



The XIX Vibration Engineering and Technology of Machinery Conference

VETOMAC-XIX

Edited by
Romuald Rządkowski



Proceedings of VETOMAC 2024

**The XIX Vibration Engineering &
Technology of Machinery Conference**

Gdańsk, Poland, September 16-18, 2024

**Organised by Institute of Fluid Flow Machinery (IMP PAN)
Polish Academy of Sciences**

**Edited by
Romuald Rządkowski**



Gdańsk 2024

All rights reserved. No part of this publication may be reproduced or transmitted in any form without the prior written permission of the copyright owner.

The contents of all the papers in this volume were set individually by the authors or under their supervision.

No responsibility is assumed by the Publisher for any injury and/or damage to persons or property as a matter of products liability, negligence or otherwise, or from any use or operation of any methods, products, instructions or ideas contained in the material herein.

ISBN 978-83-66928-14-5

© Copyright by the Institute of Fluid Flow Machinery
Polish Academy of Sciences (IMP PAN), Gdańsk 2024



Wydawnictwo Instytutu Maszyn Przepływowych
ul. J. Fiszer 14, 80-231 Gdańsk,
tel.: 58 6995141
e-mail: redakcja@imp.gda.pl



CHAIRS

Prof. Romuald Rzadkowski
Institute of Fluid Flow Machinery, Polish Academy of Sciences, Gdansk, Poland

Leszek Pacuła
INTECH Engineering Sp. z o.o., Gdansk, Poland

CONFERENCE PARTNER



INTECH Engineering Sp. z o.o.

ORGANIZING COMMITTEE

Arkadiusz Koprowski Institute of Fluid Flow Machinery, Polish Academy of Sciences, Gdansk, Poland

Dr Pawel Troka Institute of Fluid Flow Machinery, Polish Academy of Sciences, Gdansk, Poland

CONFERENCE SECRETARIATS

Arkadiusz Koprowski Institute of Fluid Flow Machinery, Polish Academy of Sciences, Gdansk, Poland

SCIENTIFIC COMMITTEE

Prof. N. S. Vyas	Indian Institute of Technology–Kanpur, India
Prof. J. M. Balthazar	University Estadual Paulista, Brazil
Prof. R. Tiwari	IIT Guwahati, India
Prof. Z. Dimitrova	NOVA School of Sc.&Tech, Portugal
Prof. Jyoti K. Sinha	The University of Manchester, UK
Prof. C. Nataraj	Vilanova University, USA
Prof. A. K. Darpe	IIT Delhi, India
Prof. Mayank Tiwari	IIT Patna, India
Prof. M. C. Luintel	KTU, Nepal
Prof. M. Lackowski	Institute of Fluid-Flow Machinery PAS, Gdansk, Poland
Prof. M. Zieja	Air Force Institute of Technology, Warsaw
Prof. K. Gupta	Indian Institute of Technology, Delhi, India
Prof. Yuantai Hu	Huazhong University of Science and Technology, P.R. China
Prof. S. Narayanan	Indian Institute of Science, Bangalore, India
Prof. A.D. Raj Kumar	Osmania University, Hyderabad, India
Prof. K. Narayana Rao	Member Secretary, AICTE, New Delhi, India
Prof. D.N. Reddy	Jawaharlal Nehru Technological University, India
Prof. Tielin Shi	Huazhong University of Science and Technology, P.R. China
Prof. R. Szczepanik	Air Force Institute of Technology, Warsaw
Prof. Qingguo Meng	Meng NSFC, China
Prof. Cheng Wang	Hohai University, P.R. China
Prof. Guang Meng	Shanghai Jiao Tong University, China
Prof. R. Kielb	Duke University, Durham, North Carolina, U.S.A
Prof. J. Kiciński	Institute of Fluid-Flow Machinery PAS, Gdansk, Poland
Prof. R. Rzadkowski	Institute of Fluid-Flow Machinery PAS, Gdansk, Poland
Prof. C. W. Lim	City University of Hong Kong, Hong Kong, China
Prof. J. Sawicki	Cleveland University, U.S.A



KONSORCJUM W SKŁADZIE:

Instytut Maszyn Przepływowych im. Roberta Szewalskiego
Polskiej Akademii Nauk, INTECH Engineering Sp. z o.o.
realizuje projekt aplikacyjny pt.



“Turbina parowa 1MW zasilana parą wodną, wykorzystująca ciepło odpadowe i procesowe”
nr POIR.04.01.04-00-0116/17 dofinansowany z Funduszy Europejskich

Celem projektu jest zaprojektowanie, wyprodukowanie i wdrożenie w przepompowni gazu innowacyjnej turbiny parowej o mocy 1MW, dopasowanej do parametrów pary produkowanej w kotle utylizacyjnym obiegu gazowo - parowego, wykorzystującym ciepło odpadowe z turbiny gazowej.

