275. Researches of temperature influence on parameters of rotor rotation of rotary system

A. Čereška
Vilnius Gediminas Technical University, J. Basanaviciaus 28, LT-03224 Vilnius, Lithuania
E-mail: ***audrius@me.vtu.lt***

(Received 18 May 2007; accepted 15 June 2007)

Abstract. Rotary systems with bearings of sliding friction are analyzing in this paper. It is researching influence of temperature change on characteristics of work of searching system.

It had done experimental researches trying to ascertain how temperatures change is doing influence on parameters of work of rotary systems with bearings of sliding.

Experimental measurements are doing by methodology that is making specially, using different transducers of measurement.

It is describing and giving principal system of measurement and analysis, its photo, scheme of measurement and methodology of experiments performance. It is getting primary signals of measurement of rotor vibrations, temperature changes and results of analysis are giving in graphs. It is doing analysis of getting results and it is establishing inter-dependences of searching parameters, their consistent patterns of changes and influence on quality of work of searching system.

Keywords: diagnostic, temperature, rotor, rotor system, sliding bearing, transducer.

1. Introduction

Prime tests of efficiency of bearings of sliding are: legal temperature of liquid of working zone of bearing and thickness of unction's coating of liquids film [1, 2].

Film of unction, which is warranting efficiency of bearing, is bursting: transferring bearing, being a little speed of sliding or being over thermal effect [3, 4].

Thickness of unction of film of unction of film has through influence for prime schedules of rotors work. To some operating conditions temperature in zone of bearings work is affecting critical meanings, then it is decreasing viscosity of liquid and thickness of unction of film, then bearing is passing into half-fluid schedules of unction.

Increase of coefficient of friction is determining progressive emission of warm theretofore while temperature of thickness of unction is touching critical line to which liquid is losing features of unction and it is happening direct contact of working surfaces of bearing [5].

Measuring vibrations it can establish not only particular component, its element's defect and breakdown, to follow it's progress in working machine, but and to find reasons that had made it. Breakdowns can be concerned with change of dynamic powers of rotary system or with change of temperature. Dynamic powers and changes of temperature are operating on rotary system, on its elements, that is are stimulating mechanic vibrations and vibrations of liquid or are changing its sizes.

Change of dynamic powers or temperature or coming are relating with separate component of machine or with defects of all system may conditioned external and internal changes.

2. Experimental testing system

The system of measuring form: non-contact transducers of measuring improvement, thermometer of measuring temperature, different boosters and feedings block and it can be used transducers of speed measuring.

It is using different transducers of measurement to do measurements [4, 5, 6]:

- non-contact transducers of measurement of changes (firm of Germany Hettinger Baldwin Messtechnik CMBH (HBM) - mod. Tr 102.). Transducer of improvement consists of two large sensitiveness inductive reels installed in one frame scheme. Reel of measurement is strengthening in the part of lost cylindrical frame and compensatory reel is inside of frame. Carrying frequency is 5 kHz or 50 kHz.
- transducers of measurement of vibrospeed (firm of Denmark "Briuel & Kjaer" (Laser mod. 3544)). Principal of its work is based on Doppler′s effect. Doppler′s effect means that light beam being reflected from surface of vibrating object, will vibrate with the frequency proportional to vibration speed of a snatch. It matters that reflected beam will be modulated by Doppler′s frequency. Frequency of reference channel is changed by changing revolving frequency of a disk and is divided to two ranges – 4 Hz, 0…0.02 m/s and 15 Hz, 0…1 m/s.
- transducers of measurement of vibroaccelerations (firm of Denmark "Briuel & Kjaer" piezoelectric accelerometers (mod. 4370)). It's the main characteristics are: sensitiveness according to change 10...10,12 pC/ms^{-2}, or 99.0...99.4 pl/g; sensitiveness according to voltage 8,84 mV/ms^{-2}, or 86,9 mV/g; capaciousness in common with

hook is 1144 pF; resistively – 2000 MΩ min in room temperature.

- photoelectric transducer to measure phase (strobe) – original constructions;
- It is using special transducer of temperature LM 135 for measurement of temperature of Microelectronics firm. The LM 135 are precision temperature sensors which can be easily calibrated. They operate as a 2 – terminal Zener and the breakdown voltage is directly proportional to the absolute temperature at 10 mV/°K. The circuit has a dynamic impedance of less than 1 Ω and operates within a range of current from 450 μA to 5 mA without alteration of its characteristics. Calibrated at + 25 °C, the LM 135 have a typical error of less than 1 °C owner a 100 °C temperature range. Unlike other sensors, the LM 135 has a linear output.

