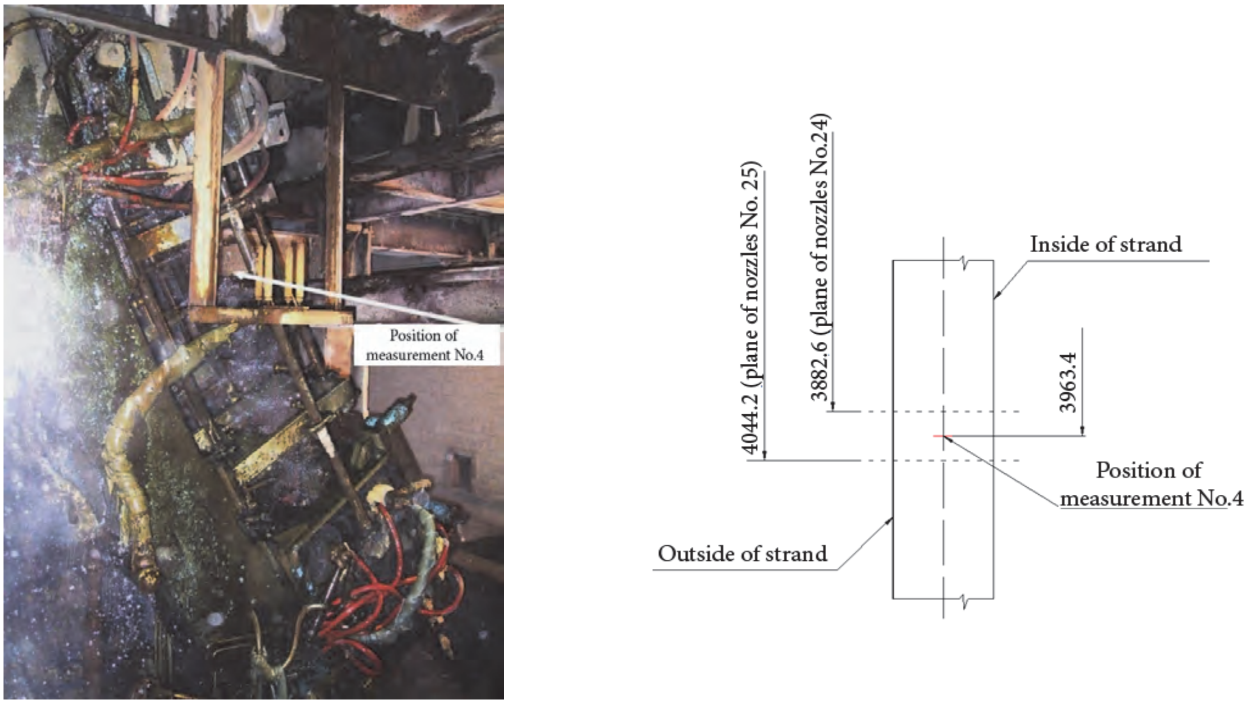

Fig. 3 Diagram of location of the pyrometers below the SEMS (pyrometer No. 4)
Obr. 3 Schéma umístění pyrometru za elektromagnetickým míchačem (pyrometr č. 4)

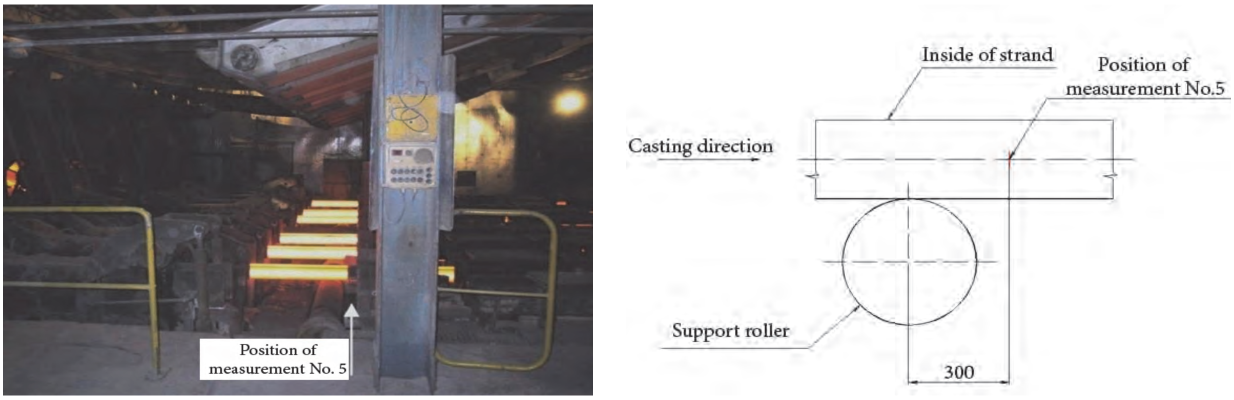

Fig. 4 Diagram of location of the pyrometer at the end of the caster (pyrometer No. 5)
Obr. 4 Schéma umístění pyrometru na výběhu (pyrometr č. 5)

The measured values were classified according to heats and other technological data were assigned to them such as: casting speed, water flow rate, etc. (Fig. 5). It was necessary to use the filtration of the measured pyrometers [2, 3]. During processing of measurement results, the filtration with the use of recursive median filter proved to be the most appropriate. The diagram in Fig. 6 shows the evolution of the measured data from pyrometers filtered by the median recursive filter with the filter order *r* = *5*.

$$y_i = median\,\{y_{i-r}, \ldots y_{i-1}, x_i, , x_{i+1}, \ldots x_{i+r}\} \qquad (1)$$

