COMPARISON OF THE TRIBOLOGICAL PROPERTIES OF THE SURFACE LAYERS OF TiN and CrN

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Abstract

This work revealed the results of comparative surveys of the impact of formed surface layer TiN and CrN and two component surfaces layer TiN-steel and CrN-steel. The slide couple worked in conditions of lubricating the friction area with Lotos Syntetyk 5W/40 and Castrol GTX Magnatec 5W/40 engine oils. In the friction couple the counter sample was made from CuPb30 bearing alloy. The tribological survey was carried out on a Tester T-05. The results of the tests proved the possibility of implementing two component surface layers in slide couples, which work under mixed friction conditions. The surveys revealed that the friction force, temperature within the friction area and wear of bearing material, depend on friction conditions and combination of mating surface layers of friction couple. Beneficial friction parameters were observed in case of friction couples with binary CrN-steel surface layers of the journal.

1. Introduction

Obtaining the required level of product reliability is strictly related to technical economic demands determined while designing the product and during its production. One of the methods of improving the usage characteristics of machines is the application of a surface treatment to the parts of the machine which make contact. With the use of models determining the impact of surface consolidation it is possible to match optimal parameters of the surface treatment with particular conditions in the part of the machine works. This matching is possible provided the impact of technological parameters on working characteristics of the said parts has been well determined. In case of a slide bearing working under mixed friction conditions, the surface layers revealing appropriate tribological properties are of significant importance. On basis of operating recommendations the slide bearing journals should be: highly resistant to wear, resistant to corrosive impact of the lubricant and feature low friction coefficient [1, 2, 3, 6].

2. Experimental details

The aim of this work is to determine what impact technologically formed surface layers of the journal working in kinematical friction couples have on friction parameters under mixed friction conditions. For the purpose of the survey Steel 45 sample journals were made with following surfaces layers: TiN and CrN and two component TiN-steel 45 and CrN-steel45 (Fig. 1), additionally samples from steel 38HMJ which underwent ionizing nitration were made. The journals were working in a friction couple with a counter sample made from a CuPb30 bearing alloy, and 5W/40 Lotos Syntetyk and 5W/40 Castrol Magnatec engine oils

