PRÜFTECHNIK

Machinery Service

# VIBNODE® keeps kilns turning

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# Vibnode keeps kilns turning

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*This article describes the special features of the low cost VIBNODE and subsequently discusses the latest developments in PRÜFTECHNIK online measurement technology. The descriptions are based on the example of a double pinion drive with a spur gear.*

Successful implementation of condition-based maintenance in a manufacturing plant not only requires effective use of suitable measurement methods but relies on a condition monitoring partner who can offer expert diagnostic and consultation services. In the area of online measurement technology, PRÜFTECHNIK condition monitoring uses Condition Monitoring Systems (CMS) that operate completely autonomously and indicate promptly any changes in running and operating characteristics. Since online CMSs are able to send measurement data by eMail, the PRÜFTECHNIK Diagnostic Center can offer customers remote startup and telediagnostic services. In cement manufacturing, the VIBNODE online CMS is ideally suited to the continuous monitoring of rotary kiln drives. The system monitors and evaluates frequency-based diagnostic parameters for the gear teeth and roller bearings. Because rotary kilns run at variable rotational speeds, VIBNODE tracks the diagnostic bands on the basis of the rotational speed.

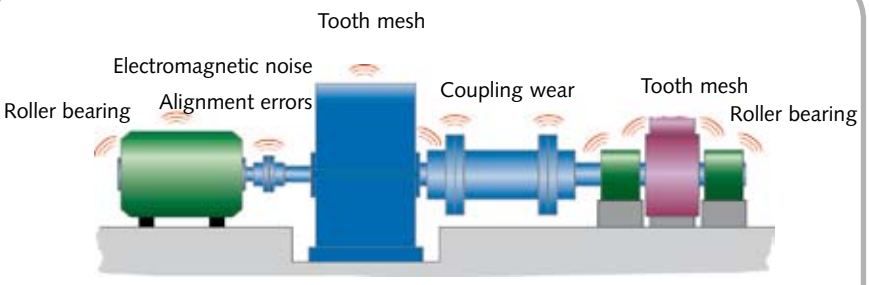
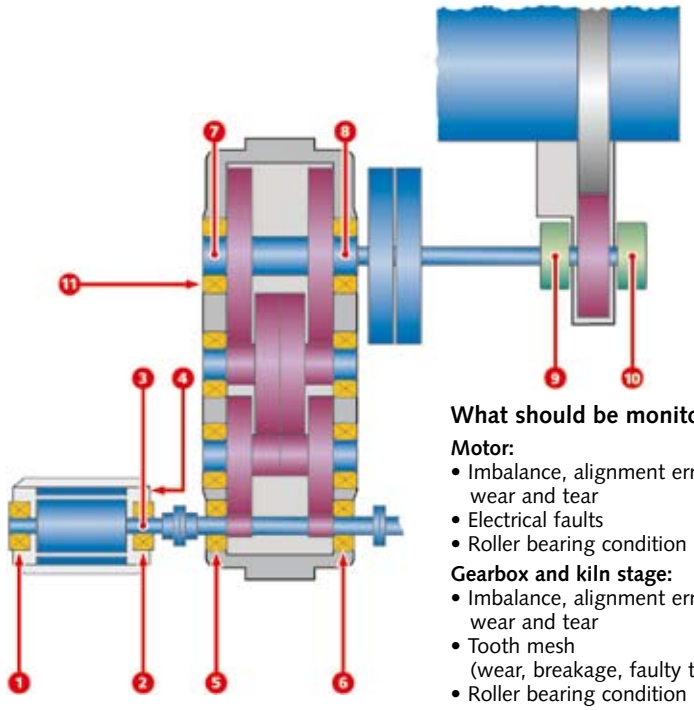



Figure 1: potential sources of failure on drive components that can be identified prior to breakdown by vibration-based CMS

## Initial situation

Condition monitoring techniques offer excellent opportunities for condition-based service and maintenance of rotary kiln drives (Figure 1). Maximum availability and operational reliability are a top priority in these systems. It is therefore important to detect and eliminate typical faults and damage before they lead to machine failure. These include alignment errors, imbalance, coupling faults, electrical faults and roller bearing and gear tooth damage. For example, with vibration-based condition monitoring, so-called 'fingerprints' of the drive components can be recorded throughout operation and then used to identify even the smallest changes in vibration behavior.




