



DIAGNOSTICS OF MACHINES AND EQUIPMENT



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1. VIBRATION

Vibration = repeated movement of the machine or its part from the central position to the extreme positions

- it is normal that the machines vibrate and show noise
- it applies also to the perfect operating state
- if vibrations and noise increase, it always means deterioration
- there is always a power causing the vibration
- vibrations generate an image of the state of the machine care, it is possible to read an information about the type of a fault

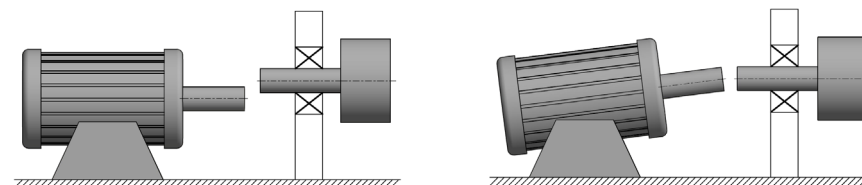
The most common causes of vibration occurrence are:

- | | | |
|-------------------|----------------------|--------------------------|
| • unbalance | • bent shaft | • electromagnetic forces |
| • misalignment | • mechanical release | • resonances |
| • bearing failure | • gearing failure | • hydraulic forces |

In the technical practice there are alternating forces arising due to clearance and inaccuracies in the rotational movements of machines, movement of vehicles and their parts, working with various work tools, etc.

Examples of vibration sources:

Incorrect machine installation: when rotating, it causes a repetitive force affecting the machine. Frequent causes of this phenomenon are incorrect seating, uneven floor, thermal deformation, twisting due to torque or improper mounting of couplings.



- Worn down rotating parts - toothing, worn belt
- Damaged fan, blower blades
- Excessive clearance in shaft supports, bearings
- Loose machine fastening screws

Consequences of vibrations:

- | | |
|-------------------------------------|--------------------------|
| • damage of bearings | • stoppage of production |
| • damage to machinery and equipment | • increased noise level |

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2. TECHNICAL DIAGNOSTICS, MAINTENANCE

High requirements are currently imposed on modern machines, which concern not only their construction and technological parameters, but also their reliability and related diagnostics. The most demanding is using machine tools in unattended mode with continuous operation.

In such used machines, there is placed a great emphasis on their timely and correct self-diagnosis that shall assure that the diagnostic system reveals the dangerous trend of any of the monitored quantities or a failure itself.

Properly selected diagnostics will save companies the cost needed to maintain machines and equipment, and assure timely diagnostics of the failure emerging on the used machines and its effective removal, or at least mitigation of the impact on the production quality, employee health, energy efficiency and environment, and ultimately satisfaction of customer needs and requirements.

Standard maintenance

- maintaining machines and equipment in fixed cycles
- detection of malfunction shortly after or prior its occurrence,
- lack of time to remove the failure - long delivery times for spare parts, long delivery time for the repair service

Vibrodiagnostics in maintenance

Vibrodiagnostika je užitočným nástrojom v modernej proaktívnej údržby vo všetkých prevádzkach, v ktorých sa nachádzajú stroje s rotačným alebo vratkým pohybom. Jej výhoda spočíva v univerzálnosti použitia pre určenie stavu strojného zariadenia priamo v prevádzkových podmienkach bez potreby demontáže. Nevýhodou zariadenia vibrodiagnostiky do plánu údržby môže byť prevažne v kladení vysokých nárokov na odbornosť a know - how pracovníkov.

Division:

1. One-shot measurement

carried out primarily within the operational maintenance, where the measurement is required as a direct consequence of the equipment state change.

2. Periodical measurement – walkdown

are parts of the preventive and predictive maintenance schedule, where the vibration is measured deliberately on the machine with a good technical care with a regular time span. On the basis of tracking and analysis it is possible to effectively identify the resulting damage and

determine its causes.

3. On-line measurement

is a part of the preventive and predictive maintenance schedule where vibration sensors are installed on the machine or line, and the measurement is performed through the on-line system continuously or in very short time intervals.

How to do it ?