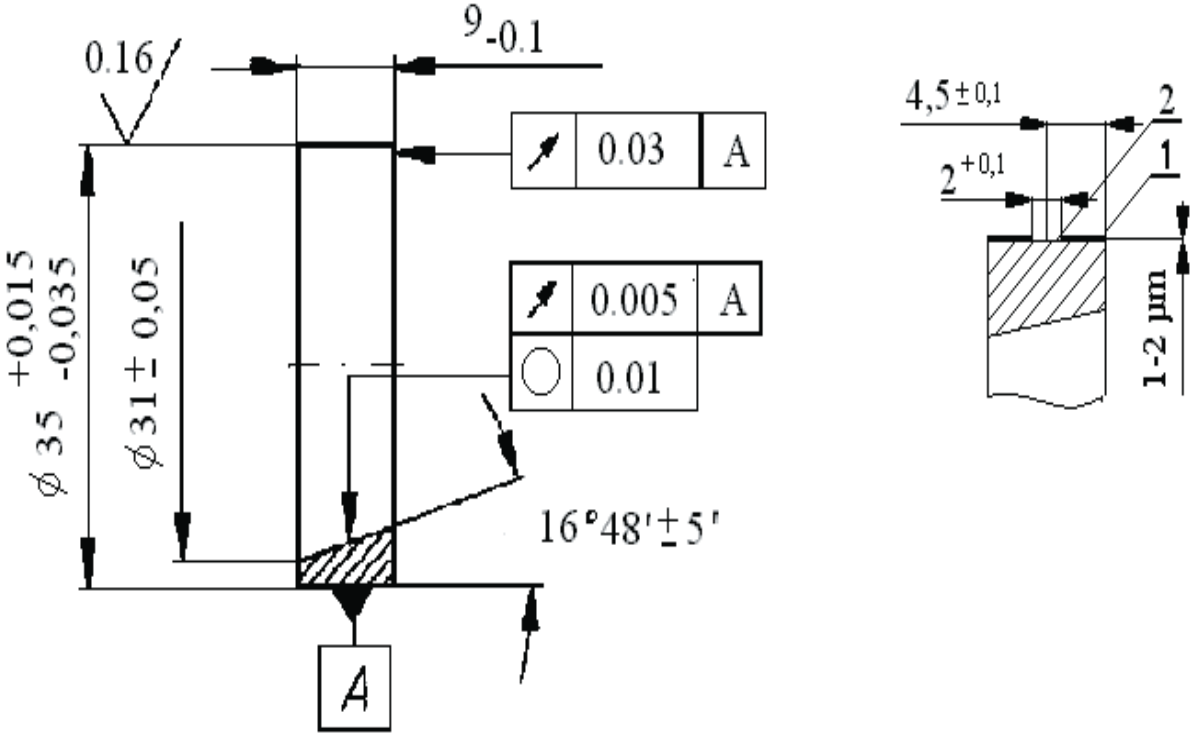

Fig. 1. Shape and dimensions of two components ring samples 1–coating, 2–material of ring

lubricated the area of friction. The tribological test was carried out on tribological machine type T-05 [4].

3. Results and discussion

While testing the kinematical couples with two-component journals - CrN – steel, lowest friction values were recorded, however the changes obtained did not depend on the oil applied. A similar level of friction force value was observed in the test of a couple with TiN journal layer but only with Castrol oil lubrication. The couples with CrN layer in comparison with the remaining tested associations revealed significant increase in friction force value rising together with increase of the load. In case of remaining tested couples the recorded friction force values for the tested sets journal – bush were comparable, and no significant impact was observed in case of surface layer modification and change of the lubricant. Therefore, general relations between surveyed values cannot be determined for the observed changes of friction force. The obtained records of friction force as well as its value are individual for each tested kinematics couple. The recorded values of friction force proved that they rise together with the load of the friction couple (Fig. 2).

Slide couples with journals with two component CrN-steel surface layer in Lotos oil lubricant environment reveal least friction forces. However couples with journals with one component CrN surface layer in same conditions reveal highest friction force values. For the remaining tested slide couples associations the recorded values of friction forces are comparable. Lubricating the slide couples with Castrol oil has impact on balancing of friction force values for slide couples with journals with surface layer containing CrN which underwent ionizing nitration. The highest values of friction force in these lubricant conditions were recorded for couples with journals with TiN modified surface layers (Fig. 3).

