UDC 621.746.047

Manufacturing Technology of Rollers with Bimetallic Bands for Continuous-Casting Machine

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The basic parameters of manufacturing centrifugal casting band rollers are developed. Tested on continuous-casting machine they showed their advantage in comparison with serial one-piece forged ones.

Keywords: STEEL, CENTRIFUGAL CASTING, ROLLER, BIMETALLIC BANDS, TECHNOLOGY

Introduction

One of the main tasks of restructuring the steel industry in Ukraine now is to increase the share of continuous steel casting and thanks to this a significant reduction of specific consumption per ton of metal ingots, while increasing the quality of workpiece [1]. One of the key issues for widespread adoption of continuous steel casting is to ensure continuous casting machines (CCM) with the tools - rollers. Currently forged rollers are used for CCM.

Steel alloys are used as materials for rollers. The most efficient and economical way of getting hollow cylindrical bimetallic billets is centrifugal casting. At the same time in domestic practice there is no data on the use of cast steel rollers, and therefore such studies are relevant, and the problem has practical importance.

The purpose of the study was to investigate and develop the basic parameters of manufacturing centrifugal casting band rollers.

Results and Discussion

Based on the experience of earlier studies [2, 3] steel with high resistance to thermal erosion and wearability of type H12MFL was selected for external layer of the working rolls, and for the inner layer - low-alloyed heat-resistant steel of type H1M1FL. Production of experimental-industrial lot of bimetallic billets for rollers with diameter 370 and 380 mm was carried out in the workshop of Nikopol Pivdennotrubny Works.

Taking into account the characteristics of the works technological scheme of manufacturing bimetallic billets was developed, comprising a complex of technologies: simultaneous smelting of bimetallic alloys; serial production, deoxidation and alloys dosing; consistent casting alloys into centrifugal casting machine; solidification of alloys and bimetallic billets controlled cooling; thermal processing and quality control.

Steelmaking of selected grades produced in electric arc furnace ДСП-5 with a basic lining. The cast preparation was carried out during the period from furnace plugging for the regular melting to its release. This included the calculation of the charge, the exact weighting of the charge components and loading them into the bucket, serviceability check of the cleanout tool and refilling furnace lining, delivery of refractory fettling, dosage and baking of the required ferroalloys and deoxidants, providing graphite electrodes and some other operations.

Steel was smelted in the fresh charge with the oxidation of iron ore impurities. The carbon content in the charge was 0.3-0.4% higher than its content in steel, what provides intensive bath boiling, and therefore the conditions for removal of phosphorus from the metal and oxygen were created. Steel smelting included periods of melting, oxidation, and finishing. The total duration of melting was 4-4.5 h.

First and second metal tappings were produced in quantities required for casting of one billet. First metal (Х12МФЛ) tapping temperature was 1620-1650 °C, second (Х1М1ФЛ) - 1630-1660 °C. During the process of tapping, after filling one-third of the ladle deoxidizers were added, then slag was skimmed off and weighted on floor scales with an accuracy of ± 10 kg.

Transportation of the first and second metals to the centrifugal cast machine was carried out with the help of high-speed electric travelling cranes.

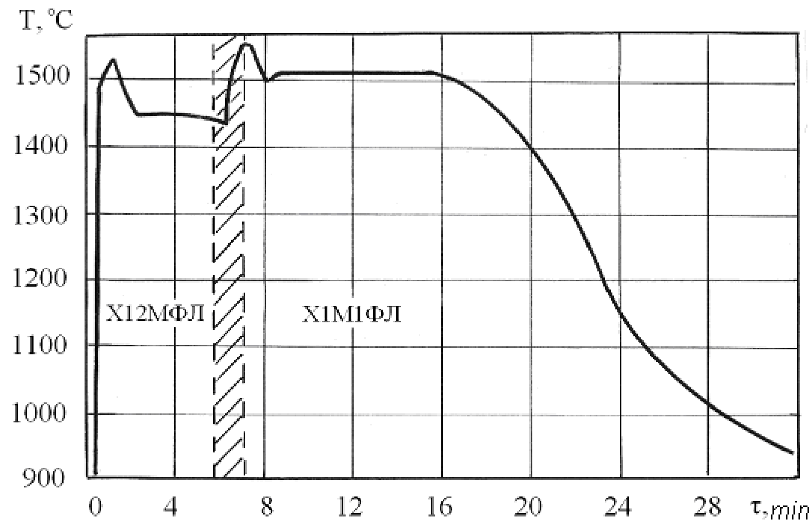

Figure 1. The temperature change of the free surface of the first and second alloy during the casting process of bimetallic billets

Casting of the first and the second metal into the mold of the centrifugal cast machine was produced in series. In the process of casting and solidification of the first and the second metal temperature measurements of free-surface forming workpiece were carried out. A typical curve line of temperature change of the free surface in the casting process of bimetallic billets size 405x330x250x3600 mm is shown in **Figure1**.

