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EXPERIMENTAL ESSAYS AND INTERPRETATION OF RESULTS OF THE CAST IRON – ALLIED STEEL FRICTION COUPLING AT RELATIVELY HIGH TEMPERATURES AND SPEEDS

VASIU Teodor, BUDIUL BERGHIAN Adina

UNIVERSITY POLITEHNICA TIMISOARA
FACULTY OF ENGINEERING HUNEDOARA

Abstract
In this work, there is determined the dependency between the friction forces and the temperature of the semi-coupling of an experimental installation based on the dry friction between a disk (of cast iron) and a cylinder (allied steel). The conclusions refer to the influence of the alloy elements on the values of the determined friction forces and can lie at the basis of studying, from the tribological point of view of the rolled metal – guiding interaction.

Keywords:
wear, cast iron, allied steel, temperature, speed

1. INTRODUCTION

The idea of the thematic of this work was suggested by specialists involved in the activities of maintenance in iron and steel firms. Within the respective economic agents, there was established, along time, significant losses of material at the guiding of wire laminators. These sears are due to the contact between the respective guiding and rolled metals.

The particularly useful information elements resulted from the experiments performed with friction coupling cast iron – steel S 235 JR (SR EN 10025-A1) at high temperatures and speeds [1] got the interest for other brands of steels, using the same counter-piece (the cast iron disk), that, as material, is proper for guiding and rolling cylinders.

The experiments were performed respecting the general conditions described in [1] and [2] for approx. 10 tubes of each steel brand.

2. THE EXPERIMENTAL INSTALLATION USED

The experiments have been carried out on the installation shown in fig. 1 [2], which allowed the obtaining of the desired parameters meant for trials at relatively high temperatures and rolling rates. The installation is mainly made of four parts:

A. The mechanical part, made of a disc, whose revolution rate can be set between 0 to 2000 rot/min. The disc represents one of the elements of the friction coupling, the latter being a test rod, attached to a special device.
B. The electric drive of the disc. The revolution of the disc is obtained with the help of a motor – generator group. The revolution rate is maintained at the desired value by an amplidyne.
C. The device measuring the friction force. The electric diagram used in measuring and recording the friction force has been carried out by means of the following type – elements: magnetic modulator, AC amplifier, oscillator and an amplifier base.
D. The temperature-measuring device. Temperature has been measured and recorded with the help of an oscillograph, which had as an input the voltage at the plots of the thermal couples mounted on the edge of the disc and inside the test rod. The warming up of the test rod, considered to be the warm element, has been carried out with a generator, by means of a contact clip, mounted on the test rod.

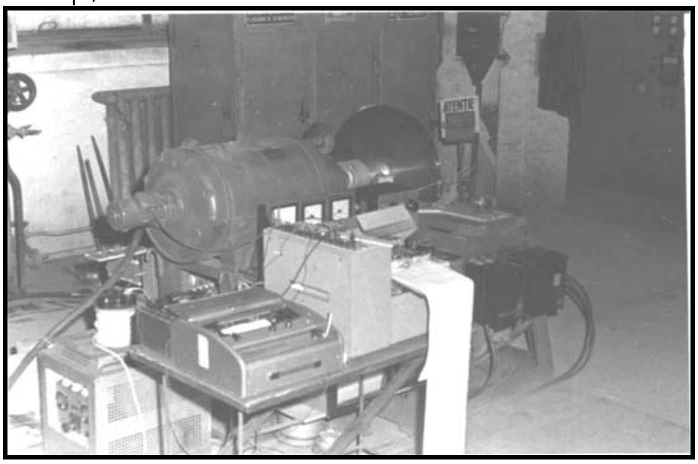

Fig.1 The experimental installation for the study of dry friction

3. CONSIDERATIONS ON THE CHOICE OF THE FUNCTIONAL PARAMETERS OF THE INSTALLATION

In order to establish the basic parameters, there was started from the idea that the most frequent friction coupling hot metal – cold metal are formed between the rolled metals, on one side, and reinforcing and cylinders, on other side. Since the practical interest is laminating steels under the form of semi-manufactured laminates and full finite laminates, one of the elements of the coupling was considered steel. The other element of the studied coupling was taken the cast iron. This pair steel – cast iron was imposed by the fact that the most problems are raised by the finishing laminators, where the guiding is of cast iron.

Table 1 Chemical composition of the studied materials

Material brand	Chemical composition [%]							
	C	Mn	Si	Cr	Ni	Mo	P	S
S 235 JR	max. 0.20	max. 0.80	max. 0.07	-	-	-	-	-
Gray cast iron	3.0-3.3	0.60-0.70	1.50-2.20	-	-	-	max.0.3 -0.5	max.0.12
42CrMo4	0.38-0.45	0.60-0.90	0.17-0.37	0.90-1.20	-	0.15-0.30	-	-
13CrNi35	0.09-0.16	-	-	1.25-1.65	3.25-3.65			
RUL 2	0.95-1.1	0.90-1.2	0.40-0.65	1.30-1.65	max.0.3	-	-	-

At the experimental installation, the disk was manufactured of gray cast iron and the test tube of 42CrMo4 (SR EN 10083-1), 13CrNi35 (STAS 791-88) and respectively RUL2 (STAS 1456/1-80). The chemical composition of the studied materials is indicated in table 1.

4. EXPERIMENTAL RESULTS

The tries performed led to obtaining the values of the friction force between the disk – test tube coupling, in function of the test tube's temperature, at different relative speeds [m/s] in the contact points. The results obtained are indicated in a graphical form in the figures 2, 3 and 4.