**What should be monitored?**

**Motor:**
- Imbalance, alignment error, wear and tear
- Electrical faults
- Roller bearing condition

**Gearbox and kiln stage:**
- Imbalance, alignment error, wear and tear
- Tooth mesh (wear, breakage, faulty tooth mesh)
- Roller bearing condition

Figure 2: typical measurement locations for mobile vibration analysis on rotary kilns

## Mobile measurements? Yes, but ...

Regular mobile vibration analyses, such as with the VIBXPERT FFT measurement data collector, are one possibility for detecting damage in the drive train and tracking its increase. Figure 2 shows a kiln gear and the locations for mobile measurements. In this type of herringbone gear, even small changes in the amplitude of the tooth mesh frequency can be an indicator of unacceptable contact pattern shifts. Mobile measurements pose difficulties when it comes to condition diagnosis on low-speed bearings and on the gear teeth of the kiln stage.

At similar rotational speeds, measurement periods of five minutes are necessary to achieve a representative number of passes and reproducible measurement results.

## Online CMSs are the better system

A more reliable and effective method is the use of an autonomous diagnostic system that records the vibration condition around the clock for sufficiently long measuring periods. It independently calculates the frequency spectra, automatically analyses any deviations and sends notification of damage by email. If initial damage occurs, operators often require information on the remaining life to determine if, for example, the system can continue to be operated until the next scheduled annual shutdown. At this point an experienced diagnosis specialist should be consulted to evaluate the measurement results and supply remote access to the CMS to be able to assess damage growth.

Figure 3: basic VIBNODE unit installed on rotary kiln

## VIBNODE as a low-priced online CMS

VIBNODE is an autonomous, robust and extendable modular system for measurement, analysis and monitoring. It combines the functions of an intelligent data collection device with an analysis and diagnosis computer. All standard vibration sensors can be directly connected to VIBNODE without additional signal processing and without a separate sensor power supply. Due to its wide operating temperature range (-40°C to +70°C) and industrial-suited housing (IP65), VIBNODE can be operated in the immediate vicinity of the drive.

The JAVA-capable multitasking operating system coordinates the parallel processing of data collection, triggering, control, data preprocessing, data analysis, storage and communication.

Data exchange and communication are performed using Internet technology (TCP/IP, HTTP). In general, Ethernet (LAN) is used to connect VIBNODE to the data network. A telephone modem (analog / ISDN), GSM or WLAN can also be used. VIBNODE sends an email with the attached measurement data to a service center, where the data are registered in the OMNITREND database software. When the connection is established, the VIBNODE HTML pages are automatically loaded into the user's browser (see Figure 3).

## Typical measurement parameters on rotary kilns

Based on experience in mobile measurement applications, the PRÜFTECHNIK Diagnostic Center has defined a set of measurement parameters that are important in the diagnosis of rotary kilns with double helical gears, for example. It has also programmed software modules specifically for online condition and vibration monitoring and integrated them into VIBNODE.

Double pinion drives of rotary kilns are monitored using the following parameters and sensors:

a) one motor current and one motor speed measurement to establish the current operating conditions of the kiln and to permit the interpretation of transient operating conditions.

b) two housing vibration measurements on the motor bearings – one on each of the A-side bearings – using accelerometers whose signals are analysed for alignment, motor and bearing condition.

c) six housing vibration measurements on the gears – three on each of the two gears – using accelerometers whose signals are likewise analysed to assess roller bearing and gear tooth conditions and the rotational vibrations in the gear.

d) two displacement measurements – one on each gear output – using an inductive displacement transducer to analyse axial offset and axial vibrations in low-speed shaft lines.

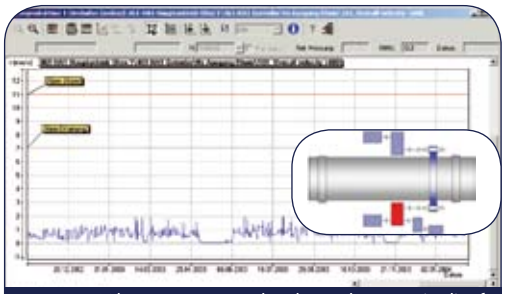


Figure 5: 'Vibration severity' levels on the gear (red) of a rotary kiln drive.

