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Non-destructive diagnostics of influence of different factors on rotary systems with bearings of sliding

A. Čereška

Vilnius Gediminas Technical University,

Basanaviciaus str. 28, 03224 Vilnius, LITHUANIA, Phone: +370 5 2370594, Fax. +370 2745043,

E-mail: audrius@me.vtu.lt.

Abstract

In the paper the influence of different factors on a rotary system with bearings of sliding by means of non-destructive diagnostic is studied. The experimental-research stand is described which consists of: gears of refrigeration-lubrication, electronic gears, systems of measurement and analyzes of results. Primary parameters of research stand, its technical possibilities are given and principal scheme of the research stand is given.

Methodology of research is described, the obtained results are discussed.

Keywords: nondestructive diagnostic, rotor system, bearing, factors, amplitude, frequency.

Introduction

Rotary systems with bearings of sliding are currently gaining quite broad applications, because they can work with the better frequencies than systems with rolling bearings. But these systems are investigated much less than bearings of sliding. [1].

Different factors are acting on rotary systems with bearings of sliding. Primary factors influencing on functionality of rotary system, are the following [2]:

- size of clearance between rotor and sliding bearing;
- temperature;
- frequency of the rotor revolution.

Clearance, temperature between the rotor and the bearing and the frequency of rotor revolution have direct influence on a quality of work of rotary system. Getting critical values of these parameter may cause problems of functionality of a rotary system. Only experimental researcher can establish influence of these factors on functionality of a rotary system.

Diagnostics of different systems often is performed disassembling researching system.

Rotary systems are very sophisticated and their disturbance is very unwanted for diagnostics and for repair. In this work the rotary system with bearings of sliding friction with way of all-in-one control is investigated.

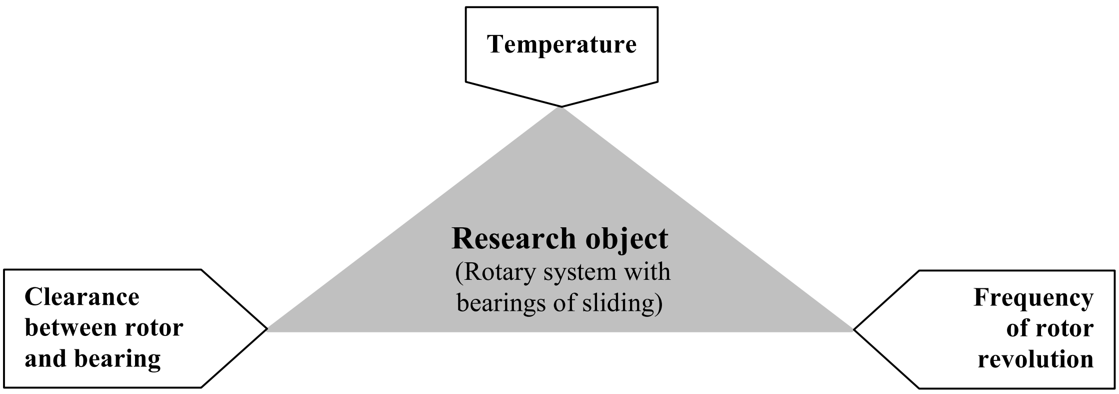

Fig.1. **Primary factors that are acting on a rotary system**

For investigation a special stand is used, in which different measurement transducers for doing all-in-one control may be exploited: non-contact transducers of change measurement, transducers of transducers of vibroacceleration measurement, transducers of vibrospeed measurement, transducers of phase measurement and etc.[3].

Experimental-research stand

Experimental-research stand is complex, that is, it is covering several systems. Several elements are interlinking systems, from its quality depends work of all system.

Experimental stand consists of the following systems:

- rotary system-it is object under investigation;
- electronic system of gear – it is safeguarding revolving movement of rotary system;

- lubrication-refrigeration system, that is safeguarding lubrication and refrigeration of bearings of sliding;
- measurement system, that is including different measurement instruments;
- system of analyzes of measurement results.

