

Раздел 2. «Машиностроение, технологические машины и транспорт, строительство»

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Method for determining the actual duration of heating slabs in continuous furnaces using the Excel program

The duration of slab heating in the continuous furnace is one of the key parameters of the thermal preparation of billets before processing in hot rolling mills. The duration of heating is less than optimal, taking into account the thickness of the slab, the type of fit, the temperature mode of heating and the design of the furnace, will lead to a low enthalpy of the slab at the discharge, uneven heating of the slab, and, as a result, to the breakdown of rolling equipment and a decrease in the quality of finished products. Prolonged oversitting of the metal leads to increased scale, irrational fuel consumption and the appearance of defects on the rolled products. Determining the actual duration of heating at a number of mills is complicated by the lack of modern tracking systems and reliable information on the settling time of each particular slab. This work is devoted to the development of a method for determining the actual duration of slab stay (heating) in continuous furnaces in the absence of information about the actual time of planting. A method for determining the actual duration of heating slabs in a pusher-type method furnace of the sheet rolling shop is considered. To use this method, the following data are required: the width of the slabs, the time of exit from the method furnace, the exact dimensions of the continuous furnace. The width of the slabs can be obtained from the database, as well as the time of dispensing from the continuous furnace. The exact dimensions of the method furnace are on the drawing of the unit. Usually, in such databases, information on several furnaces is used at once, in this article we will consider the case of data on three methodical furnaces. Digitizing the process using Excel allows you to get the desired result more efficiently with the elimination of human error. For example, a database with 6000 rows of information is used.

Keywords: method furnace, methodology, heating duration, excel, semi-automation of the process, slab, formulas for excel, digitization, rolling production.

Introduction

Determining the heating time of slabs has several key aspects that affect the parameters of the processing process:

1. Quality of processing. The correct heating time ensures that the temperature is evenly distributed throughout the slab, which prevents internal stresses and defects such as cracks or deformations.
2. Physical properties of the material. The heating time affects the microstructure of the metal. Insufficient or excessive heat can alter mechanical properties such as strength characteristics, hardness, and ductility.
3. Energy efficiency. Optimizing the heating time helps to reduce energy costs. Prolonged heating leads to overconsumption of energy, and too short may require additional processing.
4. Performance. Knowing the heating time allows you to optimize production cycles, which improves the overall efficiency of the plant.
5. Reduced risk of defects. Heating time control helps to minimize the risk of defects in the final product.
6. Information. Knowing the exact time spent in the furnace contributes to obtaining information about all influencing factors. For example, what temperature affected the slab while in the furnace.

Thus, the correct determination of the heating time of slabs is critical to achieving high standards of quality and efficiency in rolling production [1].

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Methodology and materials

To calculate the heating time of a slab billet, first of all, it is necessary to determine the length of the furnaces. Having studied the drawing of the MF (Methodical Furnace) in the version with five heating zones, the scheme of the unit was drawn up (Fig. 1) and the data in Table 1 were obtained.

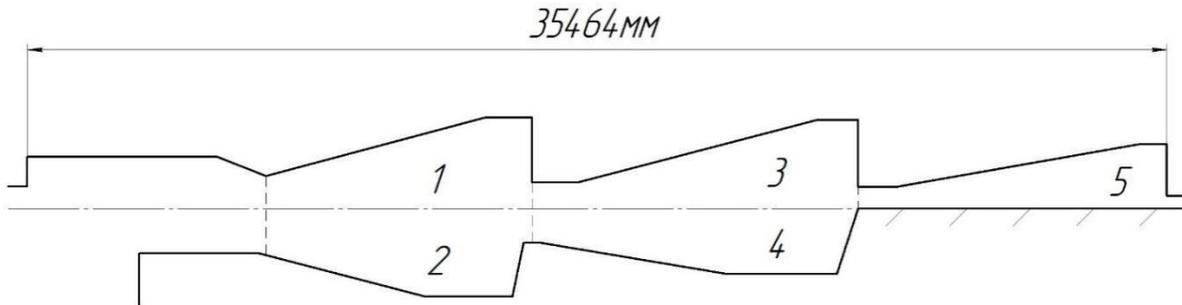


Figure 1– Profile diagram of the furnace working area (digits indicate zone numbers)

The data [2] confirmed that the lower part of the slab entering the continuous casting furnace corresponds to the large bending radius on the continuous casting machine (CCM), and the upper part corresponds to the small one.