- Introducing information passing from different areas of maintenance.
- Increasing the knowledge level of maintenance staff, for example: certificates from the device manufacturers and authorized training enter.
- Using proper tools, procedures, adhering to proper tolerances, using the proper lubricant.
- Observing the proper seating of machines and equipment.
- Preventing the additional forces from coupling and pulley alignment.
- Preparing the superior lubrication plan. Training the workers – greasing staff, tribotechnics. Replacing old lubricants with advanced ones, ensuring regular lubrication.
- Training the technical diagnostics staff, or assuring the technical diagnostics services through an external company.
- Providing the documentation for failures describing the damage, lubricant condition, pollution, bearing care, other damages to the machine. Assuring a detailed analysis of bearings and lubricants to determine the exact cause of the damage. [Activities carried out in the field of diagnostics and maintenance of machines:](#)

2.1 VIBRODIAGNOSTICS

is an assembly free method of diagnosing rotary machines that is a set of methods for obtaining vibration information. By using the vibrodiagnostics, we can accurately determine the cause and location of the failure. Vibration is associated with the dynamic state of the equipment, its technical care, clearances in the bearings, bearings care, alignment, unbalance of rotor parts, wearing, loosening, etc.

Reasons:

- Reference measurement of turbine and generator vibrations
- Periodical measurement of turbine and generator vibrations
- Measurement of basement vibrations
- Separation of stator parts of the machine or basement due to vibrations
- Determining the cause of increased vibration beyond periodic measurements
- Operational balancing
- Measuring the total vibrations

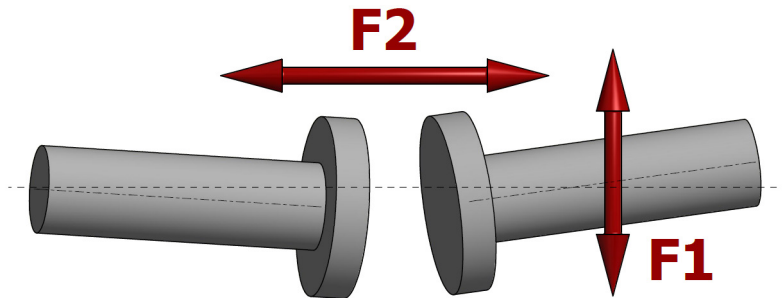
Using the vibrodiagnostics we can identify the following errors:

- Bearing wearing
- Release of bearings
- Sliding bearing faults
- Unbalance
- Misalignment of coupling shaft
- Belt drive faults
- Shaft distortion
- Eccentric rotor
- Mechanical release
- Transmission failures
- Resonance
- Errors in constructions, etc.

2.2 ADJUSTING THE MACHINE ALIGNMENT

Misalignment of the driving and driven shafts imposes dynamic forces, which greatly contribute to wearing of bearings and shafts. They increase the noise level and the vibration powerfulness. The clutch tries to create alignment, while arise:

- Axial force effects
- Radial force effects



Methods:

- Alignment, parallelism of shafts,
- Planeness, linearity of foundations, machine stand
- Uprightness of stands
- Setting of the propeller shafts
- Measuring the thermal deformations

2.3 TRIBOTECHNICAL DIAGNOSTICS

is a technical diagnostic method without need of disassembly, which uses the lubricant as a medium for obtaining information on friction node changes. The outcome of measurements is information on the condition of foreign matters in the lubricant. In the tribodiagnostics we monitor the oil aging course in operation and assess the magnitude of the change in intensity and degree of oil degradation to change, the utility qualities, and thereby the oil ability to ensure trouble-free operation, as well.

Reasons:

- Evaluation of oils, lubricants
- Continuous inspections of rotating machine oils
- Oil filtration

2.4 ULTRASONIC MEASUREMENT

Reasons:

- Interception of unusual sounds
- Assessment of development of the individual sounds intensity
- Discovery of discrepancies (scratch, scrapping, shocks, lubrication failure ...)

2.5 MOTOR-MONITOR

Reasons:

- Contactless check of condition of the technical equipment interior
- Evaluation of wear and tear

2.6 DEFECTOSCOPY

Defektoscopy is a science branch dealing with a non-destructive method of detecting defects in materials and products, eventually predicting the possibility of material defect occurrence in operation.

In practice, it is not possible to produce an ideal perfect material or product. Faults (defects) often occur in the production process or during operation in materials and products, even with the greatest attention in production. Under the term "error" we understand such material or product failure whose nature, shape, dimensions, and spatial orientation may affect adversely at the product loading during operation.

Material defects can be divided into the following main groups:

- internal and surface defects of macro-integrity
- structural and chemical inhomogeneity
- material confusion
- product dimensional errors

During operation of machines and equipment in the material may occur:

- changes in structure, substructure and properties due to aging
- formation and propagation of cracks
- changes in shape and dimensions due to corrosion and wear

The general principle of any defectoscopic method is indicating the tested object by the appropriate physical medium and recording the result of medium influence on the object.