During the research four long bimetallic billets were cast. In order to reduce the cast intensity of the formation, the billet with free surface temperature of 900-1100°C was placed in a preheated well and cooled at a rate not exceeding 50 °/h. After processing the experimental data, including thermal and time parameters, a cyclogram of centrifugal casting of bimetallic billets size 405x330x250x3600 mm of alloys Х12МФЛ and Х1М1ФЛ was developed (**Figure 2**).

Bimetallic billets were removed from the well at a temperature of 550-600 ° C, visually assessed the quality and sent for heat treatment. The temperature of the furnace charging was 400-500°C.

During the heat treatment the measurement

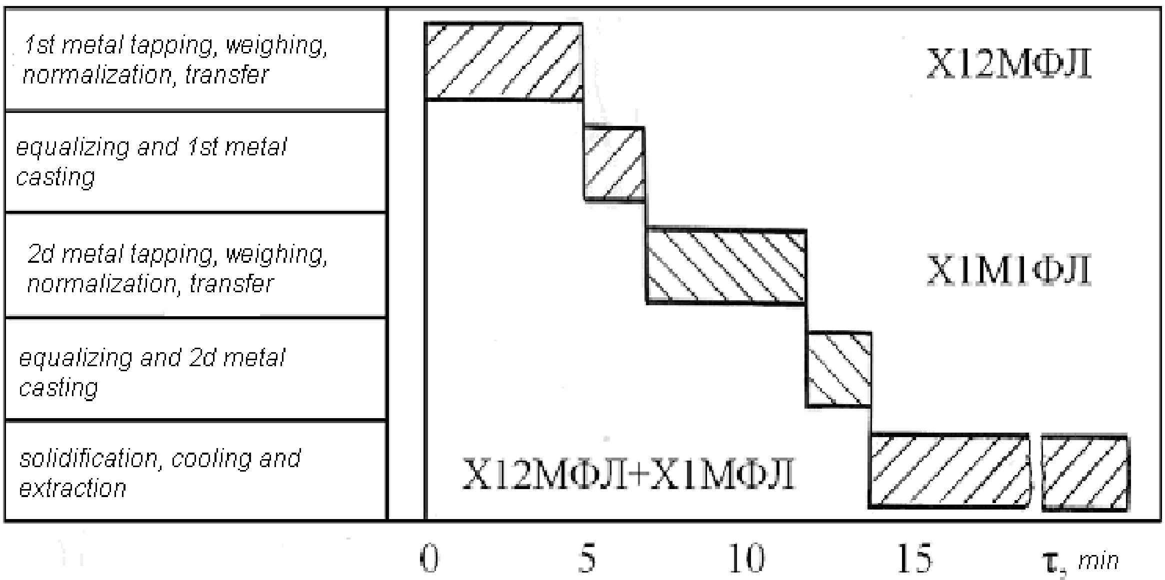

Figure 2. Cyclogram of centrifugal casting technology of bimetallic billets

the temperature of billets and space in the furnace was carried out. After leveling the temperature of bimetallic billets and space furnace heating was started at 30-50°/ h. Steady heating provided uniform temperature over the cross section of the billet. After heating to a temperature 1050°C equalizing was produced for 3-3.5 h and the billets were subjected to normalization, i.e. they were rolled out from the furnace, where they were cooled on smooth air to a temperature of 600°C for 2-2.5 h (**Figure 3a**). Then centrifugally cast billets were placed in the furnace for undergoing high-temperature drawing-back at 740°C for 3 h.