Table 1

Furnace length parameters

№ Methodical Furnace	Furnace length, mm
1	35464
2	35464
3	35464

At the second stage, we receive information from databases. An example is presented in Table 2.

Table 2

Example of an information database (8 rows)

Line Number	Time of issuance	Heat	Party	Slab width, mm	Grade	VIEW_POSAD	Methodical Furnace
1	30.09.24 19:00	344281	20724	1190	20sp	H	3
2	30.09.24 19:01	344281	20724	1190	20sp	H	2
3	30.09.24 19:11	242171	20725	1190	3 sp	C	2
4	30.09.24 20:02	242171	20725	1190	3 sp	C	3
5	30.09.24 20:07	242171	20725	1190	3 sp	C	2
6	30.09.24 20:07	242171	20725	1190	3 sp	H	1
7	30.09.24 20:09	242171	20725	1190	3 sp	C	1
8	30.09.24 20:11	242171	20725	1190	3 sp	C	3

Note 1. Type of posad. H – denotes hot posad, C – cold posad. Usually, in case of hot planting, the heating time of the slab should be approximately 10% less than that for cold slurry.

Note 2. № Stoves. In the case of an example, this parameter is determined automatically based on the operation of the pushrod.

Now, from a large amount of data, it is necessary to make a "list". As can be seen from Table 2, it contains slabs heated in different furnaces. Therefore, at the next stage, it is necessary to form a list for each furnace. In a separate sheet, create what is displayed in Table 3, and create in the same way for the rest of the furnaces.

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Table 3

Formation of a list for the methodical furnace No1

MP-1		
Line Number	Checking the furnace number	Number in the «List»
-1		
-1		
-1		
-1		
-1		
6	1	1
7	1	2
-1		

For each column, the following is used:

1. Line number. In the same column, the formula (1), an example for the first row, is used. The «value -1» means that the line does not belong to the method furnace No1, and if it does, then the number is indicated.

$$= IF('Furnace Number'!$B2 = 1; 'Furnace Number'!$A2; -1) \tag{1}$$

2. Checking the furnace number. In the same column, formula (2) is used, an example for the first row. The value "-1" means that the line does not belong to the method furnace No1, and if it does, then the number 1 is indicated.

$$= IF(A2 <> -1; 1; "") \tag{2}$$

3. Number in the «List». In the same column, formula (3) is used, an example for the first row. Those lines that do not belong to the first furnace are left blank, and those that belong are assigned a number in order for calculations.

$$= IF(A2 <> -1; SUM(B2: B2); "") \tag{3}$$

After the formation of the «List», we proceed to calculations. For about the first 30 lines for each furnace, the data cannot be calculated, because the method is calculated according to the logic «slab output = planting of another slab». The total length of the furnace working area is 35464 mm, i.e. the slab fit into the furnace is determined by the moment of discharge of the previously issued slab that has passed this distance. In some cases, when one slab is delivered, two slabs can enter the continuous furnace at once, so it is necessary to make calculations separately for each case. Actually, this is the reason for using Excel, because it takes a lot of time to calculate all these rows every time. There is information that the maximum width of a slab is 1500 mm, so at least 23 slabs can be in the furnace at the same time. This can be determined from formula 4.

$$T = \frac{L}{S} \tag{4}$$

where, T is the minimum number of slabs in the furnace. The result must be rounded down, because when rounded up, the slab is already issued and is not in the furnace;

L is the length of the furnace working area, mm;

S is the maximum width of the slab, mm.

