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BADANIE TEMPERATURY ZEWNĘTRZNEJ POWIERZCHNI MIESZKA GUMOWO-KORDOWEGO SPRZĘGŁA PNEUMATYCZNEGO PRZY RÓŻNYCH WARTOŚCIACH PRĘDKOŚCI OBROTOWEJ WAŁÓW

Streszczenie: W artykule przedstawiono metodę wyznaczania temperatury zewnętrznej powierzchni mieszka gumowo-kordowego, stanowiącego wyposażenie sprzęgła pneumatycznego, w przypadku różnych wartości prędkości obrotowej wałów. Opisano budowę stanowiska badawczego i przedstawiono wybrane wyniki badań. Na ich podstawie sformułowano zalecenia odnośnie możliwości zastosowania sprzęgieł pneumatycznych w przypadku różnych urządzeń mechanicznych.

Słowa kluczowe: element pneumatyczny, układ mechaniczny, temperatura, sprzęt testowy.

ANALYSIS OF EXTERNAL TEMPERATURE IN FLEXIBLE ELEMENT AT VARIOUS SPEED LEVELS

Summary: The article describes the change in the external temperature of the elastic element when it is loaded by different swarms. Checking whether the change in speed affects the temperature of the spring element. The article describes the test equipment and the instruments used for the measurement. It examines the effect of the temperature on the resilient element and determines whether the resilient element can work in various mechanical devices.

Keywords: pneumatic element, mechanical system, temperatures, test equipment.

1. Introduction

When designing torsionally-oscillating mechanical systems, it is necessary to proceed in such a way that the adverse effects of torsional oscillation are eliminated as much

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as possible [3,13,22]. To reduce the adverse effects of torsional oscillation, it is advantageous to use flexible shaft couplings. The development of these couplings are to devote our department for several years. Flexible pneumatic elements are used in these flexible shaft couplings [12,14,15,18,19]. We have to say a negative fact. The imbalance of dynamic properties of flexible couplings caused by aging, fatigue, and the effect of heat on the elastic elements causes the meltdown of the pre-tuned mechanical system. The spring element is heated by the stress and thus alters its properties and hence the properties of the coupling and the entire mechanical system in which they are located [3,4,5,6,8,16,17].

To ensure trouble-free operation of the flexible shaft couplings, the maximum allowable temperature for flexible rubber couplings must not exceed 70 °C. The temperature of the elastic members influences the elastic modulus of the rubber in compression, the damping, relaxation, aging and fatigue of the rubber.

This article aims to investigate the temperature on the surface and inside of the elastic element stressed by dynamic stress. The article investigates what temperature arises on the surface of the resilient element when this element is subjected to various dynamic stresses. It determines whether these temperatures affect the properties of the elastic element.

2. Basic properties of rubber

Rubber is very often used in engineering because of its characteristic properties. Natural rubber, has been of great interest due to its many useful properties, such as high tensile strength, high elasticity, flexibility, good crack growth resistance and low heat build-up [1.2]. The rubber particle is formed from polyisoprene chains having their hydrophobic parts close together to form a globular structure, leaving their hydrophilic ends on the surface. Although there has been continual technological advancement in the area, it is still impossible to synthesize a rubber exactly like because of this branch point network. Is, therefore, in high demand for many rubber products, such as tyres, flexible elements, auto parts, and surgical gloves.

The properties of the rubber are determined by the chemical composition of the mixture, vulcanization conditions, shape and dimensions of the product.

Rubber is different from conventional construction materials. These are the properties of the rubber that are most distinct from metals and alloys:

- the mechanical, chemical and dynamic properties of the rubber have relatively large
- variations,
- the rubber is usable in a relatively narrow temperature range,
- the impact of time on all its properties is great.

Rubber has its advantages:

- high elasticity and the ability to return after releasing the tension to the original
- shape,
- the ability to withstand relatively large repeated deformations without damage,
- the ability to convert a large amount of mechanical energy into thermal (damping)
- high chemical stability,
- gas and water impermeability.

We studied the elastic element will burden the dynamic stress. If we load a rubber part in any way (pressure, pull, slip, torsion or combined), we supply the energy to it. After the load is over, we will not get this energy back. Some part turns to heat. The temperature of the rubber piece rises until the thermal equilibrium is reached. The amount of heat supplied from the internal energy losses equates to the amount of heat emitted by conduction or radiation from the surface of the rubber element. Temperature rise at high alternating amplitudes in conjunction with high frequencies can cause thermal cracks inside the rubber. Temperature greatly affects relaxation. Under relaxation, in the broader sense, processes that are related to the transition from an imbalance to an equilibrium are considered. Relaxation is more pronounced at a lower temperature for which all relaxation periods are prolonged. At high temperatures, relaxation usually takes place so rapidly that the development of deformation reaches practically immediate limit values. At low temperatures, relaxation takes place so slowly that no elastic deformation needs to be considered. In practice, rubber parts are most often stress-strained, usually periodic [11,12,15].