Since VIBNODE can process up to 12 measurement channels, the CMS is able to cost-effectively monitor double pinion drives. It measures and monitors frequency spectra, overall vibration values and diagnostic parameters. Figure 5 shows an example of the overall vibration value of "Vibration severity, gear", which was recorded over a period of one year. The running and vibration characteristics remained stable despite variations in the rotational speed.

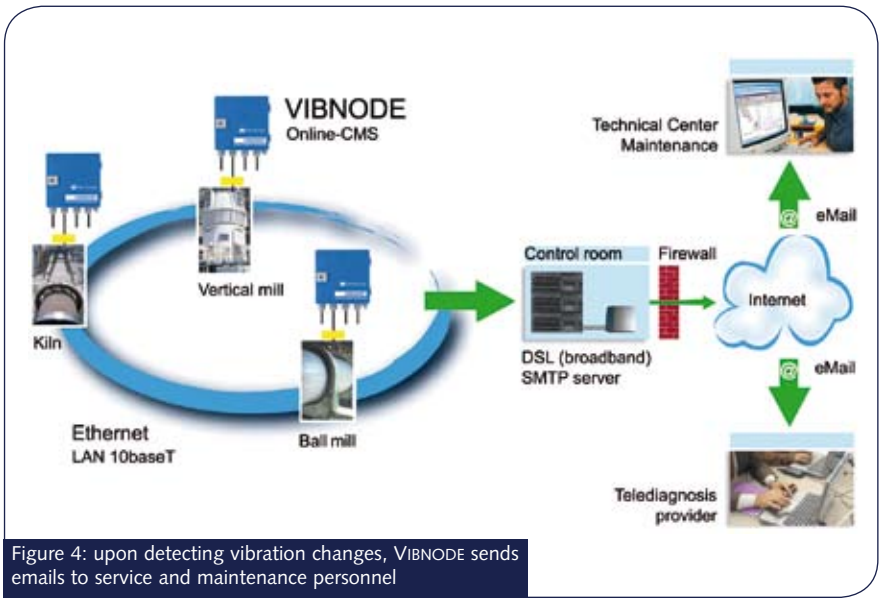



Figure 4: upon detecting vibration changes, VIBNODE sends emails to service and maintenance personnel

## Installation and startup

Technicians and plant electricians

can install VIBNODE without outside assistance. A 24V power supply, the additional measurement parameter signals and network access must be provided at the installation location. The tasks of configuring the system for data transmission by email and integrating it into the company network are easily accomplished by an IT specialist. Included in the PRÜFTECHNIK package is a three-month start up period during which machine behavior is observed and programmed into the system. Should any deviations arise, the operator is informed and receives specific recommendations on how to proceed, if necessary.

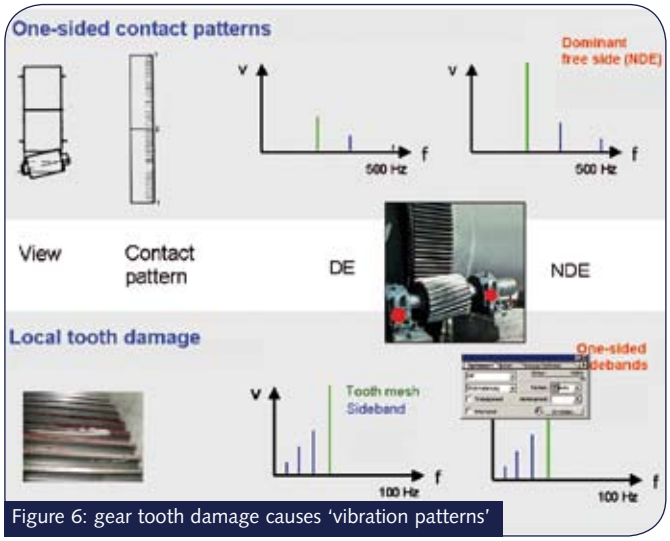


Figure 6: gear tooth damage causes 'vibration patterns'

## Measurement data evaluation and alarm notification

In addition to evaluating overall vibration values, VIBNODE is also capable of calculating and analysing diagnostic parameters as shown for a kiln stage in Figure 6. The tooth mesh generates characteristic tooth mesh frequencies and irregularities lead to atypical vibration patterns in the frequency spectra: a one-sided contact pattern generates unequal amplitudes and local tooth damage causes one-sided sidebands at the tooth mesh frequency.