Results and discussion

A method has been developed for calculating the residence time of slabs in continuous furnaces based on real data. Based on the above formulas, it is possible to create a semi-automatic process, where a person will only need to enter the initial data:

1. Information from the database

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2. Characteristics of the length of the furnace working area

Table 4

Calculation for determining the time of entry into the continuous furnace (example of already obtained data)

Heat	Party	Furnace Number	Steel Grade	Temperature in Zone 1	Temperature in Zone 2	Temperature in Zone 3	Temperature in Zone 4	Temperature in Zone 5	Time of entry into the continuous furnace	Time of issuance	Heating Time, h:min
242240	20983	1	08кп	1195	1099	1285	1120	1165	04.10.2024 09:06	04.10.2024 12:00	02:54
242240	21001	1	08пс	1201	1104	1279	1111	1157	04.10.2024 09:16	04.10.2024 12:44	03:28
242240	21001	1	08пс	1201	1104	1279	1111	1157	04.10.2024 09:25	04.10.2024 12:49	03:24
242240	21001	3	08пс	1172	1011	1267	1137	1237	04.10.2024 08:39	04.10.2024 13:12	04:33
242240	21001	2	08пс	1233	1044	1292	1088	1235	04.10.2024 08:44	04.10.2024 13:17	04:33
242240	21001	1	08пс	1201	1104	1279	1111	1157	04.10.2024 09:37	04.10.2024 13:20	03:43
242240	21001	3	08пс	1172	1011	1267	1137	1237	04.10.2024 08:39	04.10.2024 13:23	04:44
344345	20984	2	08кп	1233	1044	1292	1088	1235	04.10.2024 08:48	04.10.2024 13:25	04:37
344345	20984	1	08кп	1201	1104	1279	1111	1157	04.10.2024 09:48	04.10.2024 13:28	03:40
344345	20984	3	08кп	1172	1011	1267	1137	1237	04.10.2024 08:48	04.10.2024 13:31	04:43
344345	20984	2	08кп	1233	1044	1292	1088	1235	04.10.2024 08:52	04.10.2024 13:33	04:41
344345	20984	1	08кп	1201	1104	1279	1111	1157	04.10.2024 09:48	04.10.2024 13:35	03:47
344345	20984	3	08кп	1172	1011	1267	1137	1237	04.10.2024 08:51	04.10.2024 13:38	04:47
344345	20984	2	08кп	1233	1044	1292	1088	1235	04.10.2024 08:58	04.10.2024 13:40	04:42
344345	20984	1	08кп	1201	1104	1279	1111	1157	04.10.2024 09:55	04.10.2024 13:41	03:46
344349	20985	2	08кп	1233	1044	1292	1088	1235	04.10.2024 08:58	04.10.2024 13:43	04:45
344349	20985	3	08кп	1172	1011	1267	1137	1237	04.10.2024 08:58	04.10.2024 13:43	04:45

As a result of the fact that the methodology has a digital format, it adds the ability to interact with other electronic databases. For example, this opens up the possibility of determining the exact temperatures affecting the slab, on the basis of which it is possible to analyze and determine a more accurate framework for the slab in each zone, taking into account temperatures. Table 4 provides an example of the final result when using this methodology.

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Excel бағдарламасын қолдана отырып, үздіксіз пештердегі шламдардың нақты қызу ұзақтығын анықтау әдісі

Өту пешіндегі шламдарды қыздыру ұзақтығы ыстық илемдеу диірмендерінде өңдеу алдында дайындамаларды термиялық дайындаудың негізгі параметрлерінің бірі болып табылады. Сабтың қалыңдығын, фитинг түрін, қыздыру температурасының режимін және пештің дизайнын ескере отырып, оңтайлы емес қыздыру ұзақтығы сабтың төмен