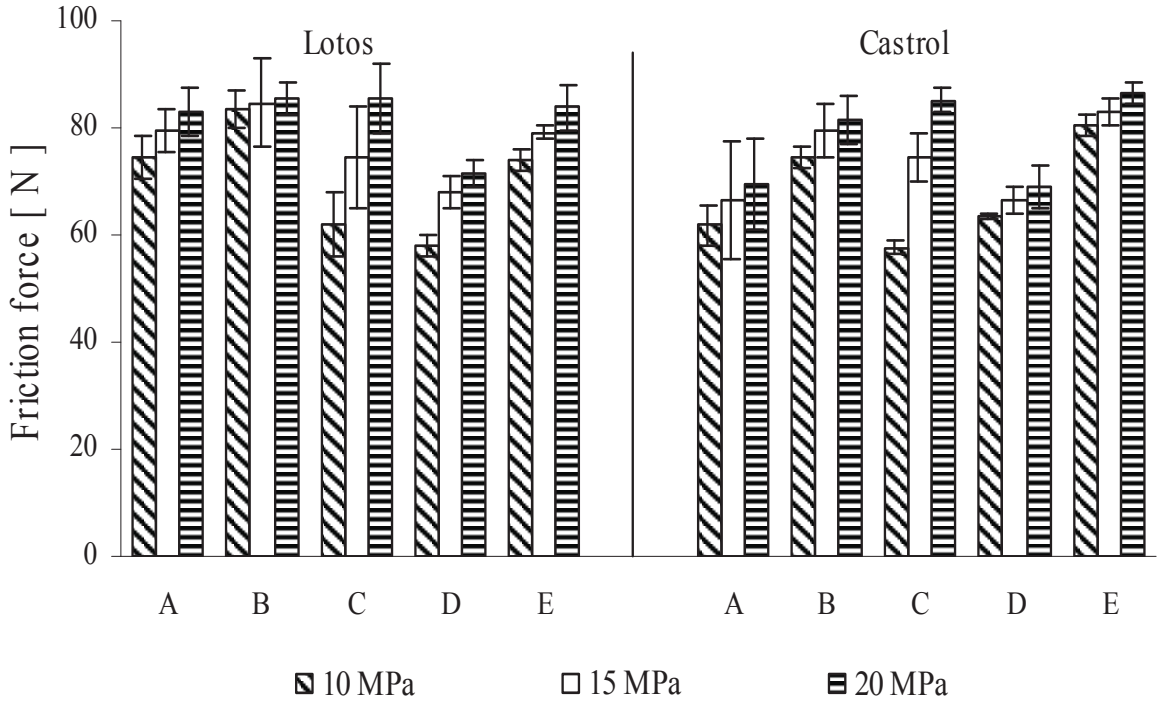

Fig. 2. Value of friction force in moment of starting friction couple; A) TiN, B) TiN–steel, C) CrN, D) CrN–steel, E) ion nitriding

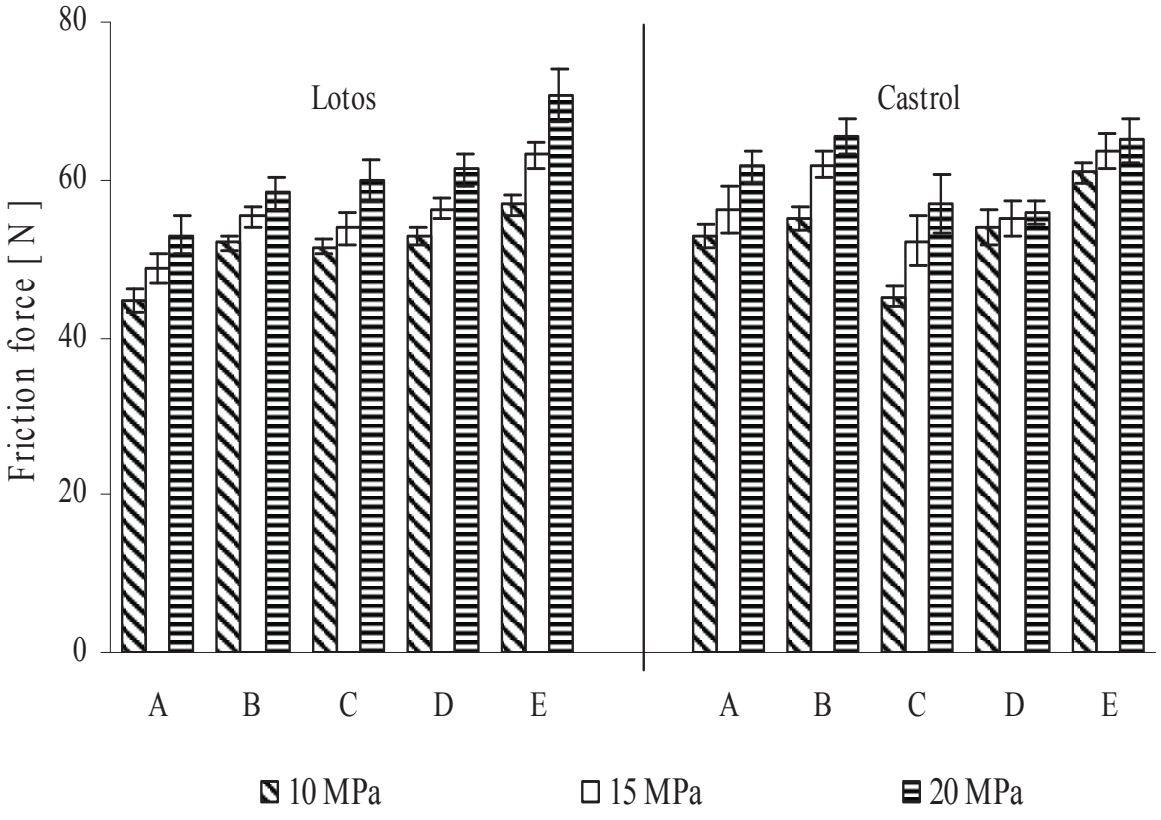

Fig. 3. Friction force as a function of load of kinematic pair; A) TiN, B) TiN–steel, C) CrN, D) CrN–steel, E) ion nitriding