Figure 7 shows how diagnostic parameters and trends can be generated from spectra. For every characteristic excitation in the spectrum, a narrow frequency band is defined within which the amplitude or signal power is recorded. Thus, each band delivers a diagnostic parameter whose development can be represented by a trend curve.

These frequency-related diagnostic parameters are generally set up by diagnosis specialists during the startup period and are the basis for the automated evaluation of measurement data. Should one of the characteristic diagnostic values be exceeded, an email notification is issued.

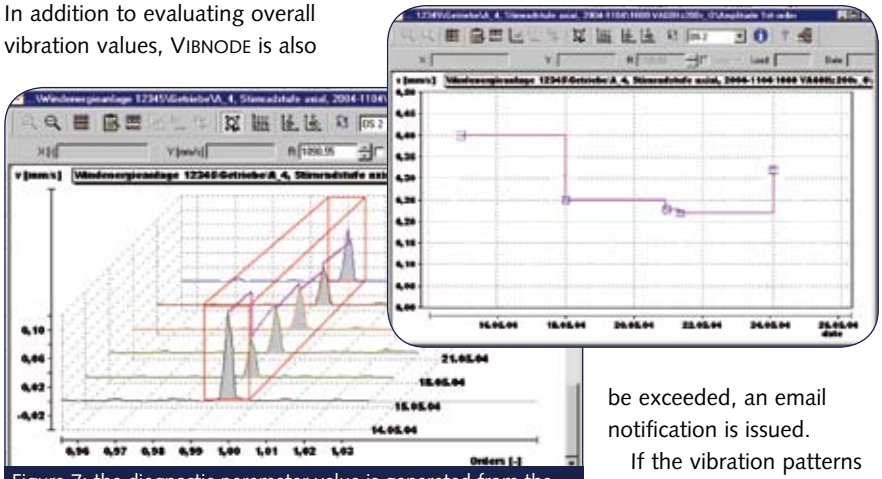


Figure 7: the diagnostic parameter value is generated from the frequency-selective recording of characteristic excitations

If the vibration patterns are complex, multiple characteristics are linked by mathematical logic operations in order to produce clear diagnoses. Any new experience is simply programmed into the existing applications and activated in the CMS by remote transmission. Thus the CMS always remains up-to-date and grows to reflect personal experience.

## OMNITREND WebReport as a tool for central service management

Since condition monitoring techniques alone are insufficient to ensure maximum drive availability and service and maintenance quality, PRÜFTECHNIK condition monitoring has continued to develop its Webservice technology and integrate it into the new OMNITREND WebReport module. This software is designed as a client-server application and generates editable reports from the centrally maintained OMNITREND measurements database. This makes it possible to always provide the latest measurement results and to process information on a customer-specific basis. It also ensures access to measurement data and all service and drive-related information at all times, regardless of the particular platform in use. At a click of the mouse, reports can be generated on the basis of templates, stored permanently and exported as a PDF. The diagrams in the report can be manipulated by cursor and zoom functions to interactively process and evaluate the results. Data exchange with CMMS (Computerised Maintenance Management System) software takes place in SAP/IBIP and other freely definable text formats.

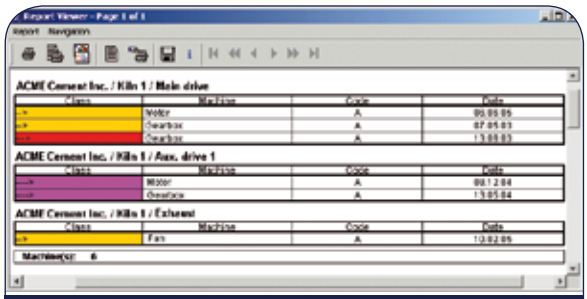


Figure 8: OMNITREND WebReport, alarm status report (the alarm classes are color-coded)

## Summary

By combining modular online CMS, advanced software technology and expert service, key production plants can be secured to almost 100 per cent, virtually assuring their availability. Even in complex cement applications, customised solutions can be implemented at a relatively low investment.