Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 113 (2015) 332 – 336

Procedia Engineering

www.elsevier.com/locate/procedia

International Conference on Oil and Gas Engineering, OGE-2015

The research of rotation frequency influence and technical state condition upon the level of vibration spectrum components of rolling bearings

Kazarin D.V.[a], Bazakin V.V.[a], Zaytsev A.V.[a], Teterin A.O. [a], Kudryavtseva I.S.[a,b]*

[a]OOO NPC " Dynamics", 108, Rabinovicha St., Omsk 644007, Russian Federation
[b]Omsk State Technical University, 11, Mira Pr., Omsk 644050, Russian Federation

Abstract

The aim of this paper is to carry out the research of rotation frequency influence and technical state condition of rolling element bearings upon the level of vibration spectrum components which corresponds to the frequencies of rolling element bearing failure exposures. The research was being carried out on the basis of experimental planning by means of experimental board enabling to assign frequency and to record vibration signal. Different types of bearings have been subjected to the experiment. Those were: regular rolling element bearings as well as rolling element bearings having artificiality created failures and the bearings with failures which have been received during long-term utilization. The results obtained show the availability of direct dependence between the level of spectrum components which corresponds to the frequencies of rolling element bearing failure exposures and rotation frequency. It should be noted that the responsiveness of the given dependence is directly connected with the technical state of the rolling element bearing being investigated.

These results were taken into account while comprising mathematical models of rolling element bearings vibration used in automatic expert diagnostic system series.

Peer-review under responsibility of the Omsk State Technical University

Keywords: rolling bearing; vibrodiagnostic vibration spectrum; rotation frequency; experimental board

* Corresponding author. Tel.: +7-381-225-4244; fax: +7-381-225-4372.
*E-mail address:*post@dynamics.ru

Peer-review under responsibility of the Omsk State Technical University
doi:10.1016/j.proeng.2015.07.274

1. Introduction

Rolling bearings are considered to be one of the most widely spread and responsible elements applied in up-to-date machine building industry. Their technical state provides not only the reliability of machine's running but also technogenic safety of the processes in which these machines take part consequently [1].

The most effective technique which enables to detect embryonic and developed failures of rolling bearings is the vibroacoustic technique of non-destructive verification [2].

Vibration spectrum analyses is used to determine failures of internal and external shackles, rolling element bearing failures, lubrication, separator failures as well as setting and fitting ones. It suffices to notice as a rule frequencies of failure exposures in the spectrum of the vibration signal is associated with rolling element rotation frequency by familiar relations [1].

Since rolling element bearing utilization is connected with the rotation frequency changes in the wide range it is required to know the link between rotation frequency and technical state of rolling element bearings and the level of vibration spectrum components which correspond to the frequencies of rolling element bearings failures. To achieve these objectives it is necessary to solve the following tasks:

- to develop experiment technique running which will make it possible to define rotation frequency and technical state influence upon the levels of vibration spectrum which corresponds to frequency failure exposures;
- to put into operation to realize the experimental board which allows to assign prescribe different rotation frequencies for rolling elements bearings as well as to make records of vibration signals.

2. Study subject

A regular rolling element bearing, rolling element bearings with artificially created failures of external and internal shackle and rolling element bodies failures which appeared during the process of long - term utilization have been subjected to the experiment.

3. Methods

The research was being carried out by means of experimental board, performed on the basis of Vibrodiagnostic system of dynamic equipment (VSDE) – Radio Receiving Transmitting Device (RRTD) using 1602 drive. It allows to assign the magnitude of axis and radial load, rotation frequency and to measure vibration in radial direction (Fig. 1). The research was being carried out in accordance with the fundamentals of experiment planning according to the techniques prescribed in Fig. [3] While experimenting the record of temporary vibroacoustic signal realization was performed. Later it was processed and the levels of spectrum components corresponding to the frequencies of rolling element bearing failures were calculated.

