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Vibration Monitoring, Analysis, Alignment & Balancing

3 - 14 February 2025

Vienna

Vibration Monitoring, Analysis, Alignment & Balancing

course code: E6013 From: 3 - 14 February 2025 Venue: Vienna - course Fees: 6750 Euro

INTRODUCTION

In today's highly competitive marketplace, it is more important than ever that production plant operates in a safe and reliable way. Unscheduled outages caused by plant breakdown can be very costly and engineers must use every possible means at their disposal to maximise plant reliability and performance.

Predictive maintenance, which incorporates condition based maintenance, is a vitally important technical approach to the maintenance of rotating and reciprocating machines. Sadly, however, many organisations never manage to achieve high performance in this field because they are not able to deal with the complexities associated with the most powerful and important condition-based maintenance technique, which is vibration monitoring.

Vibration monitoring and analysis is still seen by many engineers as less than mainstream. It has a mixed reputation in terms of its capabilities and usefulness, and there are also many false rumours associated with its applicability (or otherwise). Yet, if vibration monitoring and analysis is properly understood and implemented, it offers the opportunity to make very significant improvements in plant reliability. It is arguably the single largest missed opportunity in typical technical maintenance systems.

The programme also addresses the closely related subject of balancing of rotating machinery. Whether it is needed as a corrective action or during the (re-)installation of a machine, achieving high quality balance is vitally important to the long term reliability and overall lifetime of plant.

PROGRAMME OBJECTIVES

- A detailed understanding of the measurement and characteristics of vibration signals, and the ways in which vibration data can be stored and represented
- A comprehensive knowledge of vibration-based fault detection and diagnostic techniques, and the practical implementation of these techniques
- The knowledge to assess accurately machinery conditions, and to make detailed and reliable diagnoses for a range of common machinery and component types
- A good understanding of the principles and practice of the balancing of routine rotating machines
- The knowledge about how to use vibration based methods to achieve high quality balance on routine rotating machinery. *Note that the balancing of flexible rotor machines such as steam / gas turbines and axial compressors is a highly specialist activity and is NOT included within the scope of this programme*
- A clear understanding of why vibration monitoring systems and approaches often lead to disappointing results and how these pitfalls can be avoided
- The ability to specify, implement and operate a highly capable vibration-based condition monitoring system within their own companies

TRAINING METHODOLOGY

This programme is a combination of instructor-led topic areas and computer-based analysis and

modelling. Delegates will learn in detail about, and practice using, best-of-breed approaches to vibration monitoring, vibration analysis and the balancing of machinery. Ample opportunity will be given for delegates to ask lots of questions about how best to apply vibration monitoring and balancing techniques in their own organisations. The programme delivers a comprehensive practically-based approach to vibration monitoring and analysis, including the use of vibration monitoring in machinery balancing applications, and delegates will discuss these concepts and have extensive opportunities to see them being applied to a wide range of real-world case studies.

PROGRAMME SUMMARY

The purpose of this programme is to explain precisely how vibration monitoring and analysis should be performed, and to demonstrate exactly how it can be used to make significant increases in the improvement of plant reliability and performance.

The programme gives a detailed treatment of the detection, location and diagnosis of faults in rotating and reciprocating machinery, using vibration analysis.

The act of balancing a machine can be performed with the rotor either *in situ* or transported to a specialists balancing machine. Either approach requires that vibration is monitored on the bearings at each end of the rotor, and thereafter that calculations are performance to establish the mass changes that need to be made to achieve the desired balance quality. Both approaches are covered in detail by the programme.

PROGRAMME OUTLINE

Vibration and its measurment

- Components of a vibration signal
- Vibration transducers
- Overall and spectral vibration
- Monitoring point location
- Transducer mounting
- Common symptoms
- Time and frequency domains
- Frequency domain instrumentation
- Fast Fourier transforms
- Displacement and proximity probes
- Transducer selection, calibration, care and maintenance

Vibration symptoms of common machine faults

- Imbalance issues
- Looseness issues
- Signal distortion
- Harmonic content
- Inter-harmonics
- Misalignment
- Distinction between angular and lateral effects
- Vibration level classification
- ISO standards
- Peak and RMS levels
- Dynamic range
- Use of FFT analysers

- Constant percentage bandwidth spectra
- Automated CPB spectrum comparison
- Spectral zoom
- Case studies

Balance problems and vibration based balance correction

- Rigid rotor and flexible rotor machines
- Static and dynamic balancing of rigid rotors
- Balance quality
- Residual imbalance
- Types of imbalance
- *In situ* balancing
- The use of balancing machines
- Measurement set-ups
- Rules on thumb for trial mass location
- Single plane balancing
- Two-plane balance procedures
- Why you have to be a specialist to balance flexible rotor machines
- Case studies

Fundamentals of bearing and gear vibration

- Bearing problems calculation of bearing frequencies
- Pulse trains and line spectra
- Loaded element modulation
- Trending fault development and predicting remaining useful life (RUF)
- Gear problems
- Gear wear
- Toothmesh harmonics
- Ghost components
- Gear fatigue
- Modulation effects
- Bent shafts and gear misalignment
- Case studies

Vibration based fault diagnosis

- Time domain averaging
- Crest factor
- Sampling, digitising and aliasing
- Frequency and phase response
- Band selectable analysis (BSA)
- RMS and linear averaging
- Real time bandwidth and dynamic range
- Case studies
- What vibration monitoring CANNOT do
- Overall review of concepts learned and how they can be applied in practice