

PRÜFTECHNIK news

Telediagnose now biannual

“When is the next **telediagnose** coming out?” is a question we often hear. It took a while for No. 8 to appear – but then a lot has been happening. FLENDER was taken over by SIEMENS and Dr. Edwin Becker transferred from Flender to PRÜFTECHNIK Condition Monitoring to become head of the Diagnostic Center.

What you are looking at now is the new PRÜFTECHNIK Group service mag-

azine. In future, PRÜFTECHNIK Alignment and PRÜFTECHNIK Condition Monitoring will together report twice a year about service, alignment and condition monitoring experience gained in specific branches of industry.

At www.telediagnose.com you can download PDFs of the latest – and previous – editions in German and English. If you would like printed copies, please write us at info@pruftechnik.com. ■

New technology

Roller alignment – now faster and more precise!

Mathias Ecker

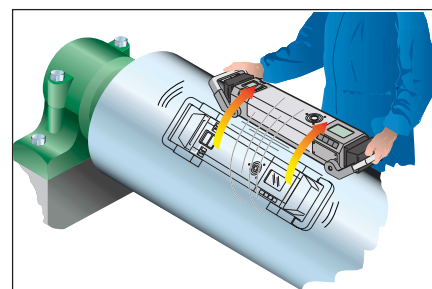
Misaligned rollers are the main reason for creasing and tearing of paper and film during production and finishing. Production lines in the paper, printing, film extrusion and rolling industries run many times faster today than they once did. Then as now, roller alignment was measured using ‘classic’ technologies such as theodolites and laser optical systems. PRÜFTECHNIK just recently introduced a completely new alignment method based on the PARALIGN® measuring instrument. In the several hundred global service calls made last year to the paper industry, PARALIGN® proved itself highly effective.

Measurement method from rocket navigation

PARALIGN® is a handheld device for quickly and accurately measuring the parallelism of rollers. It contains three highly precise ring laser gyroscopes arranged perpendicular to one another. Ring laser gyroscopes are used for navigation in the aerospace industry. To take a measurement with PARALIGN®, the user places it on the roller surface and simply drags it across the roller surface over a short distance (sweep measurement). With this straightforward procedure, PARALIGN® is able to determine the relative position of the measured roller to another roller – or to any reference. The data is then transferred



Figure 1: PARALIGN® contains three highly precise ring laser gyroscopes with orthogonal axes.



To take a measurement, PARALIGN® is simply dragged a short distance over the roller.

In this edition:

Roller alignment – now faster and more precise!

Reliable condition monitoring of vacuum pumps

Natural frequencies with enormous damage potential

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Torque and torsional vibration measurement

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to a laptop by means of wireless Bluetooth® technology.

Because data collection takes place entirely within the device and without external sensors, the location of the roller is completely irrelevant. For example, PARALIGN® can be used to measure rollers installed in the enclosed dry section – a task that is not altogether easy with traditional optical methods.

Conventional methods

Traditional alignment methods such as theodolites and laser optical procedures require a line of sight between the rollers being measured. However, a clear view is often obstructed by enclosures and other obstacles after the units are fully installed.

Example of a PARALIGN® measurement

The PARALIGN® software provides a graphic and numerical display of the alignment condition. Figure 2 shows measurements on part of a wire and press section in a paper machine. The service call, which included corrective measures, was performed during a scheduled 18-hour production downtime. The wires and felts were not in the line when measurements were taken. The main focus was on the first press felt – see bottom right of Figure 2. Shrinkage had been found at this location during production, shortening the service life of the felt. The measurement report corresponding to Figure 2 revealed that one guide roller was actually offset by 21 millimeters in relation to the selected reference.

All rollers in 4 hours

Had conventional methods been used for this task, it would have been impossible to perform all measurements – including the guide rollers in the basement – within the scheduled production downtime. With PARALIGN®, it took only four hours to measure all rollers shown in Figure 2.

On the basis of the measurement report, the plant maintenance team aligned the guide rollers in the basement during the downtime and the corrections were checked again with PARALIGN®. Conclusion: Felt shrinkage is no longer an issue. ■