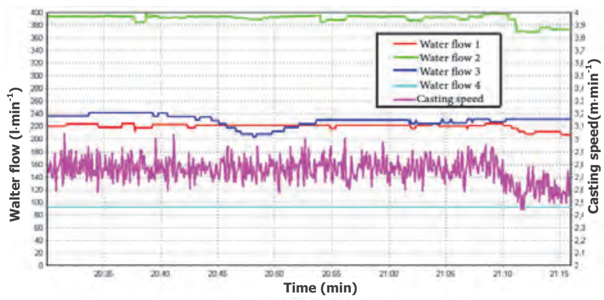

Fig. 5 Values of parameters from operational measurement for the heat of the steel grade TERMEX-1
Obr. 5 Hodnoty parametrů z provozního měření pro tavbu s ocelí značka TERMEX-1

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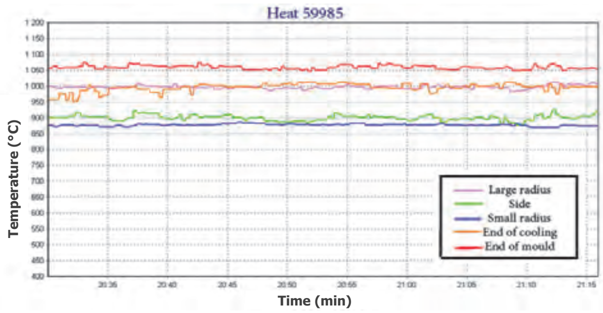


Fig. 6 Measured surface temperature for the heat of the steel grade TERMEX-1, processing by means of median recursive filter

Obr. 6 Měřené povrchové teploty pro tavbu oceli TERMEX-1, zpracování mediánovým rekurzivním filtrem

Temperature measurements showed a great asymmetry between the surface temperatures at small and big radiuses at the point of bending of the casting strand. As stated in the article [4], the CCM billet is symmetrical along the circumference of the profile. The measurements, however, show that functional symmetry is not reflected here. According to Fig. 6, the difference between surface temperatures in the first measurement point exceeds 200 °C. The main reason for this asymmetry is the varying intensity of heat removal from the small and big radiuses in the mould. The surface of the continuously cast blank has therefore a different surface temperature after leaving the mould. Due to the fact that effect of the Leidenfrost temperature [5] is applied, there will be more pronounced asymmetry of surface temperatures on the small and big radiuses. This problem could be solved with the use of other nozzles in zones I. and II. A, which would have different dependences of the heat transfer coefficient on the surface temperature.

1.2 Continuous measurement of surface temperatures

On the basis of the experience with measurements described in paragraph 1.1, three pyrometers were permanently installed on the CCM, including their integration into the operational information system. The results of the measured temperatures were continuously available for the CCM operator and they were simultaneously used as input parameters for the on-line model of the temperature field.

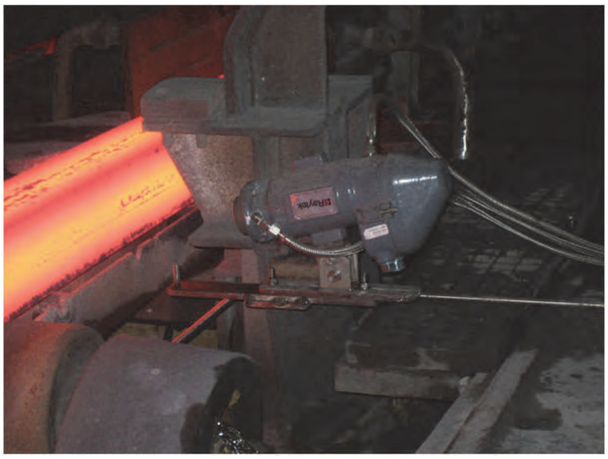
The following positions were chosen for the permanent installation of pyrometers on the CCM2 on the side wall of the utmost eighth strand:

- zone IIA, between the 4th and 5th nozzle from the top, i.e. 1.145 m below the mould lower edge (Fig. 1),
- zone IIIA, between the 4th and 5th nozzle from the top, i.e. 3.685 m below the mould lower edge,
- outlet (behind the drawing-straightening stand), i.e. 16.7 m below the mould lower edge.

Fig. 7, for example, presents photographs of installation of the pyrometers in real operation during casting, namely (a) in the zones III.A and b) in the outlet. Fig. 8 shows the position of those three pyrometers permanently installed on the CCM – they are marked with black dots.

a) Pyrometer in the zone III.A during the casting

a) Pyrometr v zóně III.A během lití



b) Pyrometer at the end of the caster during the casting

b) Pyrometr ve výběhu během lití

Fig. 7 Permanently installed pyrometers

Obr. 7 Fyzické zobrazení trvale umístěných pyrometrů

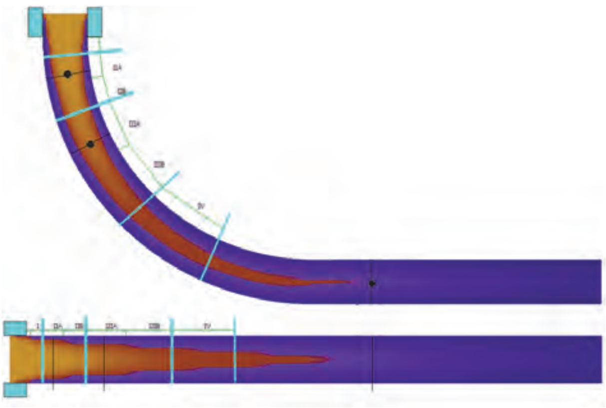


Fig. 8 Diagram of locations of the measuring pyrometers (black points)

Obr. 8 Schéma umístění měřicích míst pyrometrů (černé tečky)