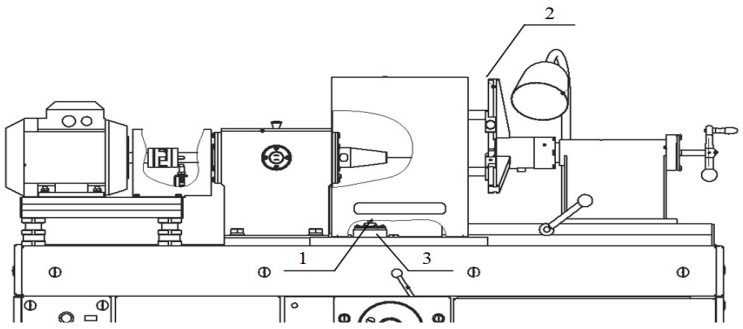

Fig. 1. Experimental board: 1 – vibration sensor setting place, 2 – axis loading preloading device, 3 – radial load device

4. Results and discussion

Fig. 2-5 show the chart graphs of dependence of spectrum components levels corresponding to the frequencies rolling element bearings failures against rotation frequency.

Due to the results obtained it is determined that the spectrum components vibration level and rotation frequency are connected by direct dependence. Besides the dependence inclination is directly connected with technical condition of the bearing investigated. Fig. 2-4 show that according to the spectrum components which are corresponding to internal and external shackle failure exposures as well as rolling element failures. It should be stressed that rolling element bearing having failures and taken out of running has the largest components level.

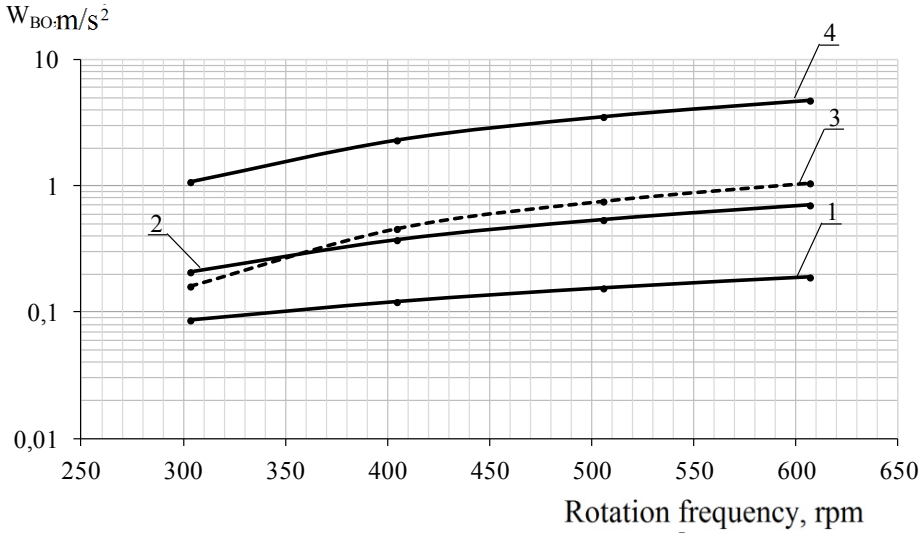

Fig. 2. The dependence of spectrum components f_{BPFO} magnitude upon rolling bearing rotation frequency: 1 – regular bearing, 2 – bearing having internal shackle failures, 3 – bearing having external shackle failure, 4 – bearing having rolling element failure