Following these principles we distinguish:

- capillary
- magnetic inductive
- ultrasonic
- radiographic testing methods

2.7 THERMAL DIAGNOSTICS

The thermal diagnostic methods are characterized by using the temperature as a diagnostic parameter characterizing the object technical care. In practical applications there are used both, local and integral temperature values, either steady (mean value, effective value...) or time-varying (instantaneous values, frequency spectra ...)

Types of readers division are as follows:

- Contact temperature measurement ... thermometers ...
- Contactless temperature measurement ... pyrometers
- Indication of thermal images ... thermovision

3. INSTRUMENTATION OF THE MACHINERY DIAGNOSTICS

There are variety types of the diagnostic instruments for detecting machine care. The decision on the suitability of the particular instrument depends on the intention, how we want to process the data. There exist instruments detecting the instantaneous conditions of the equipment, which cannot store data, up to devices for comprehensive planning inspection, measurement, data acquisition, analysis, evaluation, and tracking of trends.

There are also several manufacturers of these instruments. Our company cooperates with a reputable manufacturer – ADASH, manufacturing the following diagnostic instruments:

Adash 3900-II

On-line vibration monitoring system

Applications:

- Vibration diagnostics of machines
- Diagnostics of bearings
- Using the vibration measurement to protect machines
- Using the vibration measurement for I&C of machines

Features:

1. Vibration level
2. Measuring the bearing technical care
3. Broadband measurement of acceleration
4. Indication of exceeding ALERT and ALARM limit values
5. Using the high-quality external piezo-electric sensor of acceleration
6. Indicating the sensor or its cable failure
7. Easy interconnection of the control and PLC regulation systems
8. Simple mounting on the DIN rail, etc.



Adash 4900 - Vibrio M

It contains the expert system FASIT !

Applications:

- Vibration diagnostics of machines
- Diagnostics of bearings
- Diagnostics of lubrication
- Data storage and measurement
- Servicing
- Final inspection of products



Features:

1. FASIT – mode for identifying the discrepancy sources
2. Spectral FFT analysis
3. Measuring the time signals
4. Contactless thermometer
5. Built-in stroboscope
6. Automatic determination of the machine and bearing care
7. Automatic detection of rpm
8. Broadband measurement of effective
9. The DDS2016 Free software for evaluation and archiving of data is a component part of the device

A4910 – Lubri

Applications:

- Checking and control of the lubrication process
- Measuring the of rolling bearings condition



Adash 4300 VA3Pro

Portable apparatus - analyser – walkdown apparatus for the machine diagnostics.



Characteristics:

The latest accession to the family of portable vibration diagnostic devices. There are two signal inputs and one tachometer/trigger input. Input 2 offers connectivity to the three-axial sensor, therefore all three channels can be measured at the same time. The FASIT expert system, developed by the Adash company, automatically detects the type of machine failure - unbalance, misalignment, mechanical release, bearing damage.

Adash 4900 Vibrio M Ex

Applications:

- Vibration diagnostics of machines
- Diagnostics of bearings
- Diagnostics of lubrication
- Data storage and measurement
- Servicing
- Final inspection of products
- EX – spark safety version



Characteristics:

The device is derived from the A4900M type and its features are identical to this type. However, it is mainly designed for measuring in explosive atmospheres and unlike the apparatus A4900 M it is not equipped with the contactless temperature measurement and stroboscope for the rpm measurement.

A4400 VA4 Pro

Portable apparatus - analyser – walkdown apparatus for the machine diagnostics.

Characteristics:

The apparatus A4400 - VA4 Pro is a top instrument for measuring in the field of the machine vibration measurement. The apparatus includes basic modules of the analyser, data collector and recorder of the measured signals. Moreover, the apparatus is equipped with modules for operational balancing machines, measuring running-up and running down, ultrasonic, acoustic measurements, impact tests, lubrication control, hearing the vibration signal, and also with vibration operation shape module. The apparatus is equipped also with a unique expert system, developed by the company Adash, for automatic detection of machine failures. The apparatus A4400 - VA4 Pro is designed more or less for staff dealing with machine diagnostics, operational balancing and servicing and inspection activities.



A4404 SAB

Portable apparatus - analyser – walkdown apparatus for the machine diagnostics.