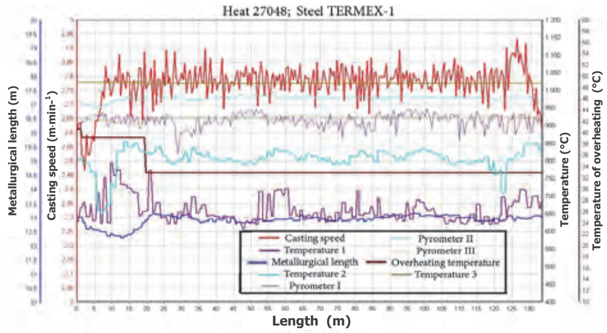


Fig. 9 Basic casting parameters and measured surface temperatures from the database of the model for the steel grade TERMEX-1

Obr. 9 Základní parametry lití a měřené povrchové teploty z databáze teplotního modelu pro ocel značky TERMEX-1

The majority 180 measured quantities on the billet CCM from the control levels I and II entered the software of the temperature model and was stored in the database. The user of the temperature model can select and plot from these measured and also calculated and stored quantities. Due to the very large number of these quantities, we strived to select the principal ones, which include more influences.

For this purpose, a diagram was created comprising the casting speed, temperature of superheating, metallurgical length and surface temperatures calculated by the model, and measured by the pyrometers at the same locations (Fig. 9). When comparing the measured temperatures with the calculated ones, the average temperature of the four points closest to the location of the pyrometer was considered as the calculated value.

It was also necessary to monitor the heat dissipated by the mould. It was possible to verify the correct function of the mould model by the average billet surface temperature along its entire circumference at the lower edge of the mould.

The water flows in the individual zones had to be correlated with the surface temperatures behind the respective zone at the point without the nozzles (Fig. 10). Five temperature values were recorded in the database at characteristic cross-sectional points that were identical with the points in the diagram of the temperature history in Fig. 16 in [4]. For display purposes, in one case we chose the average temperature of all five points, i.e. it included also the corners. In another case, we chose the average temperature from only three temperatures in the centre of the sides, since the effect of cooler corners might have overshadowed the impact of cooling by the nozzle.

In the secondary cooling circuits, it was desirable to monitor not only the flow but also the water pressure. Water flow and water pressure are functions of the nozzle constant *k* [4]. Therefore, Fig. 11 shows the change of this parameter as an example of the monitored magnitude, which could indicate the state of the nozzles in the cooling circuit.

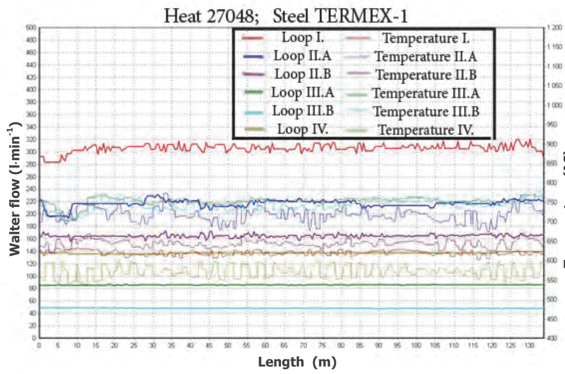


Fig. 10 Water flow rates in the secondary cooling circuits and calculated temperatures behind the zones from the database of the temperature model for the steel grade TERMEX-1

Obr. 10 Průtoky vody v okruzích sekundárního chlazení a vypočtené teploty za zónami z databáze teplotního modelu pro ocel značky TERMEX-1

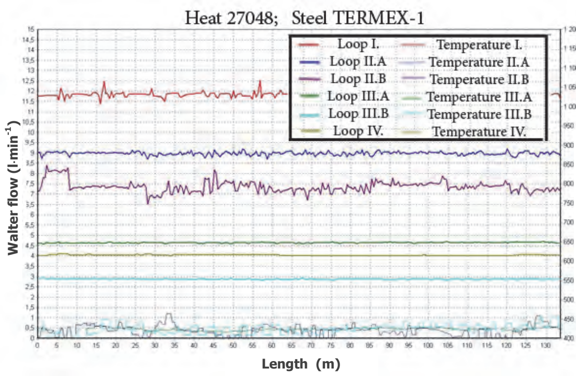


Fig. 11 Evolution of the nozzle constant and calculated temperatures behind zones from the database of the model for the steel grade TERMEX-1

Obr. 11 Průběh změny konstanty trysky a vypočtených teplot za zónami z databáze teplotního modelu pro ocel značky TERMEX-1

2. Parametric studies

Parametric studies of the influence of individual input technological parameters and properties on the resulting temperature field are the basic possibility of using the off-line version of the temperature field model. The scope of studies is made possible by parallelisation of

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the code, which allowed shortening of the calculation time. With the large number of calculations that were performed, the effect of the time step on the calculation stability was monitored and its adaptation was continuously tuned. The results of these parametric studies can be used for validation of the used empirical relations, for proposing the technological standard operating procedures (SOP) for the CCM, for a complex optimisation and for set-up of a dynamic model.

Due to the fact that the result of the calculation was a 3D temperature field, it was necessary to analyse the influence of input parameters to which it is possible to clearly define and compare the final output parameters or to choose a graphical comparison of the output parameter. The maximum metallurgical length, the maximum length of the liquid phase and the surface temperatures after the individual cooling zones were found to be the most suitable for such comparison. We present here only the results for steel grade TERMEX-1. The cooling of the mould was performed according to the technological standard operating procedures and the measured values, the inlet temperature of cooling water was always considered to be 20 °C, as well as the ambient temperature (air) 20 °C.