Dofinansowanie projektu z UE: 5 980 735,37 zł



www.mapadotacji.gov.pl

Table of Contents

Table of Contents	5
Preface	7
Design and analysis of a new solution for a shroud of steam turbine blade	8
<i>Radosław Bondyra, Krzysztof Dominiczak, Leszek Kubitz, Romuald Rządowski</i>	
Changes in the friction torque of a multi-segmented active foil bearing	14
<i>Lukasz Breńkacz, Paweł Bagiński, Artur Andrearczyk</i>	
Coupled analysis of turbine last stage blade vibrations affected by exhaust hood	15
<i>Yuriy Bykov, Lyubov Kolodyazhna, Romuald Rządowski</i>	
Intelligent misalignment detection in geared rotors: a transfer learning approach	29
<i>Pantha Pradip Das, Rajiv Tiwari, Dhrubajyoti Bordoloi</i>	
Vibration signature analysis of the rotor in induction motor due to unbalanced magnetic force under static eccentricity	38
<i>Rakesh Deore, Bipul Brahma, Karuna Kalita</i>	
Detection of the eccentricity-related faults in an induction motor by using discrete wavelet transform	50
<i>Rakesh Deore, Bipul Brahma, Santosh Kumar, Karuna Kalita</i>	
Analysis of the effect of blade mistuning on the vibrational stress state of an aircraft GTE compressor disk	61
<i>Oleh Derkach, Anton Olkhovskiy, Artem Ratynskiy</i>	
Analysis of instability of moving vehicle on layered models of railway track	69
<i>Zuzana Dimitrovová</i>	
Estimation of fluctuations in thermodynamic-flow parameters in start-up states of a low-power steam turbine ...	76
<i>Jerzy Głuch</i>	
Effect of line orientation on the 3D printed fused filament fabricated parts using TSP solver: a numerical study	85
<i>Kanak Jindal, Sajan Kapil</i>	
Kinematics of a novel machine tool for additive manufacturing	92
<i>Kanak Jindal, Sajan Kapil, B S Reddy</i>	
ORC units and turbines for waste heat recovery	105
<i>Piotr Klonowicz, Łukasz Witanowski, Tomasz Suchocki, Piotr Lampart</i>	
Computational fluid dynamics approach for calculating equilibrium positions in hydrodynamic journal bearings	106
<i>Arkadiusz Koprowski, Romuald Rządowski, Leszek Kubitz, Leszek Pacuła</i>	
Investigation of blade flutter in the last stage of steam turbines and the role of exhaust hood and stator blades .	110
<i>Arkadiusz Koprowski, Romuald Rządowski, Leszek Kubitz, Adam Feldzensztajn</i>	
Hydrogen power plant with the highest efficiency and zero emissions	114
<i>Krzysztof Kosowski</i>	
Tip-timing system for measuring rotor blade vibration using an FPGA unit	116
<i>Piotr Kowaleczko, Romuald Rządowski, Paweł Troka, Leszek Kubitz, Krzysztof Dominiczak</i>	
Challenges and solutions in developing a virtual thermometer using machine learning: a case study with Scikit-Learn's random forest regression	126
<i>Sylwia Kruk-Gotzman, Grzegorz Bzymek, Tomasz Ochrymiuk</i>	

Machinery diagnostics integrating physics and machine learning	127
<i>C. Nataraj</i>	
A new design of hydrodynamic bearing system for 1 MWe steam turbine with non-standard steam parameters at the inlet and outlet	128
<i>Artur Olszewski, Michał Wodtke, Dominik Olszewski, Emil Olszewski, Romuald Rządkowski, Arkadiusz Koprowski</i>	
Enhancing condition monitoring and diagnostics of large synchronous motors and generators through advanced vibration analysis: practical case studies and solutions.....	140
<i>Ali Rastegari</i>	
Dynamic analysis of 1 MW steam turbine during run-up.....	151
<i>Romuald Rządkowski, Leszek Kubitz, Arkadiusz Koprowski, Krzysztof Dominiczak, Krzysztof Feldzensztajn, Maciej Szymkiewicz</i>	
Passive damping treatment of curved panel vibration using a viscoelastic particulate composite spacer layer	154
<i>Vishwanil Sarnaik, Satyajit Panda, S. Kanagaraj</i>	
Optimizing vibration control in curved panels: a comparative study of constrained and partial constrained layer damping techniques	163
<i>Vishwanil Sarnaik, Rakesh Panda, Satyajit Panda, S. Kanagaraj</i>	
Investigating the effects of shroud parameters on vibration damping in turbine blade assemblies.....	172
<i>Kyrylo Savchenko, Oleh Derkach, Serhii Kabannyk, Anton Meiris</i>	
Computation of natural frequencies and mode shapes of one dimensional continuous structures with arbitrary nonuniformities, discontinuities and constraints	179
<i>Alok Sinha</i>	
Unsupervised learning approach for damage localization using guided waves sensed with FBG sensors in self-referencing configuration.....	180
<i>Rohan Soman, Farzam Omid Moaf</i>	
On site flexible rotor balancing through virtual excitation by active magnetic bearing	188
<i>Rajiv Tiwari</i>	
Data driven integration and deep learning for condition monitoring of large systems	189
<i>Nalinaksh Vyas</i>	
Measurement and analysis of analog signal pulse width from rotating blades in turbomachinery	190
<i>Michał Wachlaczeko, Mirosław Witoś, Mariusz Zieja</i>	
Changing steam production methods as a tool for network balancing	201
<i>Paweł Wojtas, Arkadiusz Koprowski, Romuald Rządkowski</i>	