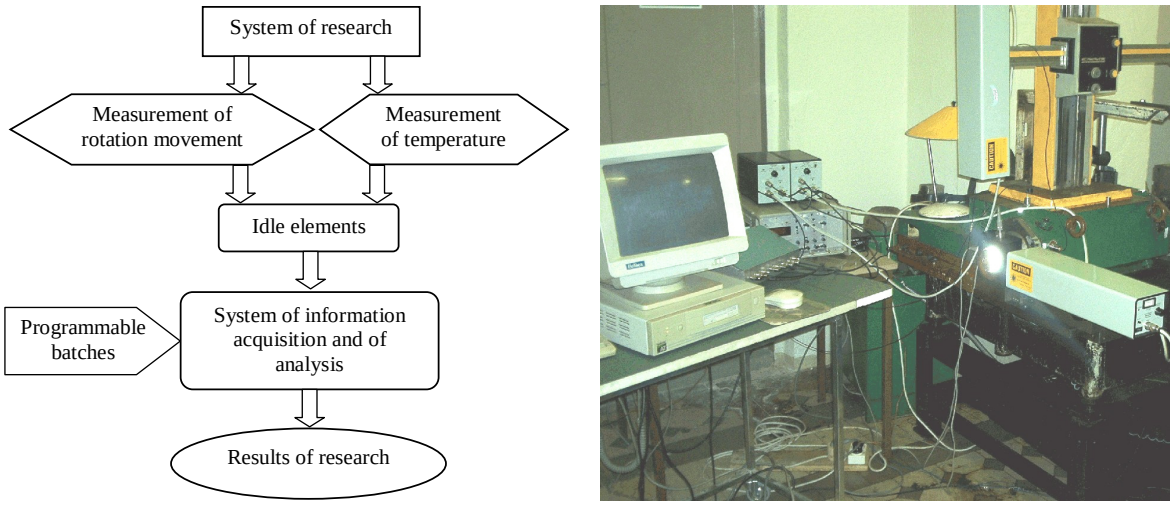
The plate of input-output DAD1210 of universal electric signals is used for transmissions information to computer, for strengthen of transducers signals and for government of experiment. The special plate DAD1210 of loading-withdrawal is feeding transducer.

The plate of input-output of universal electric signals is realized:

- Input-output function of programming of universal information;
- Function of time intervals formatting of programming length;
- Exchange of numerical signal to analogue function;
- Function of strength of programming analogical signal;

Exchange of analogical signal to function of numerical code.

Principled scheme of searching system is showing in Fig 2.



a b

Fig. 2. Experimental testing system
a - Principled scheme; b - Experimental testing stand (photo)

3. Position of transducers measuring

In diagnostically measurements transducers of measurement are lay out 90° corners of phases in respect of ones other in the thrust of sliding bearing and in the one table of roll of cross-section how is showing in figure (Fig. 2).

So position of transducers is letting to measure position of roll neck in respect of opening of sliding bearing, being any frequency of rotor rotation including and zero. It is not necessary that orientation of transducers has to be vertical or horizontal. It's choosing most comfortable position to construction of mechanism.

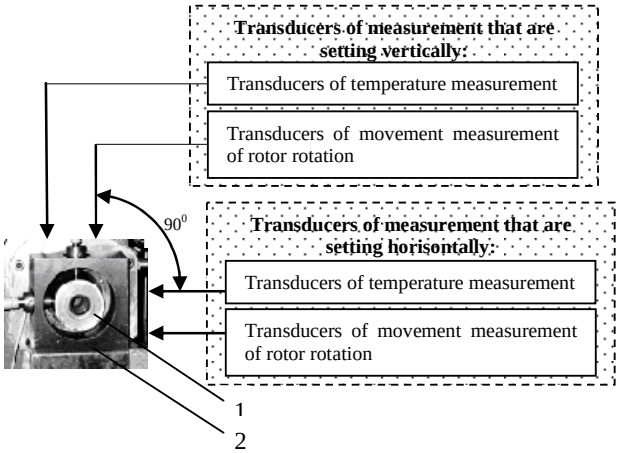


Fig. 2. Principal scheme of measurement
1-rotor; 2-holder of transducers

4. Methodology of experimental investigation

Experimental measurements of rotors system with bearings of friction of sliding diagnostically change of value of clearance from temperature and measurements of frequency of rotors rotation had done with help of non-contact transducers of change Tr.102 and with help of special thermometers. All signals of measuring are reducing to universal input-output plate DAD1210 of signals that is embed in computer. Getting results are processing using program packets "Origin 6.0", "Statistica", "Excel", „Data Master" and others [6, 7].

