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EXPERIMENTAL INSTALLATION FOR STUDYING THE LASTINGNESS OF THE ROLLING CYLINDERS

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ABSTRACT:
The installation that we have designed, made, and described in our work ensures any possibility of study of the lastingness through cyclic thermal charge, on some ring samples made of the same material as the industrial rolling cylinders. This installation allows us to make some research about the lastingness and of the mechanisms subject to thermal fatigue (the arms of the charge equipments, saw disks, scissors blades for warm cutting, guiding rolls for the continuous moulding installation etc.).
This experimental installation allows the specialists to appreciate the lastingness of the cylinders according to the number of stress cycles of thermal fatigue, until the first cracks on the surface of the calibers occur.
The lastingness installation allows us to determine the lastingness in laboratory experiments and to compare any result obtained for the working lastingness of the industrial rolling cylinders.
KEYWORDS:
Installation, lastingness, cylinders, rolling

1. INTRODUCTION

The working lastingness of the rolling cylinders is an important factor for determining the metal consumption of one rolling mill because a low lastingness increases the time for changing the calibers of the housing of the rolling-mill, the labor for recalibration and the quantity of waste bars in order to regulate the line after any change, and it also influences the productivity and the saving of the rolling-mill. In such conditions, economically speaking, it is not rational to use the cheapest cylinders because they do not ensure the lowest consumption in case of high productivity of a rolling-mill.

2. PROCEDURES FOR LASTINGNESS EVALUATION

Nowadays, in order to evaluate the lastingness of the rolling cylinders, we use an economical index that represents *the consumption of cylinders - kg/ton of laminate products* (rolled iron), [2]. This index is efficient only for comparing the quantity of cylinders between the same types of rolling-mills.

Another way of evaluating the working lastingness allows us to compare the quality of the cylinders that are used in identical conditions, and they refer to *the quantity (tons) of laminate/1 mm of the cylinder's diameter, removed after recalibration.*

The third procedure resides in evaluating the lastingness according to another criteria that precisely evaluates the working lastingness of the rolling cylinders, *as the number of stress cycles in case of thermic fatigue, until the first specific fissures occur.*

Therefore, our work presents the experimental lastingness device who allows us to evaluate the lastingness of the rolling cylinders, as well as of any other body parts, in case of thermic fatigue.

3. BODY PARTS

Figure 1 presents the experimental equipment to determine exploitation durability in laboratory conditions of hot rolling cylinders, while figure 2 provides the constructive scheme, [1]. This installation provides the possibility of the futher studiers and also to establish the durability in exploitation for all types of rolls used presently in industrial mill.

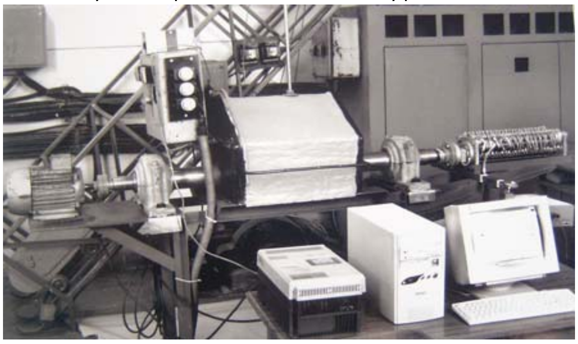

FIGURE 1. The construction plan of the installation for determining the durability of the hot rolling mill cylinders

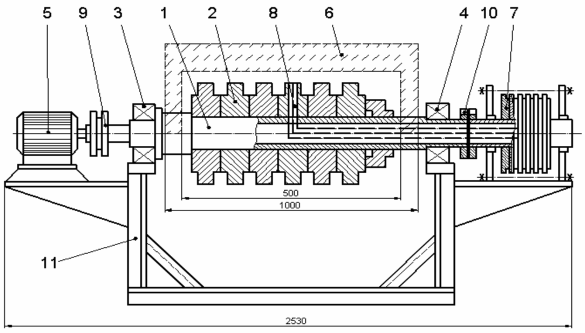

FIGURE 2. The constructive diagram of the installation for testing the durability of hot rolling cylinders

Figure 2 shows the constructive diagram of the installation used in the researches on the endurance of hot rolling cylinders. The ensemble is made of the main shaft 1, on which the experimental samples are mounted 2 represented by rings made of the steel and cast iron grades used in manufacturing hot rolling cylinders. The main shaft is attached by mans of bearings 3 and 4, and it is driven by an asynchronous electric motor 5, with the power of 2,2 kW, controlled by a three-phase static frequency converter. The rings are heated up in 6, by means of electric resistors. The main shaft and the samples are attached directly to the motor and to the thermal stress collector 7, by means of couplings 9,10, the entire system being mounted on the metallic framework 11.

In order to make any experimental research, we have used samples of six rings each, whose outside diameter was of ϕ 250 mm. These rings would be made of industrial cylinders' ends and they have allowed us to modulate them almost like the industrial cylinders. The design of an experimental sample is represented in figure 3.

In order to measure the temperature variations within the experimental rings, we have implanted a conical pin and have mounted some thermal-couples made of Pt-Pt/Rh. The diameter of the rod would be of 0, 06 mm and the response inertia lower than a tenth of second.