2.1 Study of influence of chemical composition on the temperature field

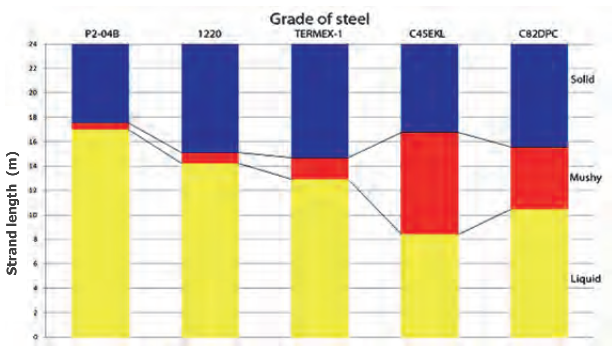
The basic recommended composition of steel for the casting of billets is given in tab. 1. The table lists one or two characteristic steels for each of the four groups. The list is supplemented with the liquidus and solidus temperature.

Tab 1 Sorting of steel grades into groups and subgroups according to their chemical composition
Tab. 1 Rozdělení ocelí do skupin a podskupin podle chemického složení

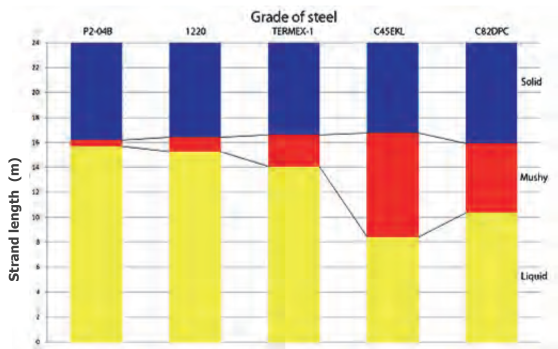
Group	Family	Steel grade	T_{LIK}	T_{SOL}	C	Mn	Si	P	S	Cu	Cr	Ni	V	Ti
			(°C)		(Mass ratio %)									
1	C15	P2-04B	1531	1489	0.020	0.300	0.040	0.010	0.010	0.065	0.050	0.040	0.000	0.000
2	B20	1220	1523	1477	0.100	1.025	0.075	0.010	0.010	0.060	0.075	0.075	0.015	0.000
3	A31	TERMEX-1	1515	1457	0.180	0.725	0.200	0.020	0.020	0.200	0.075	0.075	0.000	0.000
	D50	C45EKL	1491	1402	0.460	0.650	0.300	0.015	0.015	0.100	0.200	0.200	0.000	0.000
4	B73	C82DPC	1466	1342	0.840	0.700	0.200	0.008	0.007	0.125	0.085	0.100	0.000	0.000

The previous article [4] discussed the thermo-physical properties of the five selected steels from table 1 with significantly different chemical composition. To make the effect of the chemical composition of steel, especially of a different carbon content, on the temperature field of the billet more evident, the other casting parameters were chosen equally, i.e. the casting speed of 2.8 m·min^{-1} and the temperature of overheating of 30 °C.

Fig. 12 compares the length of the liquid phase determined by the numerical model with the metallurgical length of the steel billet from the table 1 if the following is used at CCM2: a) cooling according to the applicable technological standard operating procedure for each steel and b) identical cooling for all steel grades.



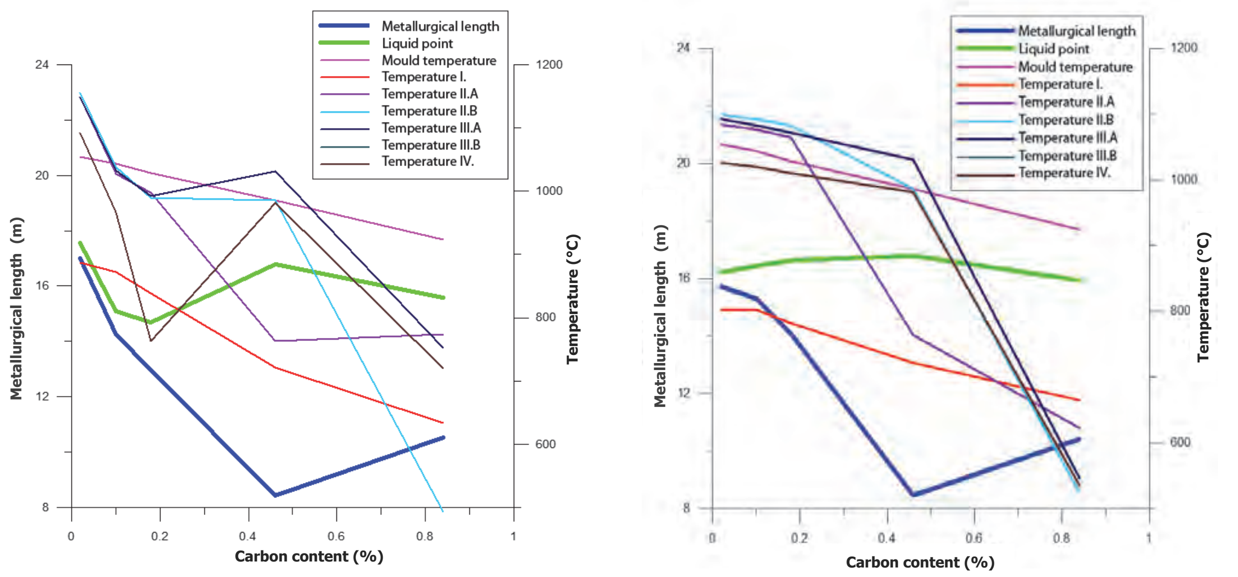
a) cooling process according to the technological specification
a) chlazení dle technologického předpisu



b) identical cooling
b) stejné chlazení

Fig. 12 Comparison of the length of the liquid phase and the metallurgical length for various steel grades
Obr. 12 Porovnání délky tekuté fáze a metalurgické délky pro různé značky oceli

