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DIAMOND-LIKE CARBON (DLC) COATINGS ON ROLLER BEARING ELEMENTS OF BELT CONVEYORS

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Preliminary Note – Prethodno priopćenje

The aim of the study was to analyse the anti-wear diamond-like carbon (DLC) coatings produced by Plasma-Enhanced Chemical Vapour Deposition. The DLC coatings were deposited on the rings of rolling bearings operating in belt conveyors. The service life of the bearings was 1,5 years. The bearings were exposed to harsh environmental conditions. After the disassembly of the bearings, the influence of the coatings on the improvement of tribosystem characteristics was assessed. Characterization of the bearing geometry was carried out using an optical surface profilometer. The use of diamond-like coatings on rolling bearings extended the tribosystem service life in industrial conditions threefold.

Key words: 100 Cr 6, bearings, belt conveyors, DLC coatings, friction

INTRODUCTION

Aggregate handling equipment operates in difficult working conditions. High loads, corrosive environment and dust caused by aggregate disintegration contribute to accelerated wear of machine components [1].

Bearings (tribosystem) in belt conveyors are but one example. Depending on the length of the conveyor belt, there may be from a few to a dozen of them. Bearing damage or failure results in production downtime, causing huge losses. To counteract the negative effects of friction, diamond-like DLC coatings can be used to increase the service life of the native bearing material. Due to very good properties, DLC coatings can significantly reduce the wear of the tribosystems in belt conveyors [1-4]. The properties of the coatings include high hardness, low coefficient of friction (less than 0,1), high abrasion resistance (up to 10-7 mm^3 \ Nm-1), and chemical stability. In addition, by modifying the technological parameters and the possibility of doping with various elements, it is possible to further improve the coating characteristics [1-4].

The coatings' main function is to protect the coated elements against tribological and corrosive wear. Surface roughness has a significant effect on the acceleration of coating wear. Therefore, it is crucial to properly prepare the substrate before applying the coating [4-7]. Under friction, hard irregularities on both the substrate and coatings may increase the resistance to motion. If a counter-specimen with a hard and rough surface structure moves over the specimen with the same surface structure, there are no plastic or elastic deformations of the material. In this case, there may be high local and point pressures in places of unevenness [8 - 11].

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MATERIALS AND METHODS

For industrial tests, ball bearings without coating and with a DLC coating were used. The inner bearing race with a diameter of Ø 107 x 28 mm and the outer bearing race with a diameter of Ø 150 x 28 mm were covered with DLC coatings. The bearings were made of 100Cr6 steel, the composition of which is shown in Table 1. The coatings were produced by PECVD at 300 ° C. The bearings were installed in the drum drive and counter-drive systems of the aggregate conveyors operating in the aggressive, corrosive environment under significant loads. After 18 months of operation, the bearings were dismounted.

The chemical composition of steel 100Cr6 is shown in Table 1. Figure 1 shown rolling bearing used in the belt conveyors friction nodes.

Table 1 **Chemical composition of 100Cr6 steel / wt. %**

C	Mn	Si	P	S	Cr
0,95 -1,10	0,20- 0,50	max -0,35	max -0,025	1,30 -1,60	1,30-1,60

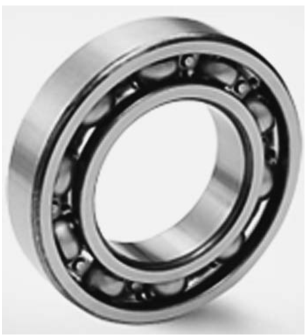

Figure 1 Rolling bearing.

Figure 2 Drive drum on which the bearing is mounted.