3. The measuring apparatus and used instruments

We measured the test equipment developed at our workplace. The schematic of the device is in Fig. 1.

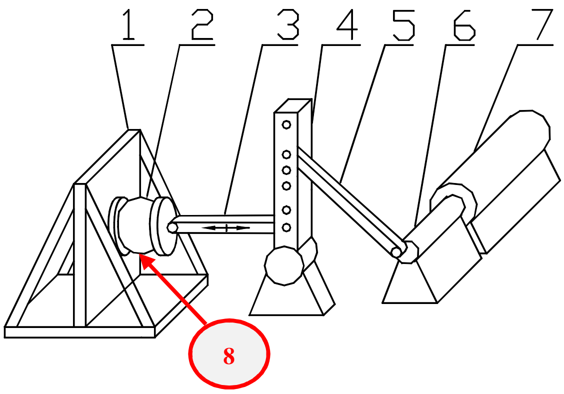

Figure 1. Schema of a device for measuring the temperature of a pneumatic-elastic element

The test device consists of a frame (1) in which the pneumatic-elastic element (2), the joint plate (8) with the connection hole, the rotary motion converter for reciprocating movement is reciprocated (3), (4) , (6) and a 16 kW direct current SM 160L electric motor (7) with an additional thyristor speed regulator of the IRO type with a variable speed change from 0 – 2000 min^{-1}. We can change the size of the amplitude by the shoulder (4). The temperature of the elastic element was measured at point 8 on the surface of the element. The M-3870D METEX digital multimeter (Fig.2) was used for the measurement with an ETP 003 heat probe: -50 – +250 °C. (Fig.3.)

Figure 2. Digital multimeter M-3870D METEX

Figure 3. Heat probe ETP–003 with measuring range: -50 ÷ +250 °C

4. The results of experimental measurements

The following Fig.4 the measured values of the outer surface are given T_{out} flexible pneumatic element subjected to dynamic stress.

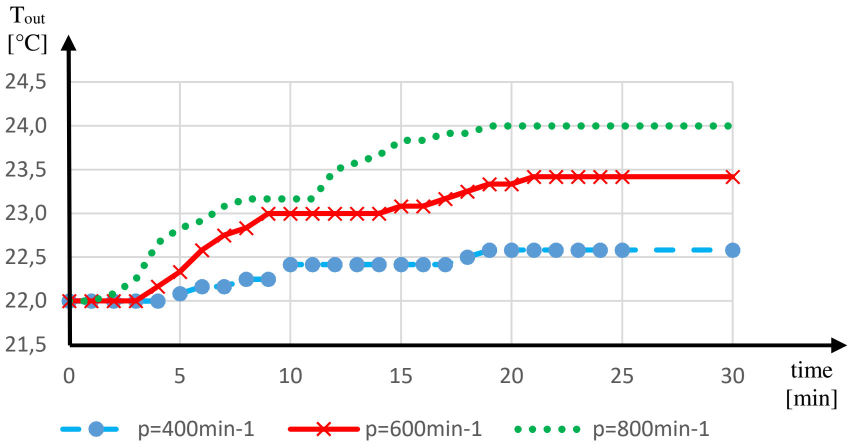

Figure 4. Temperatures of the outer surface of the elastic element T_{out} at pressures 400, 600 and 800kPa

The ambient temperature (and thus the observed values at the beginning of the measurement at time t = 0 s) was T_0 = 22°C. The indicated surface temperatures of the elastic element were recorded at times t = 1, 2, 3, ... 30 min as seen in Table 1. In experimental investigations were performed speed n = 400, 600 and 800 min^{-1}, the pressure in the non-deformed elastic elements p_0 = 0, 200, 300, 400, 500 and 600 kPa. The values in the table. 1 are already averaged values for individual pressures. The amplitude of the pneumatic-elastic element deformation was set to

A = 4 mm. The temperature measurement device is shown in Fig. 2 and Fig. 3. The location of the heat probe is in Fig. 1.

Table 1. The average value of the external temperature T_{out} outer sheath with respect to time at the speed of n=400,600 a 800 min^{-1}.