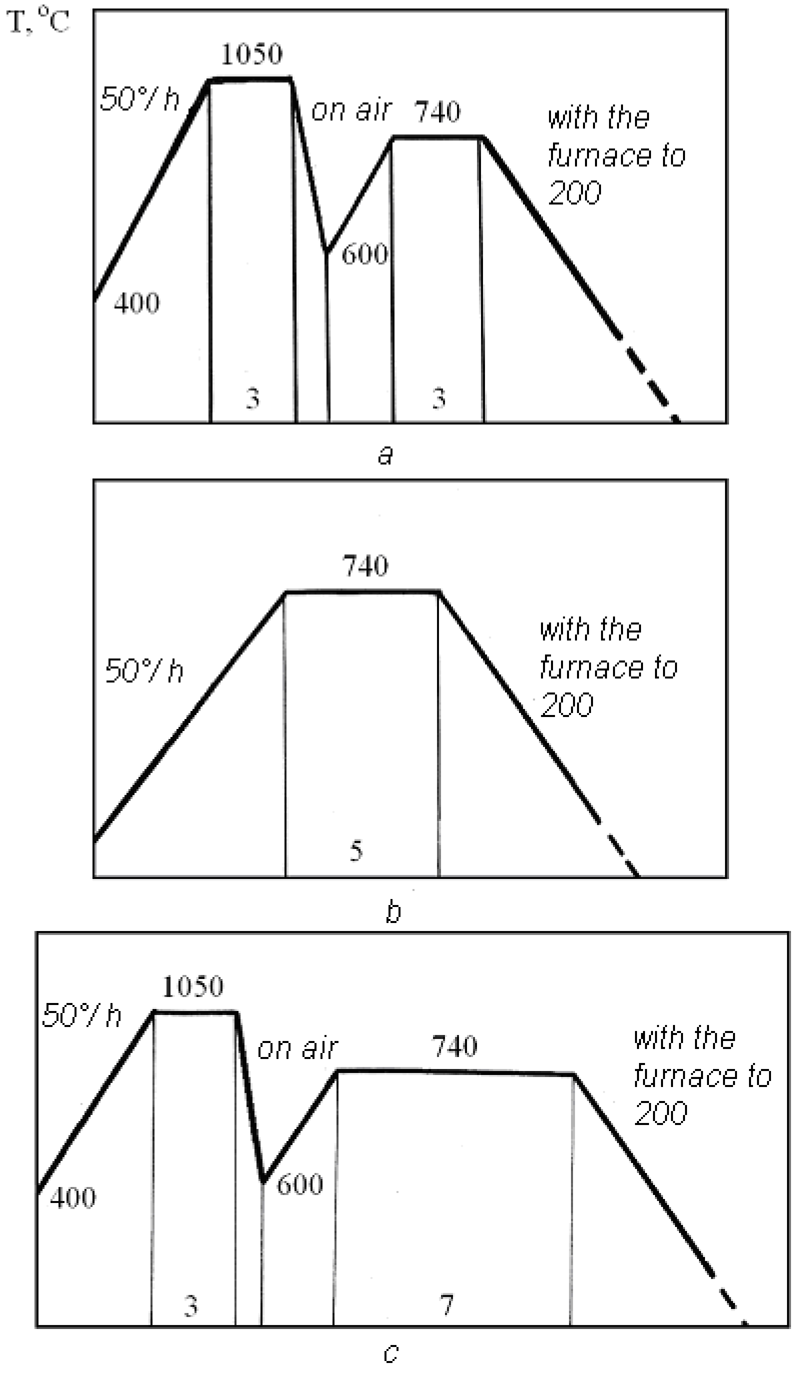

Figure 3. Heat treatment mode of bimetallic billets

After cooling ring templets were extracted from front and bottom ends of bimetallic billets and the quality of metal compounds in a bimetallic couple, the presence of defects in the form of decomposition, radial rifts, macro-impurities were controlled.

Macro-control showed that geometric dimensions of billets, external, boundary and internal diameters correspond the technical specifications and the billets can be used for manufacturing bimetallic bands.

During the billets processing on machines of ЦРМО-2 lathe group higher hardness of the metal inner layer was set. Therefore, in order to improve the machinability of experimental billets they were subjected to additional high-temperature drawing-back (**Figure 3b**). As a result of these studies the heat treatment mode of centrifugally cast bimetallic billets was adjusted. The graph is shown in **Figure 3c**.

While developing the technology of rollers with bimetallic bands there were taken into account the opportunities for supplying billet parts for axles and bands of composite rollers. As constituent parts the following workpieces were used: for axles - used forged steel rollers of the necessary diameters, for bands - experimental bimetallic hollow billets in heat-treated condition.

After the study of the properties of the roller material it was established that long-term strength of steel 25Х1М1Ф under condition of loads and temperatures, which test rollers on the curved section of CCM, is about 7,000 hours, what corresponds 2-years' work. During the selection used rollers were visually examined, including manufacturing axles from them by lathe work.

Axles of the experimental composite rollers were made of one-piece forged rollers (steel 25Х1М1Ф), which worked out an interrepair campaign without disturbing the operating conditions. Visual inspection of defects in the form of cracks in the axles of rollers was not observed.

Prepared axles were installed on the stand for the assembly of rollers, and bands workpieces on the heating stand. Bands were heated by gas burner to a temperature of attachment and were put with interference on the axle.

The design feature of rollers of this size was an odd number of bands, i.e. central, the most loaded part of the roller axle, did not have a stress concentrator in the form of the gap between the bands.

Axles with bands were passed to the drilling area, where there was made a hole and installed a fixing device in each band. After pudding fixing devices the composite roller was put to the drilling area for finishing machining.

The experimental party of band rollers was installed on the radial section of the seventh strand of the slab CCM №4 and showed after the first period between repairs the absence of thermal fatigue crack of the net shaped roll marks on the bands.

Conclusions

1. A technology of centrifugal casting and heat treatment of bimetallic billets for roller bands of CCM from alloys Х12МФЛ and Х1М1ФЛ.
2. The manufactured experimental party of band rollers was tested on CCM and showed after the first period between repairs the absence of thermal fatigue crack of the net shaped roll marks on the bands.

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*Published in Russian

Received June 2, 2011

Технология изготовления роликов с биметаллическими бандажами для МНЛЗ

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Разработаны основные параметры изготовления центробежнолитых бандажированных роликов, испытания которых на МНЛЗ показали их преимущество в сравнении с серийными цельноковаными.