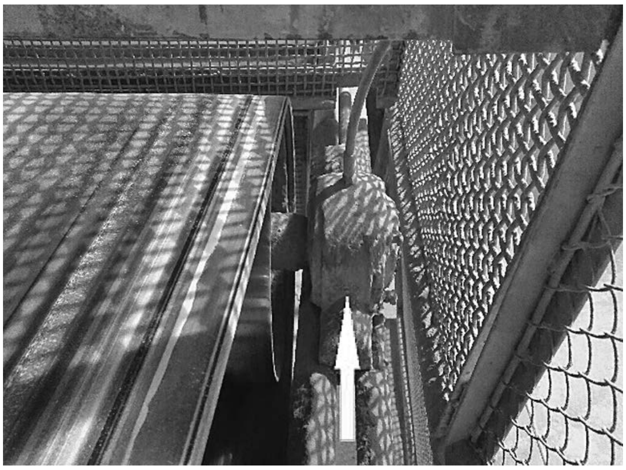

Figure 3 Counter-drive drum on which the bearing is mounted.

Figures 2-3 show the place of montage rolling bearings with DLC coatings.

RESULTS AND DISCUSSION

The geometrical structure of the surface and the wear tracks on the bearing races were observed and analysed using an optical profilometer.

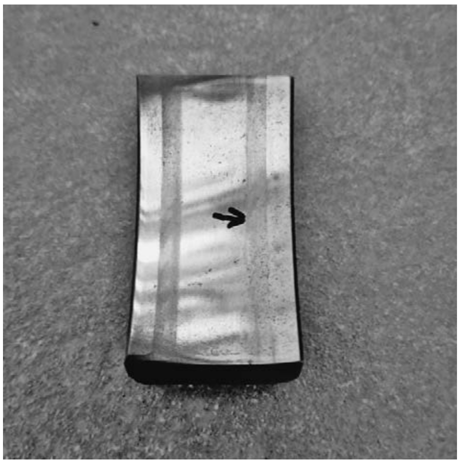

Figure 4 Non-coated bearing wear track.

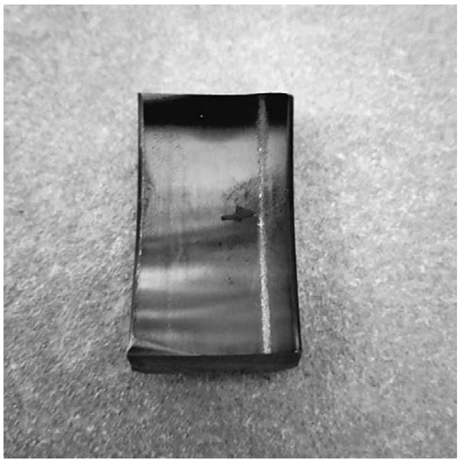

Figure 5 DLC-coated bearing wear track.

Views of the wear tracks on the bearing races are shown in Figures 4-5.

Figures 6-7 show the geometrical structure of bearing surfaces coated with DLC coatings.

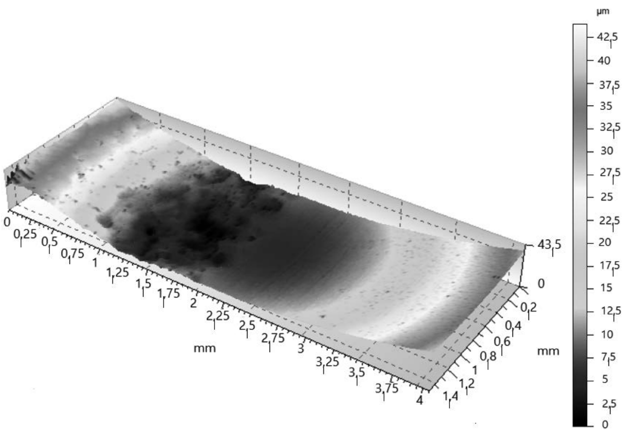

Figure 6 An isometric image of the wear track.