All systems are interacting closely and snarling up work of one system it could snarl up operation of all system.

Research system

The rotary system is the system under investigation.

The rotary system consists of a housing of the rotor, the rotor and the bearings of sliding.

Lubrication-refrigeration system

Lubrication-refrigeration system is safeguarding lubrication of bearings of the rotary system.

It is using lubrication-refrigeration system to lubricate and refrigerate bearings of sliding of the rotary system. This system consists of the reservoir of lubricant, the pump of lubricant, manometer, filters, manifolds for supply of lubricant to the zone between the rotor and the bearings.

Electronic system of transmission

This system is putting to vouch and to hold for revolution frequency of the rotor and for regime of a due work. The system consists of the electromotor (of regulation of step less revolution frequency) and the block of control, that is letting revolution frequency of electromotor to regulate in the range 0 – 8000 rev/min.

System of measurement and of results analyzes

System of measurement is interjacent system link between the measuring object and the system of analyzes.

It is using the following measurement transducers:

- non-contact transducers of measurement of vibrochange;

- transducers of measurement of vibrochange or vibrorate;

- accelerometers – the transducers for measurement of vibroacceleration;

- strobe - transducer for measurement of phases.

The measurement system consists of: non-contact transducers for measuring improvement [3], transducers for measuring vibroacceleration [3], photoelectrical transducer for measuring phase [3], different boosters and feedings block and it the transducers for speed measurement.

For measuring of the rotors rotation deflections the non-contact inductive transducers Tr. 102 from the Hettinger Baldwin Messtechnik CMBH (HBM), Germany had been applied.

Transducer of improvement consists of two high sensitivity inductive reels installed in one frame scheme. The reel of measurement is strengthening in the part of lost cylindrical frame and compensatory reel is inside the frame. The carrying frequency is 5 kHz or 50 kHz.

The sensitivity of the transducer depends on the elementary interval L_A and on its banquet ΔL. When small bridge is the balance wheel, the inside interval L_R is equal to the exterior elementary interval L_A.

Accelerometers distinguish itself the widest interval of measuring vibrations signals frequency compare witch transducers of displacement and speeds.

For measuring of absolute vibration accelerations the “Bruel & Kjaer” piezoelectric accelerometers (mod. 4370) are used [3]. Their main characteristics are: the sensitiveness 10...10,12 pC/ms^{-2}, or 99.0...99.4 pl/g; the sensitiveness to voltage 8,84 mV/ms^{-2}, or 86,9 mV/g; the capacitance in together with a hook is 1144 pF; resistance – 2000 MΩ at a room temperature.

Accelerometer is mounted on the frame of the rotor. Witch disposition of strengthening lets to fix accelerometer in any point of measuring.

The principal scheme of experimental-research stand is shown in Fig. 2.

Laser transducers of vibration speed are used for contact less measurements of vibration speeds [4]. They also are used for measurement of vibration speeds and amplitudes of objects with vibrating or rotating rubber or similar non metal parts, of optical equipment (mirrors) and etc., it is there where it is inconvenient or impossible to use accelerometers or inductive transducers of movement or speed.

The speed measurement laser transducer of type 3544 of Danish firm “Bruel & Kjaer” was used for diagnostic measurements of tribological, kechatronical and others systems. The operation principle is based on the Doppler′s effect [5].

The system of analyses consists of a computer with the special board DAD1210. The board DAD1210 is giving results of measurement, for asessment, for control and for control of programs of analyses. Results of measurement are analyzed with programmable packets: *Origin, Data Master, Maple, Ecxel, Matlabe, Statistica* and others.

It is getting all data that is showing state of diagnostic system using these programmable packages.

It is using two transducers for measurements, because it is getting much more primary information in that case than using one transducer. Having more primary information enables get more information about state of the researched system.

