Condition Based Maintenance

Technical Diagnostics I.

Vibration Analysis

Dr. István Nagy Ph.D.

2007.

Technical Diagnistics
ISBN 978-963-06-0806-0
I. Vibration Analysis
ISBN 978-963-06-0816-9

Publisher:	Delta-3N Ltd. 7030 Paks, Jedlik A. str. 2. http://www.delta3n.hu
Responsible for Issue:	Dr. Istvan Nagy Ph.D. Phone.:+36 75 510115 Fax: +36 75 510114 Executive Director drnagyi@delta3n.hu
Translated by	Anna Polgar
Publisher's reader	Michael DeMaria
Press preparation	Mr. Matyas Plezer
Cover design:	Mr. Matyas Plezer
Pressed by:	Pauker Press Ltd.

Table of contents

Acknowledgements

I really appreciate the opportunity of mutual projects carried out together with academicians Laszlo Keviczky and Jozsef Bokor, which determined my professional orientation.

Academician professor Keviczky established a globally acknowledged and highly valued school in the field of stochastic signal analzsis, modeling, process control, diagnostics and analysis. I consider myself a follower of that school.

My friend, academician professor Bokor, with his comprehensive theoretical knowledge and unique practical approach, is an internationally acknowledged expert of machine diagnostics, control and regulation.

I consider myself lucky for having the chance to work together with the above-mentioned two experts and their colleagues for years regarding the development of machine diagnostic monitoring systems. I would like to thank them both for supporting my professional development.

Just like in case of many other books, this book would have never been accomplished, if it had depended only on the author.

I am very thankful to my friend Dr. Jenő Szántó, vice-director of the College of Dunaujvaros, who encouraged me to finish this book, which overviews machinery diagnostics useful not only in case of university or college education, but also in actual industrial practice of production and maintenance.

A colleague and friend of mine, Mr. Norbert Pap followed closely the writing of this book from the beginning to its printing preparation, and he actively participated in its accomplishment. He prepared the majority of illustrations, which greatly contributed to the plainness of the book. I am thankful of two my colleagues, Laszlo Csete and Zsolt Maksa for their help to prepare typescript to press.

Special thanks for Anna Polgar for the excellent translation.

I am appreciating to Michael DeMaria, diagnostic expert from DLI Engineering Corp. for the valuable consultations and the publisher's reading the book.

Mr. Mátyás Plézer helped the publication of this book by editing drawings and illustrations and professional copy-editing. The cover of the book is also quite aesthetic.

And last but not least, I would like to thank my wife Zsuzsanna for her patience and encouragement, always providing me with the necessary help.

I wish to thank the readers of this book for devoting their precious time to hold and read this book. I hope it would be useful for all of them.

The author

Prologue

My dear readers, my original intention was to accomplish a three-volume book.

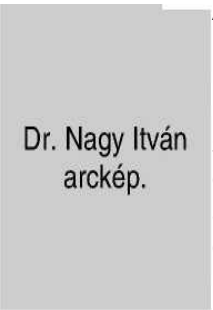
The subject of the first volume is vibration analysis, which is the most advanced field of technical diagnostics. I hope it provides enough information for those who would like to apply that technology and obtain all the knowledge necessary in order to carry out measurements and analyses properly.

In volume two, together with my colleagues, we shall overview subjects such as thermography, balancing rotary machines, shaft alignments, as well as the use of the ExpertALERT vibration analysis expert system.

In volume three we shall overview ultrasonic fault detection, oil analysis, ferrography, animation of operating deflection shapes, as well as machine protection systems and noise diagnostics of nuclear reactors.

I hope that, after reading this book, you would be willing to read the following two volumes, currently under preparation.

About the author



Author István Nagy Ph.D., nuclear engineer-physicist obtained his Master Degree in the faculty of Nuclear Power plants and Experimental Equipment, in the Moscow Energetic Technical University, in 1977. He obtained degree of candidate in technical sciences in Moscow in 1988, based on his achievements in the field of nuclear reactor diagnostics. He gained his university doctor title at the Technical University of Budapest and his academic candidate degree was nostrificated by the Hungarian Academy of Science in 1990.