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энтальпиясына, слабтың біркелкі емес қызуына және нәтижесінде илемдеу жабдығының бұзылуына және дайын өнімнің сапасының төмендеуіне әкеледі. Металдың ұзақ уақыт шамадан тыс әсер етуі масштабтың жоғарылауына, отынның ұтымсыз тұтынылуына және кассада ақаулардың пайда болуына әкеледі. Бірқатар жерлерде жылытудың нақты ұзақтығын анықтау заманауи бақылау жүйелерінің болмауымен және әрбір нақты құйманың тұндыру уақыты туралы сенімді ақпараттың болмауымен қиындайды. Бұл жұмыс бетбелгінің нақты уақыты туралы ақпарат болмаған кезде үздіксіз пештерде болудың (қыздырудың) нақты ұзақтығын анықтау әдісін әзірлеуге арналған. Илектеу цехының итергіш түріндегі технологиялық пеште шламдарды қыздырудың нақты ұзақтығын анықтау әдісі қарастырылған. Бұл әдісті қолдану үшін келесі мәліметтер қажет: шұңқырлардың ені, технологиялық пештен шығу уақыты, пештің дәл өлшемдері. Мәліметтер базасынан плиталардың ені туралы, сондай-ақ оларды үздіксіз пештен беру уақыты туралы ақпарат алуға болады. Үздіксіз пештің нақты өлшемдері орнату сызбасында көрсетілген. Әдетте мұндай мәліметтер базасында бірден бірнеше пеш туралы ақпарат қолданылады, бұл мақалада біз үш әдістемелік пештің деректерімен жағдайды қарастырамыз. Excel көмегімен процесті цифрландыру адам қатесін қоспағанда, қажетті нәтижені тиімдірек алуға мүмкіндік береді. Мысалы, ақпараттың 6000 жолын қамтитын мәліметтер базасы қолданылады.

Түйінді сөздер: әдістемелік пеш, әдістеме, қыздыру ұзақтығы, excel, процесті жартылай автоматтандыру, слабтар, excel формулалары, цифрландыру, прокат өндірісі.

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Способ определения фактической продолжительности нагрева слябов в печах непрерывного действия с использованием программы Excel

Продолжительность нагрева слябов в проходной печи является одним из ключевых параметров термической подготовки заготовок перед обработкой на станах горячей прокатки. Продолжительность нагрева, меньшая оптимальной, учитывая толщину сляба, тип подгонки, температурный режим нагрева и конструкцию печи, приведет к низкой энтальпии сляба на выходе, неравномерному нагреву сляба и, как следствие, к поломке прокатного оборудования и снижению качества готовой продукции. Длительная передержка металла приводит к увеличению окалины, нерациональному расходу топлива и появлению дефектов на прокате. Определение фактической продолжительности нагрева на ряде станов осложняется отсутствием современных систем отслеживания и достоверной информации о времени отстоя каждого конкретного слитка. Данная работа посвящена разработке метода определения фактической продолжительности пребывания сляба (нагрева) в печах непрерывного действия при отсутствии информации о фактическом времени закладки. Рассмотрен способ определения фактической продолжительности нагрева слябов в технологической печи толкательного типа листопрокатного цеха. Для использования этого метода требуются следующие данные: ширина слябов, время выхода из технологической печи, точные размеры проходной печи. Из базы данных можно получить информацию о ширине плит, а также о времени их выдачи из печи непрерывного действия. Точные размеры печи непрерывного действия указаны на чертеже установки. Обычно в таких базах данных используется информация сразу о нескольких печах, в этой статье мы рассмотрим случай с данными о трех методических печах. Оцифровка процесса с помощью Excel позволяет более эффективно получать желаемый результат с исключением человеческой ошибки. Например, используется база данных, содержащая 6000 строк информации.

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Ключевые слова: методическая печь, методика, продолжительность нагрева, Excel, полуавтоматизация процесса, сляб, формулы для excel, оцифровка, прокатное производство.

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