Characteristics:

The A4404 - SAB module is a 4-channel pocket-sized analyser. This module is identical to the input part of the apparatus A4400-VA4 Pre, which is designed to process the measured signal. After connecting the A4404 - SAB module to any computer using the USB interface and activating the program VA4 Pro Virtual Unit we will obtain the measuring chain identical to the apparatus A4400 - VA4 Pro. The technical parameters, number of channels, possibilities of measurement and processing signal are the same as for the apparatus A4400-VA4 Pro. The module A4404 - SAB is powered directly from the USB interface, so it does not require any additional external power supply.



A3716

On-line monitoring system.

Characteristics:

The A3716 is a powerful on-line monitoring and diagnostic system designed to increase the reliability of machine operation. The A3716 can work as a stand-alone monitoring system or may serve as a superstructure over the protection system. The system A3716 can also be used as a powerful multichannel analyser. Each A3716 module includes 16 AC, 16 DC channels and 4 TACHO inputs. All channels are measured simultaneously. The individual A3716 modules is possible to assembly simply modularly and to create multichannel systems.

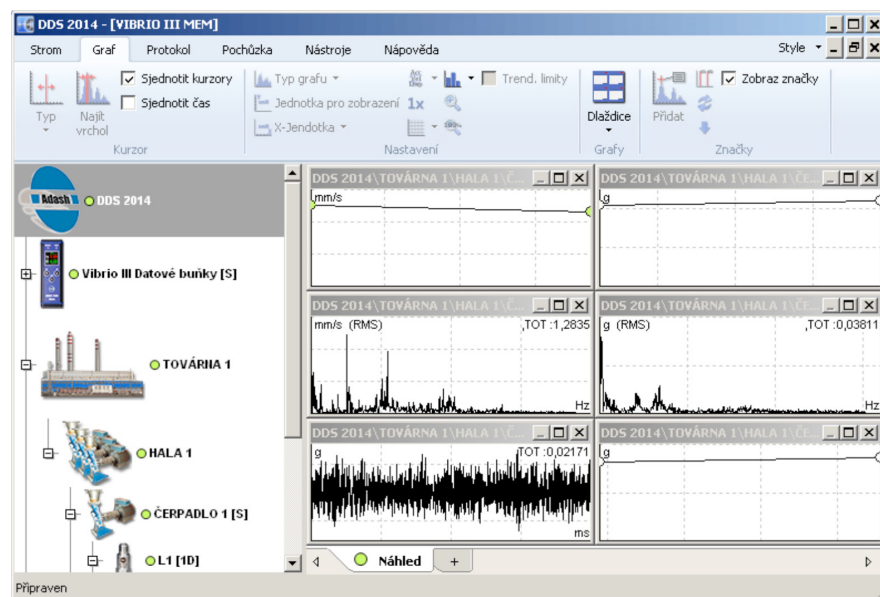


Powerful tools for collecting, archiving and evaluating data:

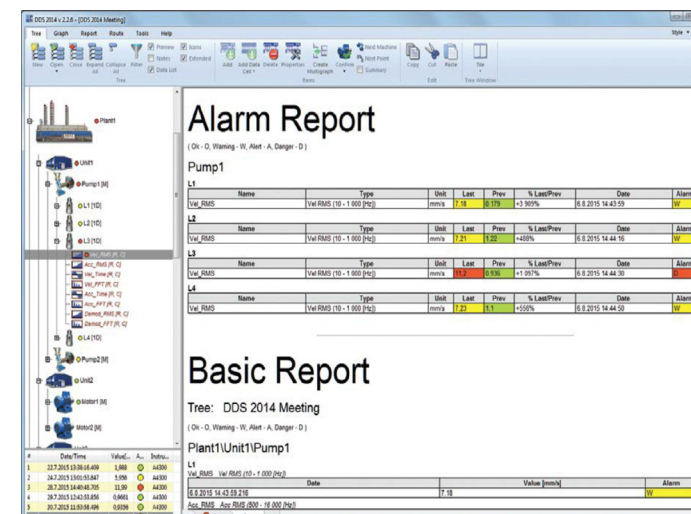
DDS SOFTWARE

It represents a very powerful tool for collecting, archiving and evaluating data related to vibration and technical diagnostics of machines. It contains the tools and functions needed for signal analysis in the frequency and time domain.