He worked at the Central Research Institute of Physics of the Hungarian Academy of Science, where he was preparing for the tasks to be fulfilled as physicist of the first domestic nuclear power plant. In the Nuclear Power Plant of Paks he had different responsibilities, such as reactor physicist, senior physicist, and later on head of reactor-diagnostics department. He participated in the establishment project of the Nuclear Power Plant helping the Plant's Commissioner and also in the actual commissioning procedure afterwards. Later on, he established the branch office of Company OLAJTERV in city Paks, and for a period, he was the head of this division. He worked as a senior research fellow at MTA SZTAKI (Computer and Automation Research Institute of the Hungarian Academy of Sciences) as well.

He currently is a professor at the College of Dunaujvaros and managing his family owned company, Delta-3N Ltd.

The main activity of Delta-3N Ltd. (www.delta3n.hu) is machinery diagnostics, especially vibration analysis of rotating machines, which is facilitated by the high-performance unique ExpertALERT expert system, developed by DLI Engineering Corp. (www.dliengineering.com) based on the requirements of the US NAVY. In addition, the company has other profiles like balancing rotating machines, laser shaft-alignment, thermography, ferrography, ultrasonic leakage and fault detection. Besides services of machinery diagnostics, the company is also involved in the development of protective and diagnostic systems for machinery, trade of tools and equipment, as well as teaching diagnostics. Outstanding customers of the company are Hungarian Oil and Gas Company Plc. "MOL Nyrt.", as well as the Hungarian Nuclear Power Plant Paks and the chemical plant Nitrogenworks Plc.

The author has great industrial experience in machine diagnostics and development of diagnostic systems. He has participated in several trainings in the United States, obtaining certificates, and he himself teaches on a regular basis.

1. Introduction

Machinery maintenance or, as it is sophisticatedly called nowadays, routine maintenance, was and most probably will remain substantial as long as people use machines for production. In spite of that, I consider it a necessary bad thing, increasing costs and sometimes even hindering production. According to my experience, most industrial manufacturers try to decrease costs at the expense of maintenance and servicing is treated a little bit like a “stepchild”, while actually a lot depends on it. When the word “maintenance” is mentioned, people imagine an old guy dressed in filthy clothing. This image, although it still remains strong, is a bit old-fashioned. The maintenance guy in our days is more likely to be an expert, who spends more time analyzing computer data of tests, making maintenance schedules and network plans, searching for information on the Internet, working in databases throughout networks, rather than standing next to the supervised machines, which are most probably clean and meticulously stainless.

Namely, maintenance engineers use modern condition-monitoring and diagnostic methods in order to reveal machine faults, and based on these measurements, they make decisions whether or not intervention is necessary in case of a certain machine, and if so, what exactly shall be done and how urgently. Our maintenance expert could easily work in a suit and tie, or at least wear an elegant, nice sportswear during work.

Since the industrial revolution, industrial production underwent several huge changes, and so did maintenance and servicing. Modern maintenance organizations schedule work according to the actual condition of machinery, based on

measurements, accomplishing the needs of production management organizations as service providers. They use high-tech measuring equipment, analyzers and data processing software, and often even expert systems, including artificial intelligence.

However, the most important task of maintenance programs, which is avoiding equipment breakdown, has not changed over the years. Unexpected breakdown of a machine – apart from the loss of production – could cause severe problems to the machine, the repair of which could be very expensive. Besides material damages, breakdowns can endanger the health of operators and the environment, depending on the technology and materials used, as well as the consequences of the accident.

The second most important task of servicing is to plan and know precisely the needs of all maintenance and repair work, by following closely the condition of the machines. This means that overtime and stock must be minimized. Repair and maintenance of production machines and systems should be carried out during the downtime of pre-scheduled preventive maintenance, based on a time plan, prepared in advance.

The third most important purpose of maintenance is to increase productivity of a factory or plant by decreasing the overall likelihood of downtime during production, especially the downtime of critical machines, keeping the capacity and power level of systems and machines at the highest value possible.

It is also an objective to ensure a more rational and pre-planned utilization of work-time for personnel.

One of my friends, who used to work as a civilian technical expert in the American Army, once said that the reason why the US Army is so successful is that it has operational machines with well-organized maintenance based on evaluation methods of machine diagnostics.

The importance of this is even more significant in case of civilian industrial production companies. Only those companies are successful and capable of improving productivity, performance and quality, as well as ensuring safety and keeping the environment, which organize their maintenance and repair activities well, and use for that purpose several methods of advanced diagnostics of measuring and analysis.