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EXAMINATION OF APPLICATED PNEUMATIC FLEXIBLE COUPLING AND ITS EFFECT ON MAGNITUDE OF VIBRATIONS IN DRIVE OF BELT CONVEYER

Summary. In general, standard of ISO10816 is used for drives of transport mechanisms, determinating general criteria and principles for oscillations of machines. On the basis of evaluative criteria of the standard mentioned above, vibrations of a belt conveyer were measured. By experimental measurements it was found that vibrations of the belt conveyer evidently exceed limiting values defined by the standard. For an improvement of unacceptable state, a consequential solution was suggested. The application of pneumatic flexible coupling in drive of the belt conveyer was one of the possible solution. Consequential experimental measurements for verification of vibrations confirmed that application of pneumatic flexible coupling resulted in decrease of vibrations by 60%. Obtained values of vibrations were lower than limiting values of vibrations required by standard. We can clearly state that by proper application of pneumatic flexible coupling, a positive change in values of vibrations of the belt conveyer was reached, and therefore the belt conveyer meets the evaluating criteria according to the standard of ISO10816. This paper was written in the framework of Grant Project VEGA: „1/0688/12 – Research and application of universal regulation system in order to master the source of mechanical systems excitation".

Keywords: drive of belt conveyer, pneumatic flexible coupling, vibrations

OCENA WPŁYWU ZASTOSOWANIA PNEUMATYCZNEGO SPRZĘGŁA PODATNEGO NA WARTOŚCI DRGAŃ UKŁADU NAPĘDOWEGO PRZENOŚNIKA TAŚMOWEGO

Streszczenie. Do oceny drgań napędu urządzeń transportowych jest stosowana norma ISO 10816, która ustanawia ogólne zasady i kryteria oceny drgań maszyn. Na podstawie kryteriów oceny wymienionej normy zostały sprawdzone drgania przenośnika taśmowego. Opierając się na wynikach pomiarów, stwierdzono, że wartości drgań przenośnika znacznie przewyższają wartości graniczne podane w normie. Następnie zaprojektowano rozwiązanie konstrukcyjne pozwalające na poprawę istniejącego i niedopuszczalnego stanu. Rozwiązanie to polegało na zastosowaniu sprzęgła pneumatycznego w układzie napędowym przenośnika taśmowego. Pomiary wykonane po modyfikacji napędu przenośnika potwierdziły, że zastosowanie sprzęgła pneumatycznego pozwoliło na zmniejszenie drgań o 60%.

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Osiągnięte wartości drgań były również niższe od wartości dopuszczalnych podanych w normie. Podsumowując, można stwierdzić, że właściwe zastosowanie sprzęgła pneumatycznego pozwoliło na osiągnięcie znaczącej pozytywnej zmiany w wartościach drgań przenośnika i obecnie spełnia on kryteria podane w normie ISO10816.

Słowa kluczowe: układ przenośnika taśmowego, sprzęgło pneumatyczne, wibracji

1. INTRODUCTION

Mechanical drive systems consist of the engine drives and gearboxes mutually connected with shafts and couplings. In term of dynamics, every driving mechanism generates a vibration system. Regarding the problem of reduction, more specifically an elimination of the torsional vibration and its consequent vibrations, it belongs to the group of complicated processes. The results of the driving dynamics [1, 2, and 3] indicate that the vibration reduction can be achieved if both a proper flexible shaft coupling is selected and the respective driving system is correctly tuned. Within this paper, the tuning of an optional mechanical drive system means the selection of the flexible shaft coupling bearing, based on the dynamic calculation, proper qualified dynamic features in order to be suitably adapted to dynamics of the given drive system [4], [5]. Pneumatic flexible shaft couplings constitute a very important group of the flexible shaft couplings.

Construction of every pneumatic coupling is characterized by a compressed air space filled by gas substance between moving and driving part. Every time gas pressure changes the pneumatic coupling is able to work with new characteristic feature. Consequently, when working, the coupling is always bearing different characteristics, specifically torsional stiffness and damping coefficient [6], [7], [8], [9].

The main aim of this paper is to present an application of a new type of the flexible shaft coupling - pneumatic flexible shaft coupling - in addition, to determinate the experimental results which characterize the impact of the given coupling on the magnitude of the torsional vibration and, practically, its consequent vibrations in the mechanical drive system.

2. DESCRIPTION OF MECHANICAL DRIVE SYSTEM USING PNEUMATIC FLEXIBLE SHAFT COUPLING

Pneumatic flexible shaft coupling (Pict. 2) has been applied in a drive of the main bend conveyor (Pict.1), which conveys crushed substance with fraction from *0* to *120mm* from under main hogger to transhipments station. The main conveyor belt drive consists of electromotor having engine power P = *37kW* s and operating speed $n = 1500\ min^{-1}$, and double cone-front coupling with gear ration $i = 22,\ 5$. Pneumatic flexible shaft coupling of type *3-2/130-T-C* has been installed between output shaft of gearbox and drum of bend conveyor. The applied pneumatic coupling has been developed in working department of Constructing engine parts, desk of KDaL, Faculty of Mechanical Engineering, Technical University of Kosice and produced in company FENA Katowice, as based on the cooperation contract from year 2008. Pneumatic flexible shaft coupling has been characterized based on the following parameters:

- $p_S = 490\ kPa$ - pressure of gas substance in compresion chamber of pneumatic coupling,
- $k = 17650\ N.m/rad$ - torsional stifness of the pneumatic coupling,
- $M_N = 6000\ N.m$ - basic troque transmitted by pneumatic coupling,
- $M_{max} = 9000\ N.m$ - maximum troque transmitted by pneumatic coupling.

Fig. 1. Conveyor belt drive
Rys. 1. Napęd przenośnika taśmowego

Fig. 2. Applied pneumatic coupling
Rys. 2. Zastosowane sprzęgło pneumatyczne

3. EXPERIMENTAL RESULTS OF PNEUMATIC COUPLING'S IMPACT ON THE MAGNITUDE OF VIBRATION IN THE MECHANICAL DRIVE SYSTEM

Experimental measurement of pneumatic coupling's impact on the magnitude of vibration drive system has been processed at operation mode of conveyor with constant coupling speed $n=63min^{-1}$. Measurements were perfomed by means of monitoring system Adash Pro 4001 with analyzator DDS 2000 at three places, concretely:

- electromotor basis,
- shaft basis,
- output shaf support.

By processing time records, the effective magnitude of vibrations in conveyor drive were determined - RMS (*tab.1*).

Table 1

The results of the effective magnitudes of vibrations in conveyor drive, based on the experimental measurements

Measuring place	Original condition of conveyor drive RMS [mm/s]	Conveyor drive using pneumatic flexible shaft coupling RMS [mm/s]	Change in experimental results [%]
Shaft support	**9,37**	**3,72**	**- 60**
Gearbox	**6,02**	**3,65**	**- 40**
Engine	**8,2**	**3,22**	**- 60**

On the basis of the experimental results, which were presented by effective magnitudes of vibrations of conveyor drive and their mutual comparison it can be concluded that use of applied pneumatic flexible shaft coupling in the given drive system resulted in reduction of vibrations in range from *40%* do *60%*.

4. CONCLUSION

Following the results from experimental measurements, it has been found that the applied pneumatic coupling, due to its characteristic features, to a large extent contribute to the dynamics of whole mechanical system. This fact has a positive and important impact on the magnitude of the torsional vibration and its consequent vibration of the whole mechanical system.

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