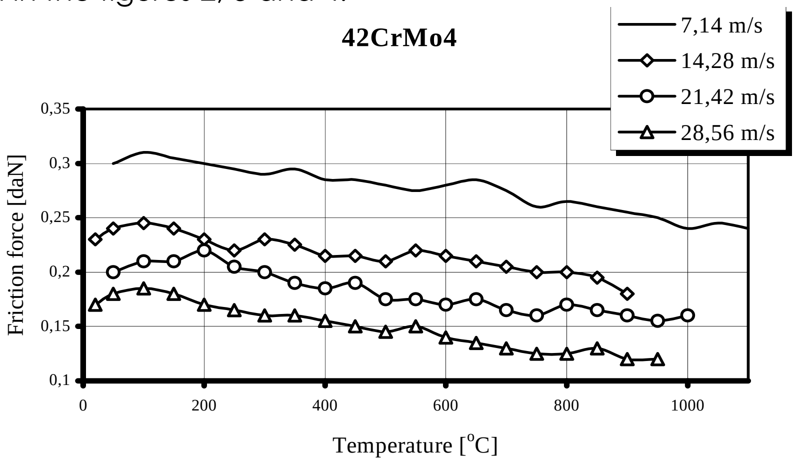

Fig.2 The dependency of the friction force between disk and test tube in function of the temperature of the test tube for 42CrMo4

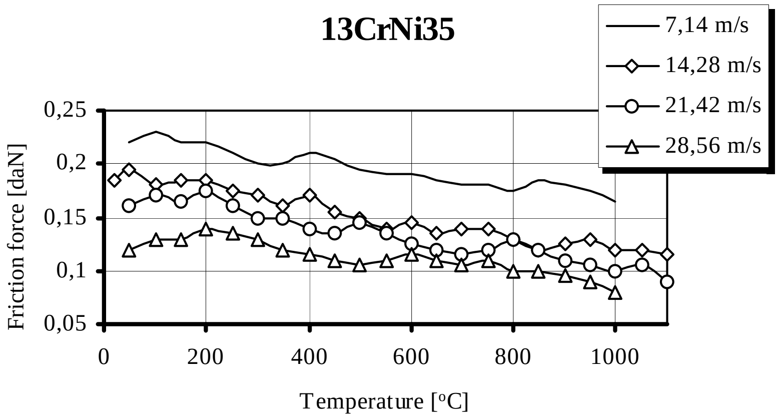

Fig.3 The dependency of the friction force between disk and test tube in function of the test tube's temperature for 13CrNi35

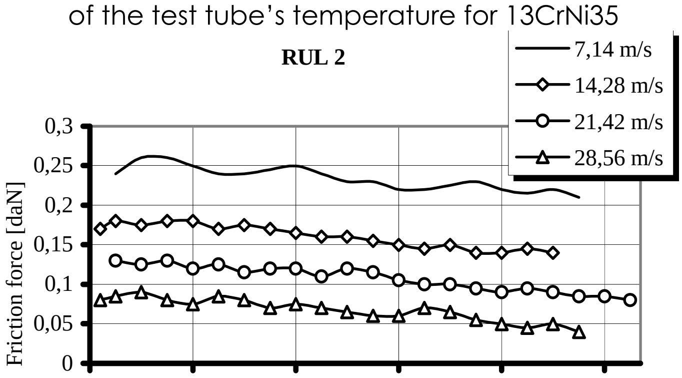

Fig.4 The dependency of the friction force between disk and test tube in function of the test tube's temperature for RUL2

5. CONCLUSIONS

Analysing the curves of the frictions force in function of temperature at normal value of 1daN and constantly maintained speeds, one can notice that they are right and the inflexion point are missing, comparatively with S 235 JR (fig. 5).

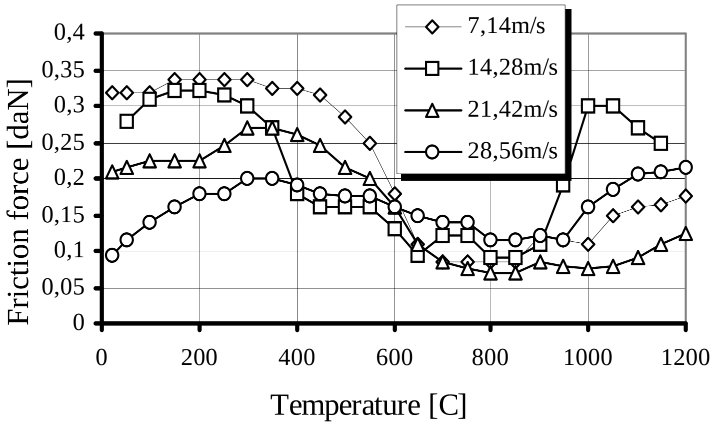

Fig. 5 The dependency of the friction force between disk and test tube in function of the test tube's temperature for S 235 JR [1]

This is due, after all possibilities, to the lack of FeO in the structure of the metallic oxides, wich is formed in the friction interface in the presence of the components of the environment. In supporting this hypothesis there pleads the analysis of the mechanism of formation of the metallic oxides in the presence of the alloying elements (chrome, nickel, molybdenum, silicon and manganese). The quantitative structure of the oxide layers is complex and with anisothropic properties of the most varied.

We have to bear in mind that the steels with alloying elements, which reduce or make impossible the formation of FeO in a free state, ensure a high stability for the friction process. The alloying elements, through the formation of specific chemical components, reduce friction and toughen contact surfaces. The increase in toughness of surfaces is due to the formation of metallic carbides, particularly under the form Fe_3C, Cr_3C_6, Cr_7C_3, Cr_3C_2, Mo_3C etc. If the economic reasons allow the use of allied steels, then they are preferable to the soft ones (with low content of carbon).

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