

AUTOMATION OF THERMAL NON-DESTRUCTIVE TESTING OF ROLLING BEARINGS

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Abstract: *The paper presents an improved program for automated monitoring of the technical condition of the rolling bearing, which considers three diagnostic parameters. The main diagnostic parameter is the maximum temperature, and additional parameters are the relative temperature and heating speed of the bearing. This allows the program to be used in different industries for different sizes of rolling bearings in the maintenance and repair system.*

Keywords: *bearing, diagnostic parameter, thermal control, automation.*

АВТОМАТИЗАЦІЯ ТЕПЛОВОГО НЕРУЙНІВНОГО КОНТРОЛЮ ПІДШИПНИКІВ КОЧЕННЯ

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Анотація: *В роботі представлена вдосконалена програма для автоматизованого контролю технічного стану підшипника кочення за трьома діагностичними параметрами. Враховано основний діагностичний параметр – максимальну температуру, та додаткові параметри – відносну температуру та швидкість нагріву підшипника. Це дає змогу застосовування програми в різних галузях промисловості для різних типорозмірів підшипників кочення в системі технічного обслуговування та ремонту за фактичним станом.*

Ключові слова: *підшипник, діагностичний параметр, тепловий контроль, автоматизація*

The main direction of improving production processes is an implementation system of maintenance and repair based on the actual condition of the equipment. The tools of such a system are modern measuring devices, computer equipment, and related software [1]. In particular, monitoring the operability of mechanical components is an important demand for ensuring the smooth operation of machines and aggregates. For this purpose, it is necessary to carry out technical control of rolling bearings. Well-known methods of diagnostics and technical control require improvement due to non-compliance with the requirements for modern technologies. Thermal testing of rolling bearings, which is the only method that determines problems of a non-mechanical nature, is carried out manually in production. This makes it impossible to switch to a system of maintenance and repair based on the actual condition, predict the final service life of bearings, improve the quality of measurements and eliminate human influence on the measurement results. Thus, the task of developing an application program for thermal monitoring of rolling bearing

performance for the introduction of automation of technical control of equipment in production is relevant.

The application program “Bearing” was developed to solve this problem, which allows automating the technical control of rolling bearings according to two diagnostic parameters: normalized – absolute heating temperature and extra – heating speed [2]. However, in the field of railway transport, two main diagnostic parameters are used – the absolute and relative heating temperature of the bearing.

An improved version of the “Bearing-2” application program has been developed to automate the thermal control of bearings for main and extra diagnostic parameters. The program considers three diagnostic parameters – absolute heating temperature, relative heating temperature, and bearing heating rate. Thus, the program becomes universal and allows it to be used in all industries for various standard sizes of rolling bearings in the system of maintenance and repair according to the actual condition.

The program is developed in the Python programming language, which allows use in various operating systems and integrates it into an existing automated maintenance system.

For operation, “Bearing-2” uses data based on the results of minute-by-minute measurements of the operating temperature of the bearing. The measurement results contribute in a file created in Microsoft Excel. For data processing, enter the maximum values of diagnostic parameters and the time interval for monitoring the heating rate. This is due to the variability of the limit values of diagnostic parameters depending on the bearing size. The relative heating temperature of the bearing is determined as needed. To do this, check the box next to the corresponding cell (Fig. 1).

Налаштування

Колонка "№ виміру"	час
Колонка "температура"	температура
t_max	70
t0_max	50
dt_max	1,1
Діапазон вимірювання dt	15 25

☒ Зберегти

Figure 1 – Initial data for calculation

Based on the results of the analysis of absolute temperature, relative temperature, and the results of calculating the heating rate for each bearing, a report is displayed in abbreviated and expanded form.

The abridged report indicates the conclusion on the suitability for further use of the bearing, indicating the values of abnormal values of diagnostic parameters (Fig. 2).

The extended report indicates the minute-by-minute temperature state of the bearing in the form of an Excel e-book in xls format (Fig. 3). According to the heating rate parameter, the calculation and conclusion on the results of calculating the data are carried out only in the time interval of the regular heating mode of the bearing. This is because the previous disordered heating mode is unsuitable for diagnostics and monitoring, and in the subsequent state of heating stabilization, the bearing heating rate tends to zero. The extended report for each bearing is displayed on a separate page of the control report file.

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report_2021-04-04_04-31-06 – Блокнот
Файл  Правка  Формат  Вид  Справка
Деталь №1 (1 )
Загальна придатність: ПРИДАТНИЙ

Приданість по t_max: True
Приданість по dt_max: True

Деталь №2 (2)
Загальна придатність: НЕПРИДАТНИЙ

Приданість по t_max: False
час  температура  t_max is in borders
26      70.6      False
27      71.5      False
28      72.3      False
29      73.0      False
30      73.8      False
31      74.5      False
32      75.4      False
33      75.7      False
34      75.9      False

Приданість по dt_max: False
час  температура  dt_max is in borders
15      54.8      False

Деталь №3 (3)
Загальна придатність: ПРИДАТНИЙ

Приданість по t_max: True
Приданість по dt_max: True
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Figure 2 – Abridged report of the “Bearing-2” program

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
час	температура	t_max is in borders	t0_max	t0_max is in borders	dt_max	dt_max is in borders																				
0	22,8	ИСТИНА																								
3	23,3	ИСТИНА	0,5	ИСТИНА	-	-																				
6	24,3	ИСТИНА	1,5	ИСТИНА	-	-																				
9	24,6	ИСТИНА	1,8	ИСТИНА	-	-																				
12	23,8	ИСТИНА	1	ИСТИНА	-	-																				
15	23,6	ИСТИНА	0,8	ИСТИНА	-	-																				
18	24,1	ИСТИНА	1,3	ИСТИНА	-	-																				
21	24,1	ИСТИНА	1,3	ИСТИНА	-	-																				
24	25	ИСТИНА	2,2	ИСТИНА	-	-																				
27	25,5	ИСТИНА	2,7	ИСТИНА	-	-																				
30	25,6	ИСТИНА	2,8	ИСТИНА	-	-																				
33	26,1	ИСТИНА	3,3	ИСТИНА	-	-																				
36	26,4	ИСТИНА	3,6	ИСТИНА	-	-																				
39	26	ИСТИНА	3,2	ИСТИНА	-	-																				
42	25,7	ИСТИНА	2,9	ИСТИНА	-	-																				
45	26,7	ИСТИНА	3,9	ИСТИНА		1	ИСТИНА																			
48	26,6	ИСТИНА	3,8	ИСТИНА		-0,1	ИСТИНА																			
51	26,9	ИСТИНА	4,1	ИСТИНА		0,3	ИСТИНА																			

Figure 3 – Detailed report of the “Bearing-2” program

Conclusions. The “Bearing-2” application program allows you to monitor rolling bearings in the maintenance and repair system by their actual condition due to the possibility of integrating the program into an automated diagnostic system. The program allows you to predict the final service life of bearings by creating a database on the results of bearing monitoring. Improves the quality of measurements by using state-of-the-art temperature measuring instruments. Eliminates human influence on measurement results by processing and analyzing data by an electronic computer. The program takes into account all available diagnostic parameters that are used for the thermal monitoring of bearings.

Thus, the development of the “Bearing-2” application program for thermal monitoring of rolling bearing performance ensures the introduction of automation of technical control of equipment in production in all industries.

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