The thermocouples are type-K, made of Cromel – Alumel (Cr - Al), with a range response of tens of seconds, and are introduced into bolt 1 which has been implanted into one of the tests 2. Two of the thermocouples introduced into the bolt are situated at Δr = 1,5 and 3,0 mm width from the ring surface, and register all temperature variations from the radial section; a thermocouple which is situated at Δr = 0,2 mm width into the bolt is considered a surface thermocouple, and the temperature variations reach the highest level, [4]. The installation – bolt and thermocouples – is described in figure 4. Figure 5 represents ring mounting.

In order to ensure the working of the installation during experimental working, we would make some lateral bore holes of the bearings that have had a big diameter that could have allowed them to laterally expand – radial and axial – in case the axis is warmed up during the experimental research. Figure 6 represents the bearings and the main shaft in detail. The electrical engine is meant for moving the main shaft with samples and it is spin up by a static frequency converter for non-synchronous triple-phase engine - FDH – G 1085, who is fed from a tension source 380/220V, whose frequency reaches 50…60 Hz, [4].

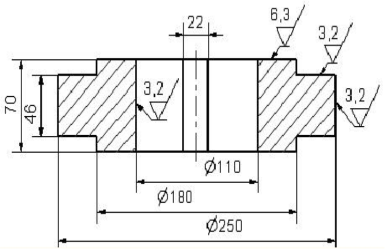

FIGURE 3. Sketch of the ring-shaped experimental sample used in the endurance trials

FIGURE 4. Thermocouple pin assembled and prepared for installation in the experimental ring

FIGURE 5.The ensemble of thermo – couple bolt in the mounting phase

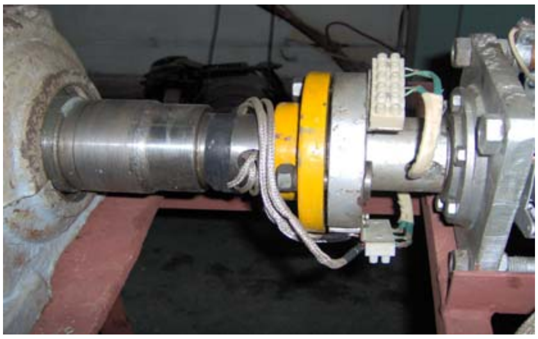

FIGURE 6. Bearing and main shaft

In the upper part, the electrical resistor furnace looks like a half-circle and it comprises an 180^0 segment from the experimental rings – figure 8. The warming up is made with the help of two electrical resistors; each of them has four locks who are situated longitudinal on the surface of the sample rings – figure 9. Each of the two resistors R1 and R2 could work independently with four locks or simultaneously with the eight locks of the warming system and it is made of four locks; the diameter of the resistor rod is 2.5 m, the section is S = 4,907 mm^2, the diameter of the spiral is 22 mm, and the length of the resistor is L = 32 m, while the length of a lock reaches almost 8 m. The length of the rods of the two resistors is of 64 m.

FIGURE 7. The design of the furnace used for warming up the samples

FIGURE 8. The setting of loops inside the electrical furnace

The warming up temperature is different, according to the working resistors; if there is one resistor, the warming area stretches to an angle of 90^0 from the circumference; if the two resistors work simultaneously, the warming up stretches to an area who encloses the entire area of the half-circle within the furnace – an angle of 180^0 from the circumference of the rings. This installation forces the warming up time to depend on the number of working rotations of the engine and of the shaft with sample rings – at every spin within the area of the furnace, these rings get warm, while they cool off at their lower end, within different already-established environments, once they get out of the furnace. In case of less hard working, they warm up with one resistor, meanwhile, in case of hard working, they get warmed up with the help of both resistors, during they make a rotation angle of $\varphi = \pi$ radian.

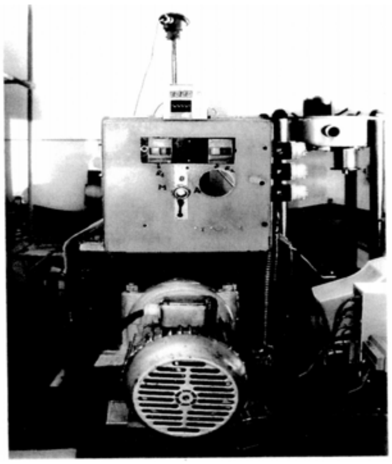

FIGURE 9. Main board of the electronic authomatical device for starting the electrical furnace used for warming up the samples

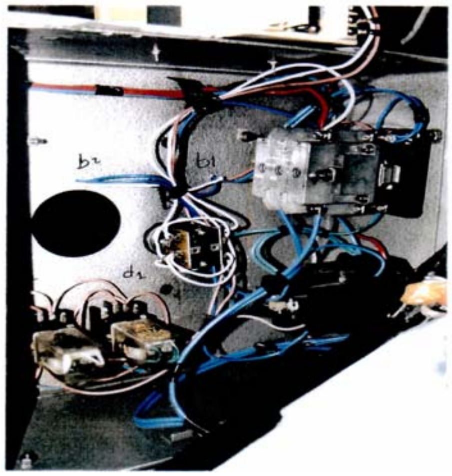

FIGURE 10. Electrical device for controlling the sample warming furnace

Figure 9 represents the main board for controlling the electrical-authomatical device for sample warm up. With its help, we are able to establish and maintain a specific temperature for the environment inside the furnace. The entire device of the electrical controlling scheme of the warming up furnace is described in figure 10.