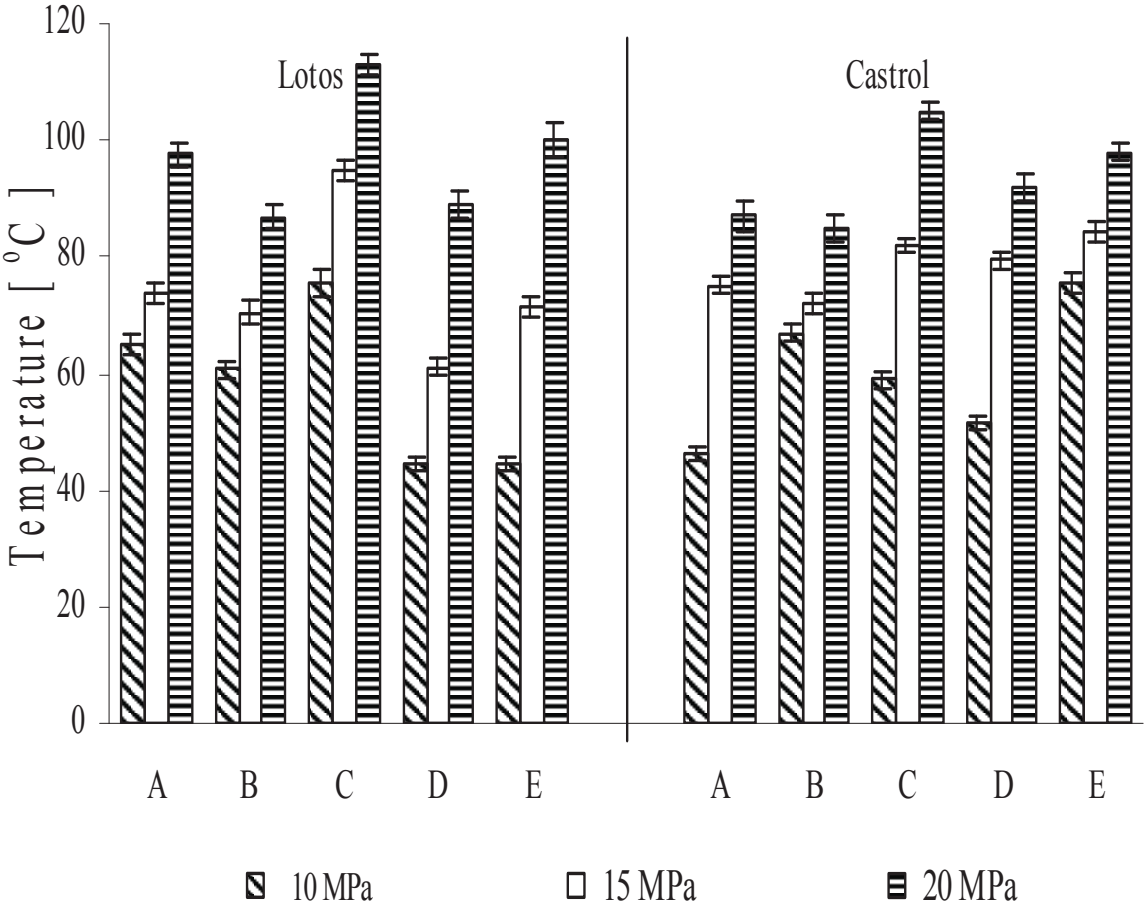

Fig. 4. Temperature as a function of load of kinematic pair; A) TiN, B) TiN–steel, C) CrN, D) CrN–steel, E) ion nitriding

The temperature readouts obtained during tests revealed lack of significant impact of the lubricant applied on the temperature value within the friction area. A significant temperature rise, particularly in case of heavy loads, was recorded in couples where journals with one component CrN surface layer were used. It may be observed however, that the use of binary surface layers results in temperature decrease within the friction area, the changes concern journals with TiN-steel and CrN-steel layers alike. The temperature values obtained for these couples are lower than those obtained in case of couples with nitrated journals (Fig. 4).

The analysis of obtained results of wear of the bearing alloys, enables stating that the application of binary surface layers of the journal does have impact on the wear processes occurring in the slide couple. Significant reduction of wear of the bearing alloy while mating with a binary surface layer as compared to mating with a one component surface layer was observed in case of journals with CrN modified layer. The wear of the counter sample in this kinematical pair is approx. twice lower in case of use of a journal with two component layer CrN – steel in the slide couple (Lotos oil). Also in case of journals with Titanium nitride – steel layers, a 10 -20 % reduction of wear as compared to couples with one component TiN layers was observed. In slide couples lubricated with Castrol oil, smaller variations in wear values of the bush was observed in the function of formed one component and two-component journal surface layer. However the feature of CrN modified layer which reveals wear similar to that occurring in couples with ion nitrated journal mating is significant (Fig. 5).