Fig. 13 illustrates the effect of carbon content of steels from table 1 on the metallurgical length: a) at cooling according to the technological standard operating procedure, b) at identical cooling. In practice, a different cooling mode or different cooling curve is selected for each group of steels according to the currently used technological standard operating procedure. The purpose of this comparison was to find out whether the cooling curves used for an individual group of steels are optimal.



a) cooling process according to the technological specification
a) chlazení dle technologického předpisu

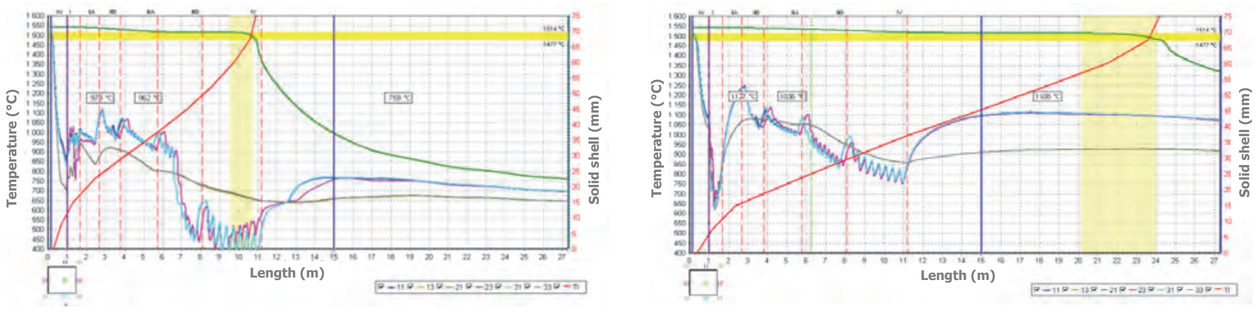
b) identical cooling
b) stejné chlazení

Fig. 13 Influence of the chemical composition on final parameters
Fig. 13 Vliv chemického složení na výsledné parametry

2.2 Influence of the casting speed and superheating of steel

The casting speed is one of the basic technological parameters of continuous casting. For the steel grade TERMEX-1 presented here, the operating speed range between 2.00 and 4.00 m·min^{-1} was considered. The water flow through the secondary cooling was increased linearly with the casting speed according to the technological standard operating procedure. The other input parameters, especially the overheating of 30 °C, were again left constant. It is not necessary to investigate the effect of higher casting speed because the metallurgical length would exceed the length of the CCM. On the other hand, lower casting speeds are used only for a short time, e.g. in the event of a risk of breakout.

For comparison, in Fig. 14 we chose the temperature history of the same cross-sectional points along the length of the CCM in combination with a diagram of the growth of the solidified strand shell for the lowest and highest casting speed of 2.00 and 4.00 m·min^{-1}, respectively.



a) 2.0 m·min^{-1}

b) 4.0 m·min^{-1}

Fig.14 Temperature history of selected points in the billet cross- section during its passage through the caster and growth of the strand shell for two casting speeds
Obr. 14 Teplotní historie zvolených bodů příčného řezu sochorem při jeho průchodu ZPO a nárůst licí kůry pro dvě rychlosti lití

From the diagrams in Fig. 14 and from the summary diagram in Fig. 15, an approximate linear dependence of the metallurgical length and of the length of the liquid phase on the casting speed is evident. The break occurs at the speed of 3.5 m·min^{-1} when the secondary cooling was already insufficient. The speed in the range from 3 to 3.5 m·min^{-1} appeared to be optimal at the adjusted secondary cooling. The speed used in the range of 2.8 to 3 m·min^{-1} was unnecessarily low.

The casting temperature must always be higher than the liquidus temperature to ensure, with a sufficient reserve, a transport of the liquid steel from the tundish through the casting nozzle to the CCM so that pouring of the melt from the tundish through a submerged entry nozzle

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is perfectly secured. From the operational point of view, it was, therefore, desirable that the casting speed with the decreasing overheating temperature would increase. Fig. 16 shows how the overheating above the liquidus temperature affected the metallurgical length. With a decreasing overheating temperature, the metallurgical length is shortened, allowing for a higher casting speed. This finding was consistent with the need to ensure timely a pouring of the tundish. The calculations showed that the influence of overheating on the surface temperatures of the billet was much smaller than that of the slab CCM on the surface temperature of the slab [5]. It was necessary to make this parametric study for steels from all four groups because, for example, the influence of superheating on steels with a wide solidification interval may be different.

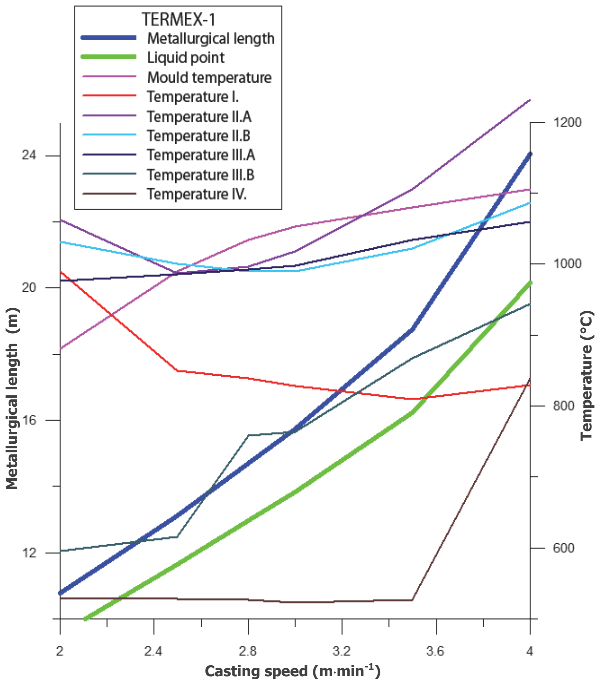


Fig. 15 Influence of the casting speed on selected parameters; steel grade TERMEX-1, temperature of overheating 30 °C