Methodology of researches

During measurements primary signals are obtained, which are with different disturbances and with biases due to different factors acting on system. So, the primary signals must be filtrate before doing further analysis.

During filtration the primary signals are analyzed, when different formats of data are got [6], that showing technical state of the system under investigation, breakdowns and the reasons of origin.

Preparative works of adjustment, coordination and calibration were done before doing diagnostic investigation. Experimental investigations were carried using the following method:

1. Calibration of measuring transducers;
2. Coordination of all separate systems;
3. Testing provided clearance between the neck of the rotor and the segment of the sliding bearing;
4. Testing changing the frequency of rotor revolution;
5. Actuating hidrostation, which is supplying oil to chambers of sliding bearings;
6. Actuating electrical motor, which is turning rotating system;
7. Coordinating several components and boosters of measuring transducers;

8. Connecting-up computer;
9. Performing measurements;
10. Data are incorporating into made-up data and informative files;
11. Data are inscribed in made – up files of data and informative files;
12. Measuring results are analyzed using special program packets.

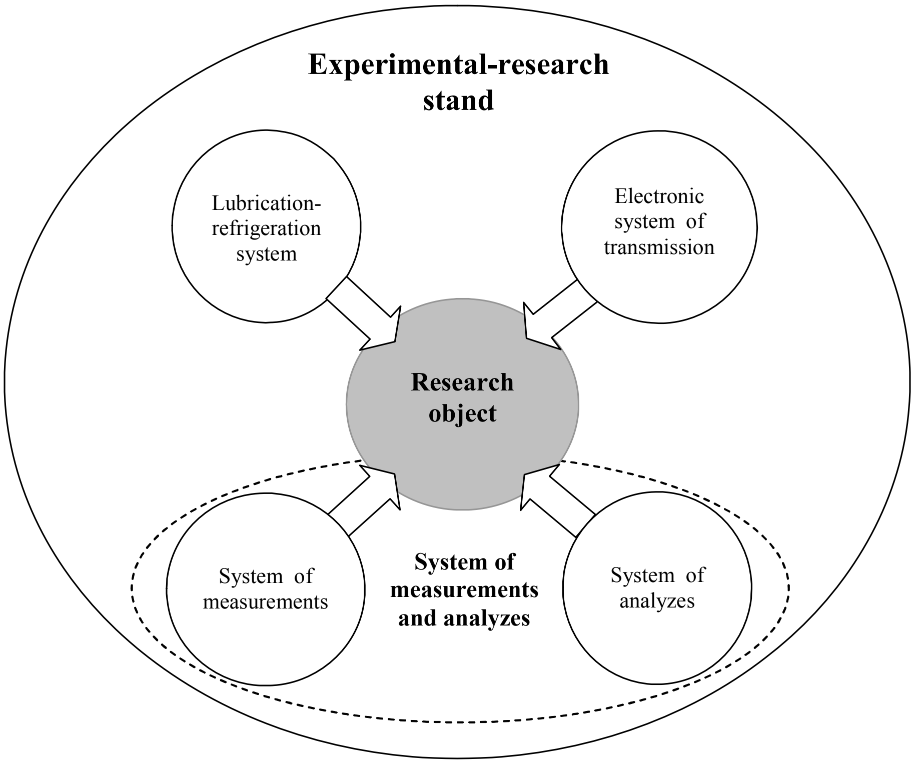

Fig. 2. **Principal scheme of experimental-researching stand**

Results of research and its discussion

The results of experimental research obtained according to the described methodology are presented in Fig. 3, 4 and 5 [7, 8].