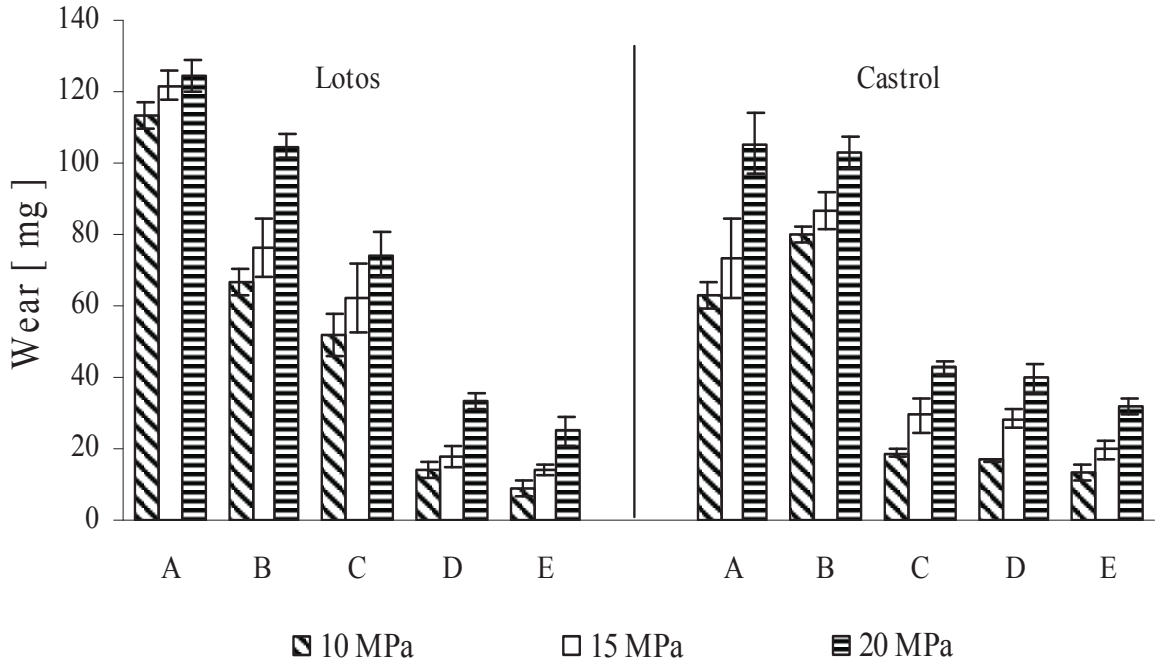

Fig. 5. Wear of bearing metal; A) TiN, B) TiN-steel, C) CrN, D) CrN-steel, E) ion nitriding

The created surface layers reveal features of high resistance to friction wear and in certain determined friction conditions possess beneficial tribological features. The sampling tests revealed possibilities of creating sliding couples with two component journals, which are able to work in existing kinematics pair. Such couples may reveal more advantageous tribological characteristic than those currently used. Nevertheless such change may require using new generation lubricants (enabling creating much more durable border layers, or working out new generations of bearing material of increased friction wear resistance).

4. Conclusions

On basis of the carried out experimental surveys and analysis of the results obtained, the following conclusions may be derived:

1. The way of constituting of the journal surface layers in the surface treatment process has impact on fluctuation of friction resistance in a friction couple. The friction force values obtained on basis of experimental tests enabled determining a significant relation of friction force fluctuation to unit pressure.
2. The impact of formed journal surface layer on wear of the bearing alloy was determined on basis of experiments. It was demonstrated that in mating of journals with two component CrN-steel surface layers and ion nitrated layers wear of bearing alloy occurred. However the highest wear has been recorded for couples with TiN surface layers journals.
3. Mating of a friction pair revealed beneficial impact of Castrol GTX Magnatec 5W/40 engine oil on reducing bearing alloys wear as compared to Lotos Syntetyk 5W/40 oil.

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