Obr. 15 Vliv licí rychlosti na vybrané parametry, ocel TERMEX-1, přehřátí 30 °C

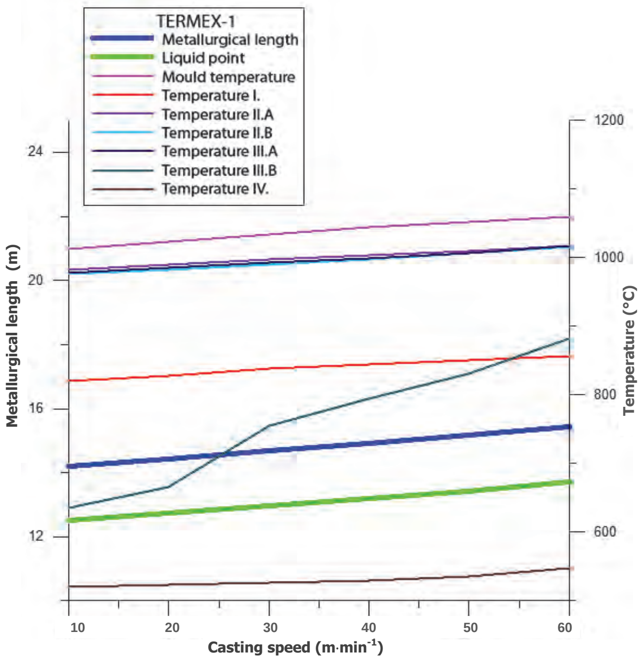


Fig. 16 Influence of the temperature of overheating, the steel grade TERMEX-1, the casting speed 2.8 m·min^{-1}

Obr. 16 Vliv teploty přehřátí, ocel TERMEX-1, rychlost 2,8 m·min^{-1}

2.3 Influence of secondary cooling

Setting the secondary cooling and its optimisation is a complex problem. The paper, therefore, studies only the effect of the secondary cooling on the temperature field for casting of the steel grade TERMEX-1 at the casting speed of 2.8 m·min^{-1} and overheating of 30 °C.

The real operation uses the so-called cooling curves, for example, according to Fig. 17. The diagrams describe the dependence of the required flow rates (l·min^{-1}) on the desired casting speed (m·min^{-1}), each for a certain cooling intensity characterised by consumption of cooling water per 1 kg of the cast steel. These cooling curves were compiled for the particular CCM2 for the cooling zones I to IV (Fig. 1). The point is that in real operation, only four cooling zones were for simplicity set (regulated): I, II, III and IV. The water distribution between the zones II.A and II.B and between the zones III.A and III.B [6] was fixed and could not be changed during casting.

A comparison of the different characteristics of the calculated billet temperature for different cooling curves of 7 l·kg^{-1} and of 20 l·kg^{-1} is shown in Fig. 18.

From the resultant temperature fields for individual cooling curves, a summary diagram in Fig. 19 was compiled in the range of the values from 7 to 20 l·kg^{-1}. This basic set of graphical dependencies served the user for an assessment which of the cooling curves was optimal for the cast steel. The cooling curves were ordered according to the amount of water in all zones.

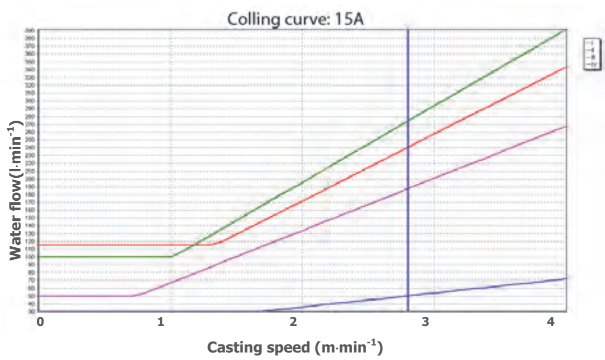
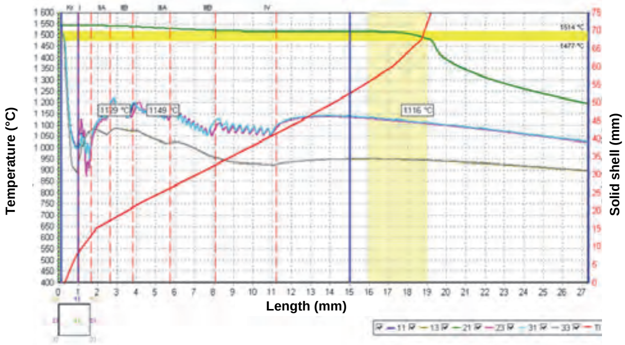
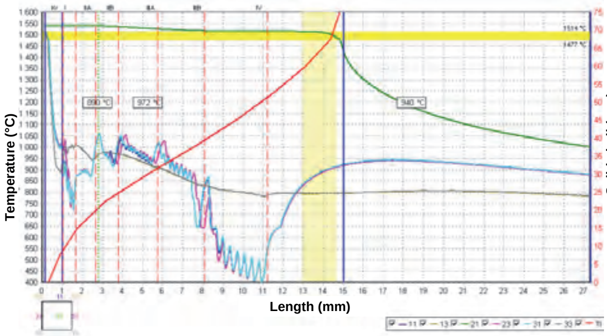