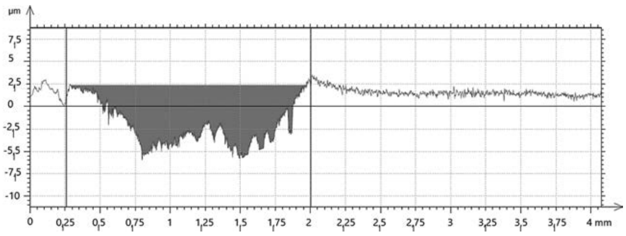

Figure 7 Surface wear track profile.

The maximum wear depth was 8,41 µm, with the hole area of 7 883 μm^2.

In Tables 2-3 summarizes the parameters of the geometrical structure of the surface according to the ISO 4287 standard. The adopted amplitude parameters listed in Tables 2-3 mean: *R*p - maximum profile peak height; *R*v – maximum profile valley depth; *R*z - maximum height of the profile; *R*c - mean height of profile elements; *R*t - total height of the profile; *R*a - arithmetic mean deviation of the assessed profile; *R*q - root mean square deviation of the assessed profile; *R*sk - skewness of the assessed profile; *R*ku - kurtosis of the assessed profile.

Table 2 **Parameters of surface geometry acc. to ISO 4287 / µm**

Rp	*Rv*	*Rz*	*Rc*	*Rt*	*Ra*	*Rq*	*Rsk*	*Rku*
0,36	0,06	0,29	-	1,21	0,19	0,21	1,72	3,11
/ µm							/ -	

Figures 8-9 show the geometrical structure of non-coated bearing surfaces.

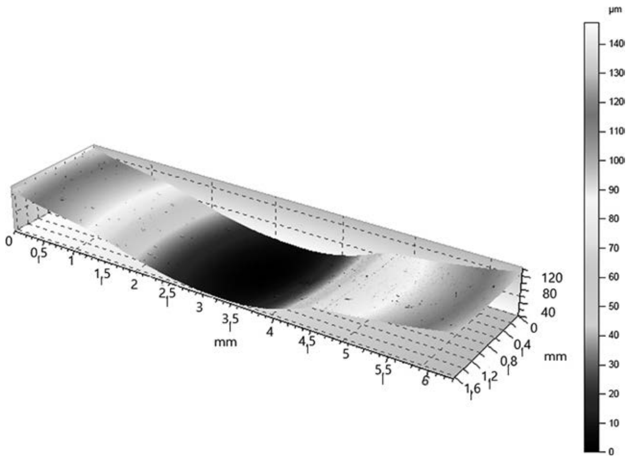

Figure 8 An isometric image of the wear track.

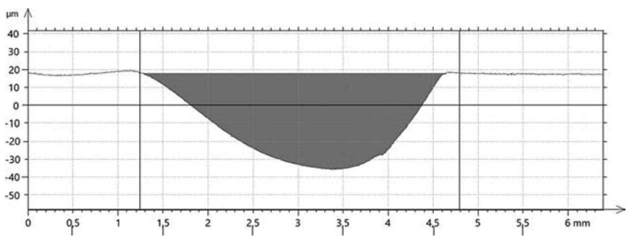

Figure 9 Surface wear track profile.

The maximum wear depth was 54,3 µm, with the hole area of 11 5023 µm^2.

Table 3 **Parameters of surface geometry acc. to ISO 4287 / µm**

Rp	*Rv*	*Rz*	*Rc*	*Rt*	*Ra*	*Rq*	*Rsk*	*Rku*
1,65	2,40	4,05	1,91	4,64	0,69	0,86	-0,47	2,93
/ µm							/ -	

CONCLUSIONS

The bearings with outer and inner rings covered with the a-C:H type diamond-like coating lasted three times longer in the tribosystem than non-coated bearings.

The wear tracks on the outer ring races of the DLC coated bearings were significantly smaller than those on the non-coated rings.

The diamond-like coating type, a-C:H, significantly improves the tribological properties of tribosystems in belt conveyors.

Increasing the reliability of tribosystems in belt conveyors increases the availability of these devices for the aggregate industry.

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Note: Translated by Nina Kacperczyk, Kielce, Poland.