Investigating changes of work of a rotary system subjected to varying frequency of rotor revolution it is possible to see that being steady clearance between the rotor and the sliding bearing and enlarging frequency of the

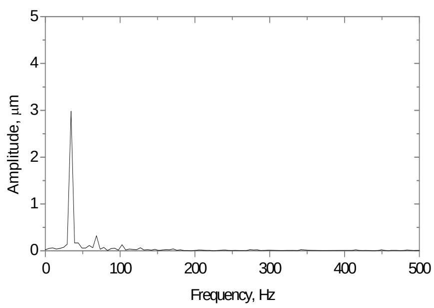

Fig. 3**. Spectrum of signals that are obtained measuring rotary system with bearings of sliding, clearance is 50 μm, frequency of rotor revolution 1000 rev/min**

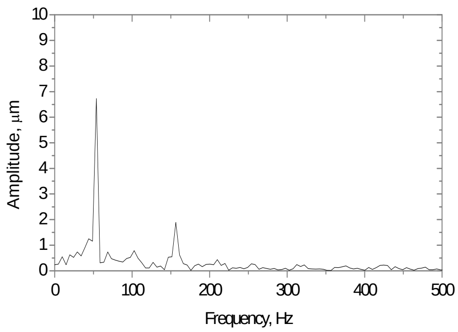

Fig. 4**. Spectrum of signals that are obtained measuring rotary system with bearings of sliding, clearance is 50 μm, frequency of rotor revolution 3000 rev/min**

rotor revolution, spectrum marginally, but is enlarging too. Being clearance between the rotor 50 μm and the frequency of rotor revolution 1000 rev/min, the amplitude of the spectrum is 3,0 μm (Fig. 3), increasing the frequency of the rotor revolution up to 3000 rev/min, the amplitude of spectrum was enlarging to 6,8 μm (Fig. 4).

From the obtained spectra follows, that enlarging clearance between the rotor and the sliding bearing the amplitude of spectrum is increasing also. Being the

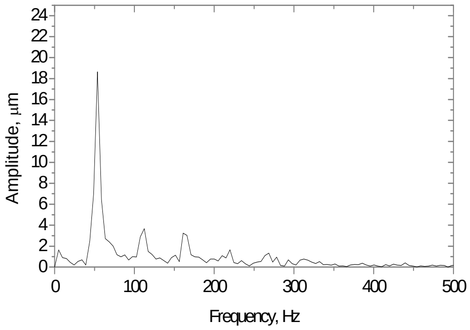

Fig. 5. **Spectrum of signals that are obtained measuring rotary system with sliding bearings, clearance is 100 μm rate of rotor revolution 3000 rev/min**

frequency of the rotor revolution 1000 rev/min, being clearance between the rotor and the sliding bearing 50 μm, the amplitude of spectrum is 3,0 μm (Fig. 3). Enlarging frequency of the rotor revolution to 3000 rev/min, being the same clearance, the amplitude of spectrum is enlarging to 18,8 μm (Fig. 5).

One could not judge about quality of work of the investigated rotary system only by spectra, but they are showing influence of different factors to changes of functionality of the investigated system.

Conclusions

The frequency of rotor revolution varying from 1000 rev/min to 3000 rev/min, the amplitude of spectrum was varying from 3,0 μm to 6,8 μm.

Enlarging the clearance between the rotor and the sliding bearing from 50 μm to 100 μm amplitude of spectrum is varying from 3,0 μm to 18,8 μm.

From the obtained results we can see, that more influence on operation of rotary systems has change of a size of the clearance between the rotor and the bearing of sliding than the change of the frequency of rotor revolution.

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A. Čereška

Įvairių veiksnių įtakos rotorinėms sistemoms su slydimo guoliais neardomoji diagnostika

Reziumė

Neardomosios kontrolės būdu tirtas įvairių veiksnių daromas poveikis rotorinei sistemai su slydimo guoliais. Aprašytas eksperimentinis stendas, kurį sudaro: aušinimo ir tepimo, elektroninė pavaros, matavimo ir rezultatų analizės sistemos. Pateikti pagrindiniai stendo parametrai ir techninės galimybės, nubraižyta principinė schema.

Aprašyta tyrimo metodika. Tyrimo rezultatai pavaizduoti grafiškai, aptarti ir pateiktos išvados.

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