Fig. 17 Example of the cooling curves 15 l·kg^{-1}

Obr. 17 Příklad chladicích křivek 15 l·kg^{-1}



a) The cooling curve of 9 l·kg^{-1}
a) Chladicí křivka 9 l·kg^{-1}



b) The cooling curve of 20 l·kg^{-1}
b) Chladicí křivka 20 l·kg^{-1}

Fig. 18 Temperature history of selected points of the billet cross section during its passage through the caster and growth of the strand shell for two cooling curves

Obr. 18 Teplotní historie zvolených bodů příčného řezu sochorem při jeho průchodu ZPO a nárůst licí kůry pro dvě chladicí křivky

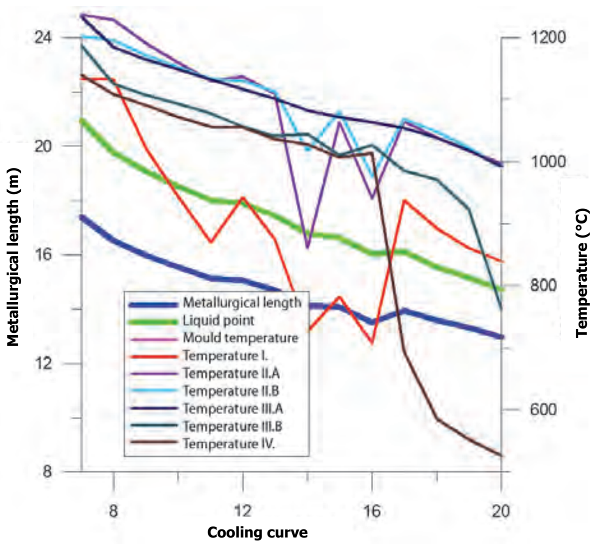


Fig. 19 Evolution of selected calculated parameters in dependence on the cooling curve

Obr. 19 Průběh vybraných vypočtených parametrů v závislosti na chladicí křivce

3. Electro-magnetic stirring

The CCM for casting of steel billets uses rotary stators of electro-magnetic stirring systems (Fig. 20). The velocity of movement of the molten steel, which is caused by electro-magnetic stirring, ranges from 0.1 to 1.0 m·s^{-1}. Electro-magnetic stirring applied to the CCM is inherently a very complex magneto-hydraulic process, moreover combined with the processes of crystallisation and solidification of the continuously cast steel. The complexity of the whole steel casting process is further amplified by the fact that a large range of casting temperatures is used from a high casting temperature to a temperature well below the solidus temperature after passing through the entire CCM. From the material and physico-chemical points of view, the evolution of the process is co-determined by a wide spectre of material and thermo-kinetic characteristics of the continuously cast steel, electrical and magnetic quantities that apply to the given steel composition. Also, evolution of the process of casting is influenced by a wide spectre of parameters of the CCM design and functional parameters, parameters of the CCM, construction and working parameters of electromagnetic stirring, as well as the parameters of their mutual arrangement and synchronization. Previous papers [7 to 10] show that the exact mathematical modelling of electromagnetic mixing in the CCM is still very difficult to solve. In principle, however, the possibility exists using the theory of physical similarity [1, 11, 12] of qualitative to semi-quantitative assessment of the mutual causality of material, thermo-kinetic, electro-magnetic and hydraulic quantities, including their interaction between the liquid and solid phases. The presented and discussed model of the temperature field presented in the paper and its use for optimising the casting parameters, particularly the casting speed and secondary cooling, works with a relatively rough computational mesh so that calculations can run in real time. Therefore, it is not possible to model the flow of liquid steel caused by electro-magnetic stirring in the mould. In order to encompass the influence of electro-magnetic stirring on the formation of the temperature field, we chose the following procedure. From the business data of the company CONCAST [13] that supplied the CCM, we obtained a diagram of the maximum flow speed along the mould height for two different excitation currents (50 and 200 A) for the electro-magnetic stirrer according to Fig. 20.

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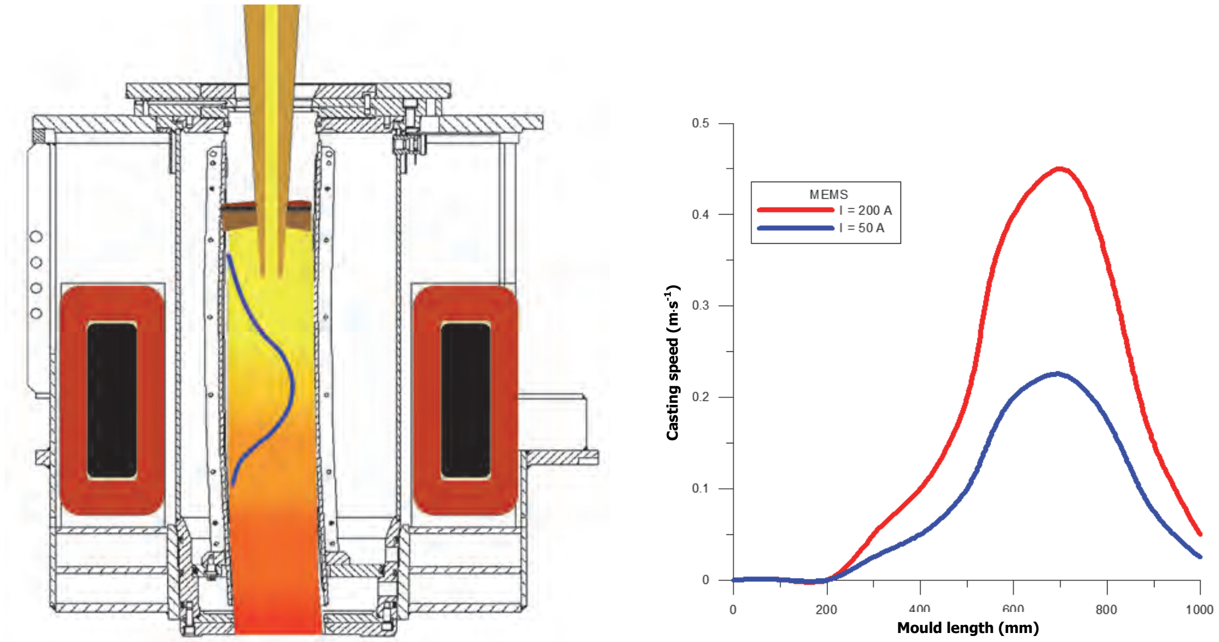
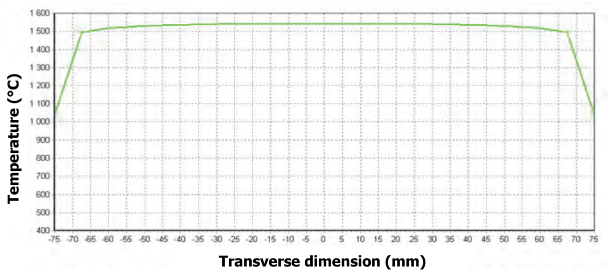