4. THE SCHEME OF THE WORKING PRINCIPLE

The working principle of the installation is based on producing thermal fatigue within the experiment rings of the lastingness installation.

The electrical furnace for heating of samples is performed on the inferior side in the shape of a semi-circle with two electrical resistances (R1, R2) each composed of four blisters arranged in longitude, parallel with the main axis. Figure 12 presents the construction scheme of the furnace.

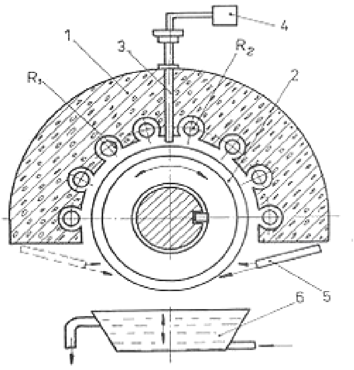

FIGURE 11.Transversal section through the heating furnace of experimental samples

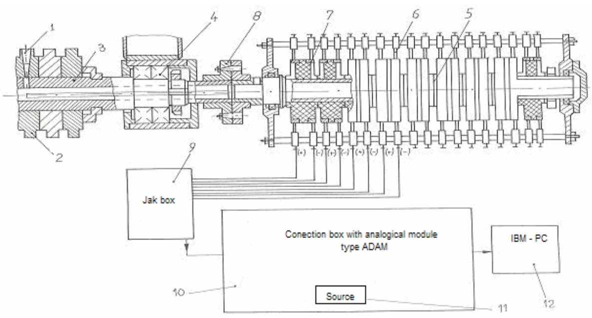

FIGURE 12. The scheme of the installation used for measuring temperature variations inside the sample rings – in case of lastingness experiments

The inside of furnace 1 contains the assembly of the ring shaped samples 2, made from roll necks which performed the rolling campaign. The temperature of the environment inside the furnace is measured by thermocouple 3, connected to automaton 4, which shows the temperature values and commands the maintaining a necessary temperature of 910 ^{0}C in the furnace. The experimental samples heat up on the superior side (furnace area) and cool on the inferior side, in different medium: A – air, B – water bath circulated in shaft 6, C – carbonic snow in streams transmitted to the rings through collectors 5.

In order to register the experimental data, the lastingness device comprises an adequate installation for measuring temperature variations inside the ring samples figure 13. These rings work on the principle of the thermal-electrical effect within the thermal-couples inside pin 1, who has been implanted inside one of the rings – experimental samples 2. The main shaft 3 of the experimental installation is mounted inside one bearing 4, who has penetrated through the axis, in the free side, and who ensures any possibility of transmitting (through the compensation cables) from the thermal-couples to the thermal-tension collector 5 made with the help of the chalk brushes 6. In order to collect the thermal-tension within the thermal-couples, with the help of the rings 7 made of copper and mounted on waterproof disks (textolite), the connection between the main axis and the thermal-tension collector is made through the coupling 8.

The electrical conductors from the conducting brushes are connected to the jack box 9, then to the connection box 10, who contains the data board, and through a data transmission coupling who connects it with the computer 11, who registers all the folders for any temperature variation.

The installation for determining the temperature variations of the experimental samples registers all temperature variations at their surface and radial section, as folders who help specialists to draw up some isochronic temperature diagrams.

5. CONCLUSIONS

The installation that we have designed, made, and described in our work ensures any possibility of study of the lastingness through cyclic thermal charge, on some ring samples made of the same material as the industrial rolling cylinders. This installation allows us to make some research about the lastingness and of the mechanisms subject to thermal fatigue (the arms of the charge equipments, saw disks, scissors blades for warm cutting, guiding rolls for the continuous moulding installation etc.).

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REFERENCES / BIBLIOGRAPHY

[1.] Pinca, C., Tirian, O., Kiss, I., Josan, A. – Experimental researches under the durability of rolling mill cylinders, 9th International Research/Expert Conference "Trends in the Development of Machinery and Associated Technology" TMT 2005, Antalya, Turkey, 26-30 September, 2005

[2.] Pleşa, D. – Research about the way the cylinders work during the technological process of warn rolling was meant for increasing their lastingness, Doctoral Thesis, Petroşani, 2004

[3.] Toader, Şt, Pinca, C., Pleşa, D. – Thermal fatigue of the hot rolling mill cylinders, Timişoara, ISBN 973-625-185-3, Romania, 2004

[4.] Pinca, C.: The researches on the hardness in exploitation of the hot rolling mill cylinders, CNCSIS cod 24, tema 6, No. 32940, Romania, 2004, Grant No.58 GR/ 19.05.2006, Tema 3, Cod CNCSIS 45