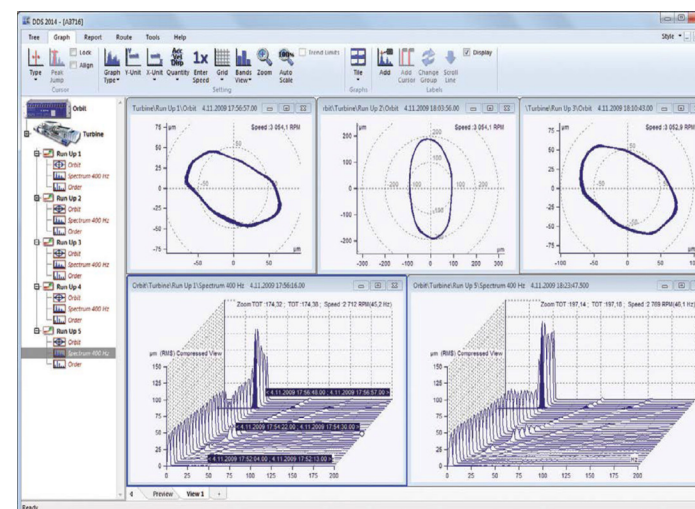
It enables off-line and on-line measuring and monitoring measurements. Moreover, it enables very fast creation of text and graphical protocols - results from the performed measurements. The software communicates with all vibrodiagnostic apparatuses and on-line systems of the ADASH company.



Limit values



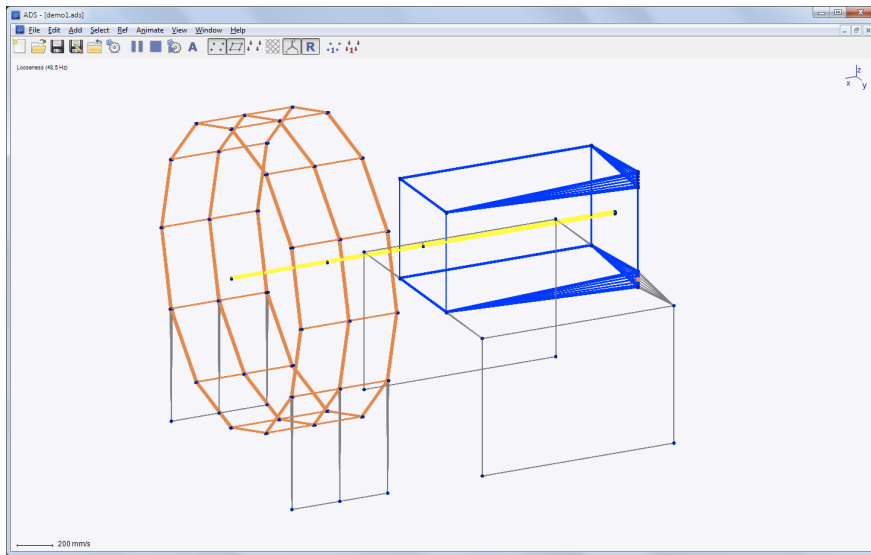
Report



ON-LINE

ADS SOFTWARE A4801

Animation Defecion Shapes – The software is based on the method of operating shapes of vibration. It visualizes the machine vibrations using animation. During the computer animation the vibrations are slowed down to a very low frequency and the movement amplitude is increased, so the movement becomes visible to the human eye. It is a combination of vibration measurement and software processing. The output of the method is visualization of the vibrational motion. The output is easy to understand for everyone and provides a conception of behaviour of the machine being measured.



Visualization of the vibrational motion

4. CONCLUSION

Machine condition monitoring is a prerequisite for maintaining the quality of production, as well as a prerequisite for quality management systems according to the requirements of the standard ISO 9001. The current trend is to predict the conditions of the equipment and to ensure the production quality.

More accurate description of the basis of vibrodiagnostics is based on the assertion that it is a consistent and algorithmic analysis of changes in dynamic features of machines or parts of machines. However, it is important to emphasize the nature and goals of vibrodiagnostics and monitoring the technical care of machines. The principle of monitoring the technical care of machines is to measure the characteristic values of mechanical oscillation and to compare the results with the critical (limit) values determined by the technical standards, by the manufacturer or on the basis of the long-term observation of the technical machine. Monitoring is usually aimed at determining the technical care, not determining the causes of changes in the dynamic characteristics of machines.

Recommendations related to the method of measurement and the place of seating – sensors installation, as well as technical care criteria are laid down in technical standards, in particular ISO, which generally have a long-term validity.

The affordability of diagnostic apparatuses on the one hand and the high level of readability of the measured data on the other hand enable companies to **optimize the cost of production continuity, its safety and quality of end products.**

Technical information is created in cooperation with the company ADASH - the manufacturer and supplier of a whole range of diagnostic instruments. They evaluate information - data by their own developed software. Its purpose lies with our company in the provision of professional - technical consultancy in the field of vibrodiagnostics, monitoring of technical condition, and equipment preservation.