It is using special stand for doing diagnostic measurements of change of sizes clearance of tribological system with bearings of sidings friction and for measurements of temperature and for doing investigations.

Preparative works of regulation and coordination and calibration of special thermometers were done before doing diagnostically researches. Diagnostically researches were done such method:

1. It is doing adjustment of system, calibration of transducers of change measuring and calibration of special thermometers;
2. Non-contact transducers of change measurement and thermometers are fixing on stand;
3. It is doing adjustment of rotor and of truth of axis's of engine tree;
4. It is establishing provided clearance between neck of rotor and segment of sliding bearing;
5. It is turning on hydro station, that is giving in lubricant to cells of sliding bearings;
6. It is turning on and squaring boosters of measurement channels;
7. It is throwing computer;
8. It is actuating electromotor, that is rotating rotary system;
9. Information are entering up in file of data and in information file;
10. It is doing analysis of measurement results.

5. Results of researches and theirs analysis

It is seeing by getting primary measurement results, that temperature which is measuring with transducers of temperature measurement that are fixing vertically and horizontally are differencing (Fig. 3). It is differencing and value of clearance too between rotor and neck of sliding of bearing that is measuring in vertical and horizontal direction. That is seeing by sizes of primary signals of measurement of change (Fig. 4, 5).

Difference between primary signals, vertical and horizontal directions, amplitudes is 4 μm. (Fig. 4, 5). Difference between peaks of amplitudes of spectrums of primary signals is 1,25 μm. (Fig. 6, 7).

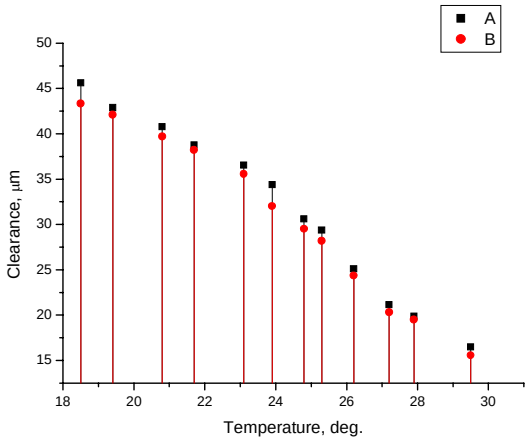


Fig. 3. Change of clearance between rotor and bearing, subject to change of temperature, when n = 2000 rev/min (1 – results of measurements in the horizontal plane, 2 - results of measurements in the vertical plane)

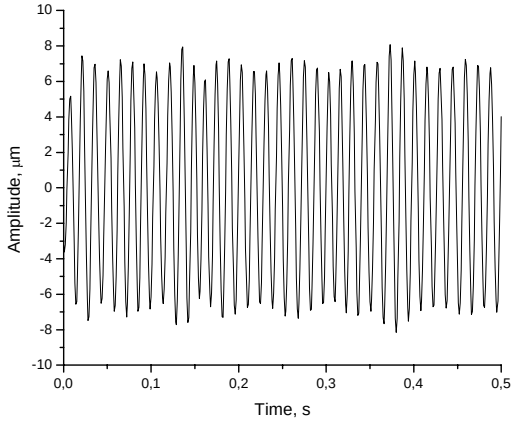


Fig. 4. Primary signal of vibrochange that was measuring on vertically direction

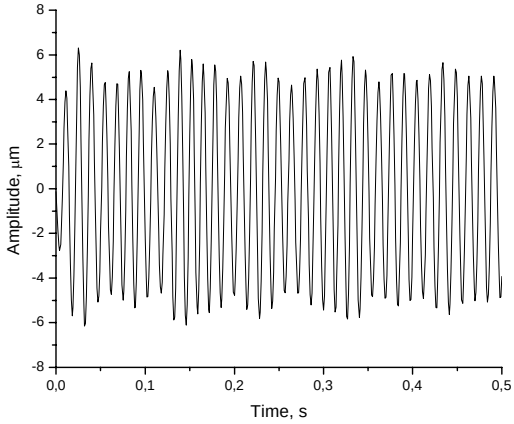


Fig. 5. Primary signal of vibrochange that was measuring on horizontally direction