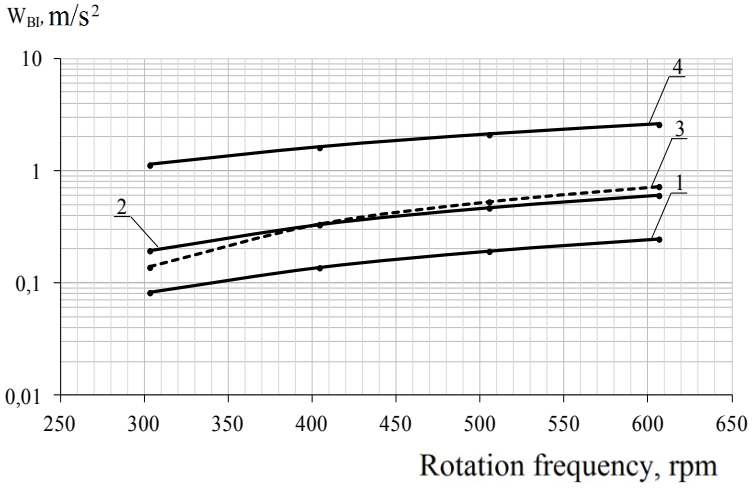

Fig. 3. The dependence of spectrum component f_{BPFI} against rolling bearing rotation frequency: 1 – regular bearing, 2 – bearing having internal shackle failures, 3 – bearing having external shackle failure, 4 – bearing having rolling element failure

It has been determined that the levels of spectrum components for the rolling element bearings having artificially created established failures are slightly different from each other. The level of spectrum components corresponding to the rolling element bearing failure exposure frequencies appeared for regular bearing appeared to be lower than for the bearings having artificially created failures. It also refers to the rolling element bearing being taken from utilization according to 2 and 10 times.

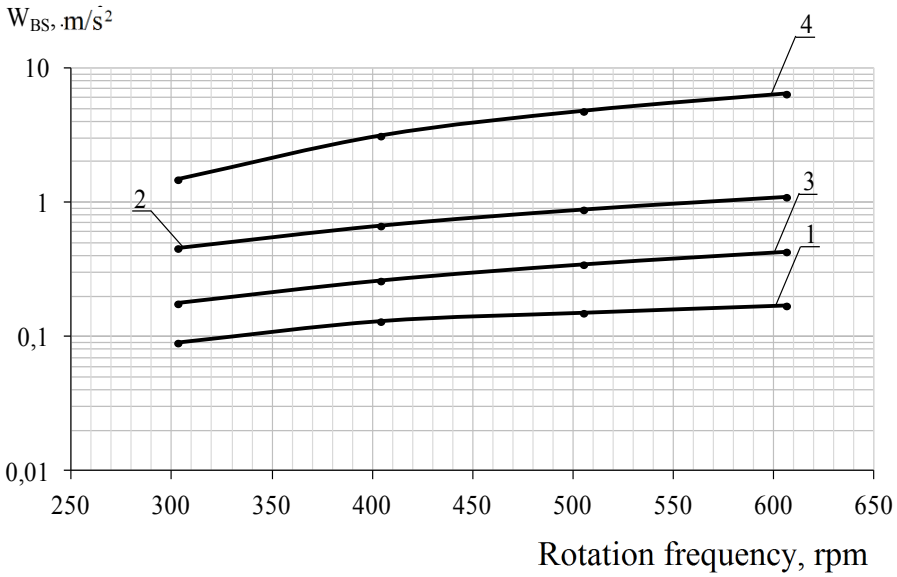

Fig. 4. The dependence of spectrum component magnitude f_{BSF} against rolling bearing rotation frequency 1 – regular bearing, 2 – bearing having internal shackle failures, 3 – bearing having external shackle failure, 4 – bearing having rolling element failure