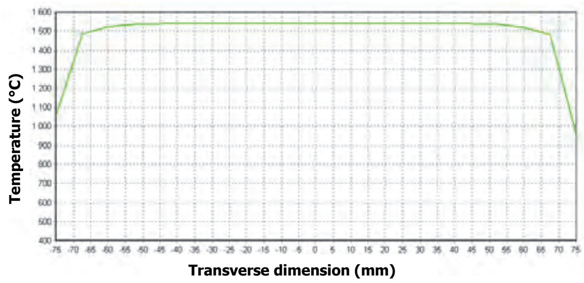
Fig. 20 Diagram of the mould with location of the electro-magnetic stirrer and its parameters
Obr. 20 Schéma krystalizátoru včetně umístění elektromagnetického míchače a jeho parametrů

In the resultant algorithm implemented into the temperature field model, the curves of casting speeds in dependence on the mould height (Fig. 20) were stored in the database, and for other values of the excitation current the maximum speed values were interpolated or extrapolated. From obtained maximum tangential speed, the components of speed w_x and w_y were calculated for each mesh elements having all nodes of the network above the liquidus temperature. Then the Fourier-Kirchhoff equation with all three components of the speed rychlosti w_x, w_y and w_z was solved [5].

Fig. 21 shows a comparison of the temperature profile in the axial section at the depth of 600 mm below the top edge of the mould with switched-off stirring (current 0 A) and with switched-on stirring (200 A). It can be seen from the figures that the influence of stirring on the temperature field calculated on this mesh is negligible and that the greatest difference is caused by the equalisation of the heat flow dissipated through the mould wall of the small and big radiuses.



a) The current of 0 A
a) Proud 0 A



b) The current of 200 A
b) Proud 200 A

Fig. 21 Comparison of the temperature field for various values of the electric current for the stirrer at a distance of 600 mm under the mould upper edge
Obr. 21 Porovnání teplotního pole pro různé proudy míchače ve vzdálenosti 600 mm pod horní hranou krystalizátoru

Conclusions

Research of thermo-kinetics of solidification and cooling of continuously cast billets requires a systematic experimental measurement on a real CCM. Its results will be used not only for tuning of the numerical model of the temperature field but also for assessment of the accuracy of this model. Experimental measurement also provides a continuous correction of the real process based on its numerical analysis. The main measured variables are the temperatures in the mould walls, the surface temperature of the continuously cast blank at the outlet from the mould, in the cooling zones of the secondary cooling and at the casting strand outlet. The off-line version of the model of the temperature field allowed to assess the influence of the chemical composition of the steel, in particular of the carbon content, the casting speed, the superheating of the steel and the influence of the secondary cooling on the resulting temperature field. For comparison, the value of metallurgical length, of the growth of the solidified shell, and the temperature history of characteristic cross-sectional points during its passage through the entire CCM were chosen.

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Průmysl: ocel není v Bruselu dostatečně hodnocena

Westdeutsche Allgemeine *17.03.2017*

Přínos oceli k odvětví recyklace není EU dostatečně hodnocena, kritizuje Hospodářské sdružení Ocel (WV Stahl) čtyři směrnice, projednávané Evropským parlamentem. Prezident WV Stahl Hans Jürgen Kerkhoff říká: „Měly by být vytvořeny stimuly pro odvětví recyklace a neměly by být vytvářeny nové překážky různými seznamy opatření s návrhy nových daní a dávek". Ocel může být recyklována stále dokola a je tak parádním příkladem pro funkční recyklační hospodářství. Jako velice neuspokojivou kritizuje WV Stahl také skutečnost, že má být členským státům znovu přidán navíc čas k dosažení zadaných předloh, jakož i časový prostor pro stanovení určitých kritérií. „Nepotřebujeme Evropu dvou rychlostí v ekologické politice, tím se odvětví recyklace v EU nepomůže," kritizuje prezident odvětvového svazu.

Oceláři na východě dostanou od dubna víc peněz

unternehmen-heute.de *21.03.2017*

Po ocelářích na severozápadě dostane přidáno i 8000 zaměstnanců ocelářského odvětví i ve východním Německu. Zaměstnavatelé a IG Metall se shodli na tom, že zaměstnanci dostanou od dubna přidáno o 2,3 %. Od května 2018 pak o dalších 1,7 %. Dohoda tarifních partnerů pro východní Německo převzala všechny podstatné části dohody, která byla podepsána minulý týden pro 72 000 zaměstnanců na severozápadě Německa.