Mechanical Systems and Signal Processing 25 (2011) 521–536

Contents lists available at ScienceDirect

Mechanical Systems and Signal Processing

journal homepage: www.elsevier.com/locate/jnlabr/ymssp

The possibility of evaluating turbo-set bearing misalignment defects on the basis of bearing trajectory features

Józef Rybczyński *

Institute of Fluid-Flow Machinery, Polish Academy of Sciences, Fiszera 14, 80-952 Gdańsk, Poland

ARTICLE INFO

Article history:
Received 20 May 2009
Received in revised form
9 July 2010
Accepted 15 July 2010
Available online 29 July 2010

Keywords:
Bearing misalignment
Rotating machine
Vibration
Bearing trajectory
Technical diagnostics

ABSTRACT

This paper presents the results of computer simulation of bearing misalignment defects in a power turbogenerator. This malfunction is typical for great multi-rotor and multi-bearing rotating machines and very common in power turbo-sets. Necessary calculations were carried out by the computer code system MESWIR, developed and used at the IFFM in Gdansk for calculating dynamics of rotors supported on oil bearings. The results are presented in the form of a set of journal and bush trajectories of all turbo-set bearings. Our analysis focuses on the vibrational effects of displacing the two most vulnerable machine bearings in horizontal and vertical directions by the maximum acceptable range calculated with regard to bearing vibration criterion. This assumption required preliminary assessment of the maximum values for the permissible bearing dislocations. We show the relations between the attributes of the particular bearing trajectories and the bearing displacements in relation to their base design position. The shape and dimensions of bearing trajectories are interpreted based on the theory of hydrodynamic lubrication of oil bearings. It was shown that the relative journal trajectories and absolute bush trajectories carry much important information about the dynamic state of the machine, indicating also the way in which bearings are loaded. Therefore, trajectories can be a source of information about the position and direction of bearing misalignments. This article indicates the potential of using trajectory patterns for diagnosing misalignment defects in rotating machines and suggests including sets of trajectory patterns to the knowledge base of a machine diagnostic system.

© 2010 Elsevier Ltd. All rights reserved.

1. Introduction

Large power turbo-sets are usually built as multi-housing and multi-rotor machines. Rotors of particular parts of a typical steam turbogenerator are linked together via rigid or semi-rigid couplings, and are supported in numerous oil bearings. From the viewpoint of mechanics, rigid couplings make the multi-rotor shaft line a continuous structure. The bearings in a multi-support machine are arranged in such a way that the shaft line constitutes a catenary and this enables a proper load distribution among particular bearings and eliminates objectionable shaft bending at the couplings. The catenary is determined theoretically in the design phase and then practically implemented in the process of machine assembly by proper positioning of particular bearings with respect to the geodesic line [1–3].

Displacing any of the turbo-set bearings from its optimal position, defined by the shaft catenary, changes conditions of operation of the oil bearings and, consequently, of rotors supported on them. The distribution of the static load of bearings

* Tel.: +48 58 6995273; fax: +48 58 3416144.
E-mail address: ryb@imp.gda.pl

0888-3270/$ - see front matter © 2010 Elsevier Ltd. All rights reserved.
doi:10.1016/j.ymssp.2010.07.011