Preface

VETOMAC-XIX (Vibration Engineering and Technology of Machinery) is the nineteenth in a series of conferences being held as an effort to bring together researchers from diverse areas in Vibration Engineering and Technology of Machinery. The conference is organized by the Institute of Fluid Flow Machinery, Polish Academy of Sciences, Gdansk, Poland and INTECH Engineering Sp. z o.o.

The purpose of the meeting in Gdansk (2024) is to promote the vital exchange of knowledge, ideas and information on the newest developments and applied technologies, theoretical, experimental and computational methodologies.

VETOMAC I was organized by the Indian Institute of Science, Bangalore in 2000, VETOMAC II was organized by the Bhabha Atomic Research Centre, Mumbai in 2002, VETOMAC III was organized by the Indian Institute of Technology, Kanpur in 2004, VETOMAC IV was organized by the University College of Engineering (Autonomous), Osmania University, Hyderabad, India, R&D Division Bharat Heavy Electricals Limited, Hyderabad, India, in collaboration with The Vibration Institute of India. VETOMAC V was organized by Huazhong University of Science and Technology, Wuhan in 2009. VETOMAC VI was organized by the Indian Institute of Technology Delhi, New Delhi in 2010. VETOMAC VII organized by Shanghai Jiao Tong University and City University of Hong Kong, in collaboration with the Vibration Institute of India, VETOMAC VIII organized by the Institute of Fluid-Flow Machinery Polish Academy of Sciences, in partnership with Koneru Lakshmaiah University, Vaddeswaram in 2012, VETOMAC IX organized by Nanjing University of Aeronautics and Astronautics, Nanjing, China, 2013, VETOMAC X organized by University of Manchester, UK, Sept 9-11, 2014, VETOMAC XI organized by National Kaohsiung First University of Science and Technology, Kaohsiung, Taiwan in 2015, VETOMAC XII organized by Institute of Fluid Flow Machinery, Warsaw, Poland, 2016, VETOMAC XIII organized by International Society of Engineering Asset Management, Queensland, Australia, 2017, VETOMAC XIV organized by Technico of University of Lisbon, Portugal, 2018, VETOMAC XV organized by University of Curitiba, Brasi, 2019, VETOMAC XVI organized by College of Engineering, Bangalore, India, 2021, VETOMAC XVII organized by Institute of Engineering, Pulchowk Campus, Nepal, 2022, VETOMAC XVIII organized by Indian Institute of Technology, Roorkee, 2023.

The technical sessions included a variety of significant papers (30) on the techniques and applications of steam and gas turbines, rotor dynamics, bearings, blading, machine diagnostics, unsteady flows in turbines, aeroelasticity, micro power plants, artificial intelligence and machine learning.

Each manuscript submitted to the Conference and printed in this volume was reviewed by two members of the International Scientific Committee and then refined by the Author(s). The editor is deeply indebted to all members of the International Scientific Committee for their efforts to shape the Symposium program and their important contributions leading to the publication of this volume. I would also very much like to thank A. Koprowski for invaluable assistance in editing and all the authors for their contributions and willingness to share their research and development activities with the vibration community. Moreover, I wish to thank the organizing committee for their time and efforts in arranging the technical program.

Finally, I would like to express my gratitude for the financial support provided by our sponsors, The Szewalski Institute of Fluid Flow Machinery, Polish Academy of Sciences and Polish Academy of Sciences, Gdansk, Poland and INTECH Engineering Sp. z o.o. This conference was organized as part of the project POIR.04.01.04-00-0116/17. All the above made this VETOMAC XIX a success.

Gdansk, September 2024

R. Rzdkowski

ISBN 978-83-66928-14-5