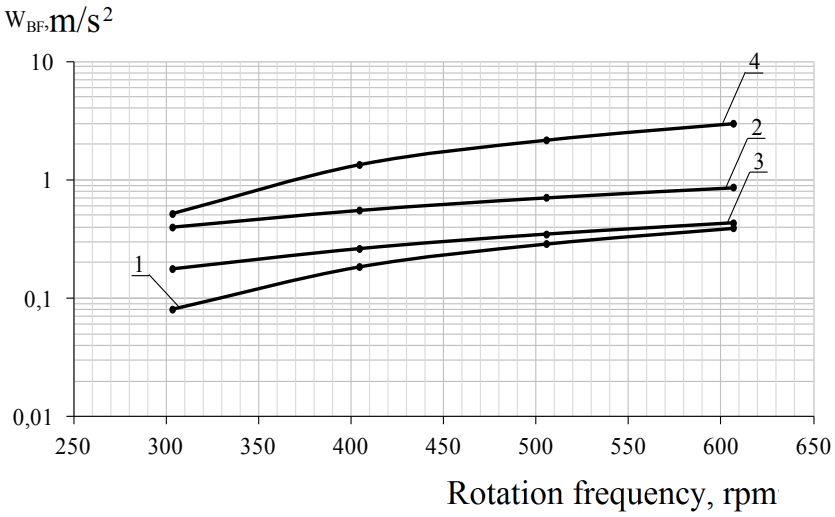

Fig. 5. The dependence of spectrum component f_{FTF} magnitude against rolling rotation frequency: 1 – regular bearing, 2 – bearing having internal shackle failures, 3 – bearing having external shackle failure, 4 – bearing having rolling element failure

The figures 2-5 mentioned above show that dependence graphs for rolling element bearings having various technical state differ not only concerning parameters levels but also due to its changes taking into account rotation frequency changes. Dependence argument quick response against rotation frequency may be described in terms of slope term which labels slope ratio dependency graph towards x - axis. Slope term of spectrum components magnitude dependency according to rolling element bearing failure frequency exposure against rotation frequency is presented in Table 1.

Table 1. Slope term of spectrum components dependency against rotation frequency

	f_{BPFO}	f_{BPFI}	f_{BSF}	f_{FTF}
	Slope term, x102			
Regular bearing	0,03	0,05	0,03	0,10
Bearing having internal shackle failure	0,29	0,14	0,21	0,15
Bearing having external shackle failure	0,16	0,19	0,08	0,08
Bearing having rolling element failure	1,21	0,48	1,63	0,81

On the one hand the most quick response of spectrum components level against rotation frequency has the bearing having been taken from utilization. It should be stressed that it is the spectrum component which corresponds to the frequency rolling elements failure exposure approves its availability which has been defined while rolling element bearing.

On the other hand the regular bearing has the least quick response of spectrum components level against rotation frequency.

Analyzing the results obtained we can conclude that the technical state of rolling element bearing influences markedly upon the dependency of spectrum components level which corresponds to rolling element bearing failure exposure frequencies against rotation frequency.

5. Conclusion

The results obtained during our investigation have been taken into account as the fundamentals in comprising rolling element bearing vibration mathematical models are used in automatic expert systems of rolling element bearing diagnostics series.

References

[1] Kostukov V.N. Monitoring besopasnosty proizvodstva. M.: Mashinostroenie. 2002. p. 224.(in Russian)

[2] Kostukov V.N. Osnovu vibroakusticheskoy diagnostiky i monitoringa mashin: Uchebnoe posobie / V.N. Kostukov, A.P. Naumenko. Omsk: Izd-vo OmGTU. 2011. p. 360. (in Russian)

[3] Metodika eksperimentalnux issledovanii vibratsii podshipnikov / A.V. Zaitsev, V.V. Basakin, I.S. Kudrevtseva, A.O. Teterin // Dinamika sistem mexanizmov i mashin. - Omsk: OmGTU 2014. - №4. - p. 112-115. (in Russian)

International Conference on Oil and Gas Engineering

(OGE-2015)

Procedia Engineering Volume 113

Omsk, Russia
25-30 April 2015

Editors:

V. Myshlyavtsev

Vladimir A Likholobov
Vladimir L. Yusha

ISBN: 978-1-5108-0988-8

Printed from e-media with permission by:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571

Some format issues inherent in the e-media version may also appear in this print version.

Printed by Curran Associates, Inc. (2015)

For permission requests, please contact Elsevier B.V.
at the address below.

Elsevier B.V.
Radarweg 29
Amsterdam 1043 NX
The Netherlands

Phone: +31 20 485 3911
Fax: +31 20 485 2457

http://www.elsevierpublishingsolutions.com/contact.asp

Additional copies of this publication are available from:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571 USA
Phone: 845-758-0400
Fax: 845-758-2634
Email: curran@proceedings.com
Web: www.proceedings.com

TABLE OF CONTENTS