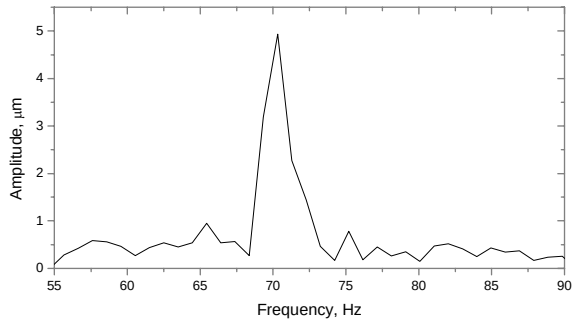


Fig. 6. Spectrum of primary signal of vibrochange that was measuring on vertically direction

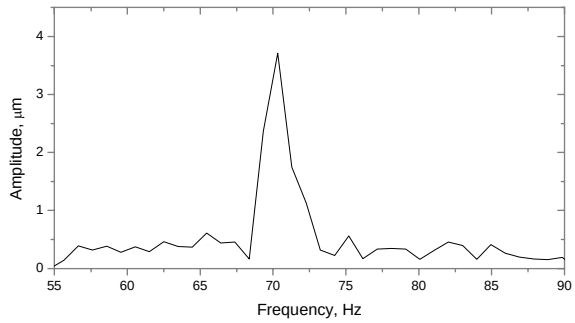


Fig. 7. Spectrum of primary signal of vibrochange that was measuring on horizontally direction

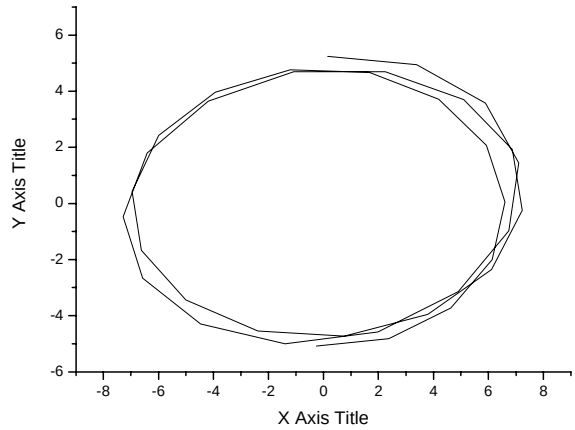


Fig. 8. Orbit of rotor rotation

Then it is seeing, that there are different sizes of temperature and of clearance between rotor and bearing of sliding in different directions of measurement (in vertical and in horizontal). So orbit of rotor rotation is not ideal form of circle, it's trajectory of movement is form of ellipse.

6. Conclusions

1. Sizes of temperature are getting measuring transducers of temperature measurement that are setting vertically and horizontally are not even (Fig. 3).
2. By amplitudes of primary signals of measurement (Fig. 4, 5) it is seeing that change of rotor are different in vertical direction and in horizontal direction.
3. Difference between primary signals, vertical and horizontal directions, amplitudes is 4 µm. (Fig. 4, 5).
4. Difference between peaks of amplitudes of spectrums of primary signals is 1,25 µm. (Fig. 6, 7).
5. Seeing that changes of rotation of rotor axle are different in vertical direction and in horizontal direction, trajectory is form of ellipse of orbits of rotor axle (Fig. 8).

7. References

[1] Vekteris V. Adaptive Tribological Systems. Theory and Application. – Scientific publications. – Vilnius: Technika, 1996. 203 p.

[2] Glavatskih S. B. A Method of Temperature Monitoring in Fluid Film Bearings. Tribology International, Volume 37, Issue 2, February 2004, 143-148 p.

[3] Ettles C. M. The Thermal Control of Friction at High Sliding Speeds. Journal of Tribology Transactions of the ASME. Volume 108. No. 1. 1986. 71-79 p.

[4] Winer W. O. Effect of Surface Film on the Surface Temperature of a Rotating Cylinder. . Journal of Tribology Transactions of the ASME. Volume 108. No. 1. 1986. 92-97 p.

[5] Cansiz A. Correlation Between free Oscillation Frequency and Stiffness in High Temperature Superconducting Bearings. Physica C: Superconductivity, Volume 390, Issue 4, 15 July 2003, 356-362 p.

[6] Vekteris V., Čereška A. Diagnostics of Functioning Quality of the Systems with Sliding Bearings. Mechanika. Nr.2 (34) Kaunas: Technologija. 2002. 51-56 p.

[7] Figliola R. S. Beasley D. E. Theory and design for Mechanical Measurements: John Willey and Sons, New York, 1991. - 450 p.

[8] Jurevičius M., Čereška A. Use of laser Transducers in Diagnostics of Tribological Systems. Journal of Vibroengineering, 2000 No3(4) p.199-201.