	T_{out}		
time [min]	n=400min^{-1}	n=600min^{-1}	n=800min^{-1}
0	22,0	22,0	22,0
1	22,0	22,0	22,0
2	22,0	22,0	22,1
3	22,0	22,0	22,3
4	22,0	22,2	22,7
5	22,1	22,3	22,8
6	22,2	22,6	22,9
7	22,2	22,8	23,1
8	22,3	22,8	23,2
9	22,3	23,0	23,2
10	22,4	23,0	23,2
11	22,4	23,0	23,2
12	22,4	23,0	23,5
13	22,4	23,0	23,6
14	22,4	23,0	23,7
15	22,4	23,1	23,8
16	22,4	23,1	23,8
17	22,4	23,2	23,9
18	22,5	23,3	23,9
19	22,6	23,3	24,0
20	22,6	23,3	24,0
21	22,6	23,4	24,0
22	22,6	23,4	24,0
23	22,6	23,4	24,0
24	22,6	23,4	24,0
25	22,6	23,4	24,0
30	22,6	23,4	24,0

In Fig. 3 to see how the temperature of the outer surface of the elastic element varies with time. Values were measured at a pressure of 100 kPa to 600 kPa and in Table 1 the mean values were already. We see that the lowest temperatures are attained by the elastic element loaded at n = 400min^{-1}. The temperature ranges from 22 °C. This temperature is constant for 5 minutes and after 5 minutes begins to gradually increase. At 20 minutes, the outside surface temperature will reach a maximum of 22.6 ° C and this value will no longer change. Higher temperatures are reached at higher revolutions and n = 600min^{-1}. The temperature starts at 22 °C as well as at lower revolutions. This temperature is constant for 4 minutes and after 4 minutes begins to gradually increase. At 9 minutes, the increase is slowed down and the temperature rise is slower until the outside surface temperature reaches a maximum of 23.4 °C, and this value is no longer changing.

The highest external surface values are measured at the maximum measured n = 800min^{-1}. The temperature starts at 22 °C as well as at lower revolutions. This temperature is constant for 3 minutes and after 3 minutes begins to gradually increase. At 7 minutes, the increase is slowed to 3 minutes, and the temperature rise is slower until it reaches 10 minutes and the temperature is not further increased. The outside surface temperature will reach a maximum of 24 °C and this value will no longer change. We can say that the value of the outside surface temperature depends on the temperature and time of the dynamic stress. The higher the rpm, the higher the temperature.

5. Conclusion

Temperature is an important factor in operating devices where various rubber elements are used. Due to the increased temperature of the pneumatic-elastic element, many properties of the rubber-cord material can be changed. Exceeding the temperature limit of the material of the pneumatic-elastic element 70 °C, structural changes of the element occur with simultaneous deterioration of its dynamic properties.

The paper describes the properties of rubber, experiment examining the described test apparatus and the measuring devices of the external surface temperature of the elastic element loaded by different speeds with respect to time.

We can say that the initial temperature for all measurements was constant and depended on the ambient temperature. The temperature of the outer surface gradually depending on the time increased. Depending on the speed, the temperature increase was different. Thus they have a higher speed so therefore the outer surface temperature reached higher values. Depending on the time, the temperature started to rise after a certain time. At 20 minutes, it was constant at each revolution. Maximum temperatures were reached at maximum speeds n = 800min^{-1} and the outside surface temperature Tout = 24 °C. But we can say that this temperature is not extreme. It allows the operation of the elastic element in the various devices in which these elements would be located. This low temperature does not change the mechanical properties of the elastic element.

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PROBLEMY ZWIĄZANE Z POMIAREM SIŁY DZIAŁAJĄCEJ NA KOŁO KIEROWNICY PODCZAS ZDERZENIA

Streszczenie: W pracy opisano problemy związane z bezpieczeństwem biernym w odniesieniu do elementów układu kierowniczego. Przedstawiono biomechaniczne kryteria oceny skutków zderzenia i na tej podstawie starano się określić wymagania dotyczące układów kierowniczych. Przedstawiono stosowane rozwiązania konstrukcyjne kolumn kierownicy zwiększające bezpieczeństwo. Opisano fazy rozpraszania energii podczas zderzenia przez elementy kolumny kierownicy. W ostatniej części przedstawiono zaproponowany czujnik pomiarowy zabudowywany do koła kierownicy mający na celu uzyskanie informacji o wielkościach sił i momentów działających na koło kierownicy podczas zderzenia.

Słowa kluczowe: bezpieczeństwo bierne, układ kierowniczy, badania

MEASUREMENTS OF THE FORCE ACTING ON A DRIVING WHEEL DURING A CAR CRASH – THEORETICAL BACKGROUND AND METHODOLOGY

Summary: In the present paper, the problems connected with a passive safety of a car passenger are discussed. The considerations are focused mainly on the steering system. The biomechanical criteria for an assessment of the crash consequences are formulated. Based upon these constraints, the demands for design and manufacturing of steering systems were defined. Some design solutions of a steering column have been presented. These solutions increase safety of passengers. The phases of energy dissipation during a crash via the elements of the steering column were described. In the final part of the work, the idea of a measuring gauge was proposed. The gauge would be placed on the steering wheel. The goal of this device is collecting and recording of an information about the forces and moments acting onto the steering wheel during a crash.

Keywords: passive safety, steering system, measurement

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