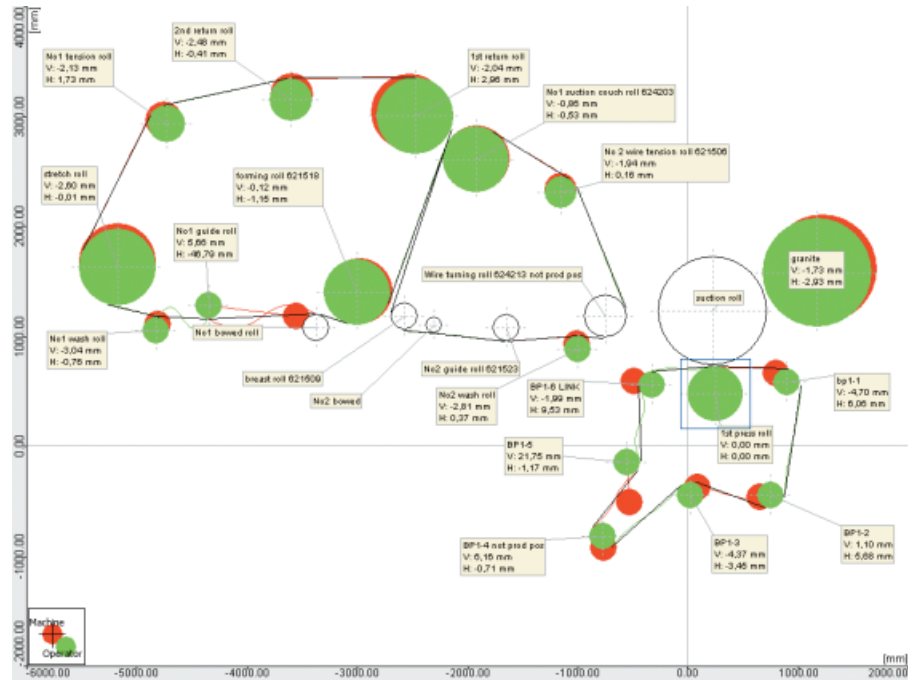


Figure 2. PARALIGN® report: The point of view of the observer is the operating side (green dot). The drive side is indicated by a red dot. The first press roller is defined as the reference roller. Because its position is vertical to the diagram surface, only the green dot is visible. The offsets of the guide rollers are clearly visible.

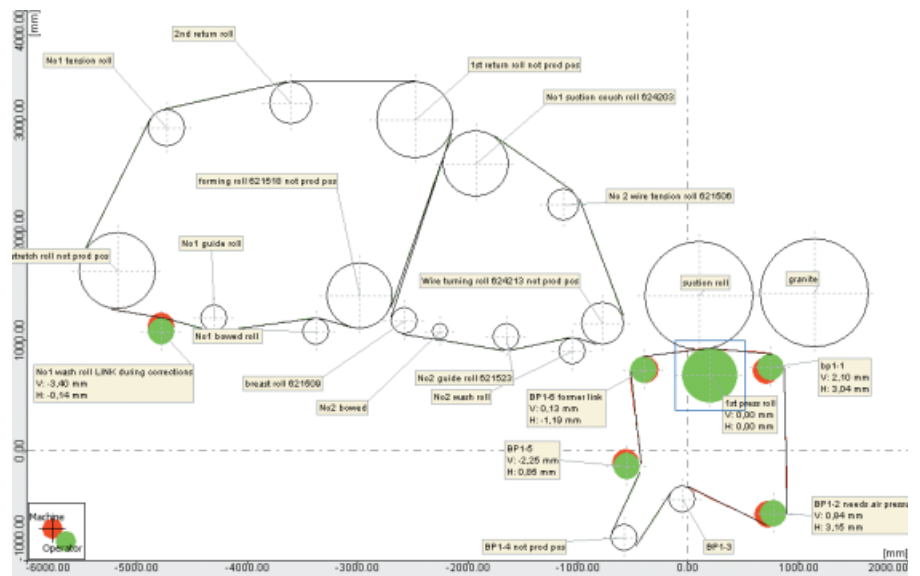


Figure 3. PARALIGN® report after the rollers were corrected. The guide rollers are clearly more parallel to the first press roller than before. Guide rollers bp 1-1 and BP 1-2 could not be corrected any further due to mechanical limitations. Conclusion: The press felt now runs without shrinkage.

Condition monitoring application

Reliable condition monitoring of vacuum pumps for paper machines

Robert Laurer, Gardner Denver Nash Deutschland GmbH
Mathias Luft

High machine availability is one of the most important goals of a line operator in the paper industry, especially when operating technologically advanced paper machines at full capacity. This article describes the benefits of Internet technology when monitoring the large liquid ring pumps used to generate the vacuum for suction rolls.

Vacuum pumps

Making paper requires large quantities of vacuum for extracting water from the paper. In modern paper machines, the vacuum is generated by liquid ring vacuum pumps with a drive power of up to 600 kW.

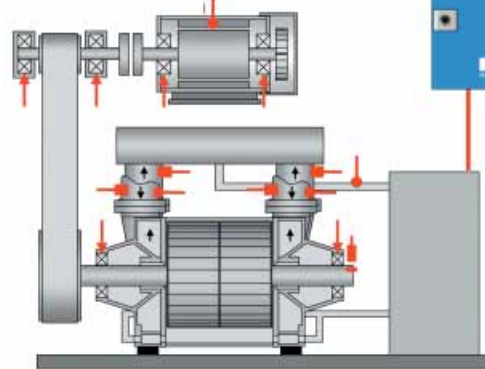
To prevent unexpected pump failure, the condition of the roller bearings and the pump in general should be monitored on a regular basis (Figure 1).

A comprehensive solution for the condition monitoring of vacuum pumps will base its findings on the following parameters:

- Frequency-selective recording of machine vibrations (imbalance, foundation problems, electrical problems)
- Recording of frequency-selective vibration values to monitor roller bearings
- In-depth diagnosis using vibration analysis of vibration spectra, envelope spectra and time signals
- Temperature measurement at pump bearings and water supply inlet
- Recording of operating conditions (rotational speed, pressure on suction and pressure sides)
- Recording of motor current



Vacuum pump



Maintenance/service



Figure 2: A comprehensive monitoring solution for vacuum pumps

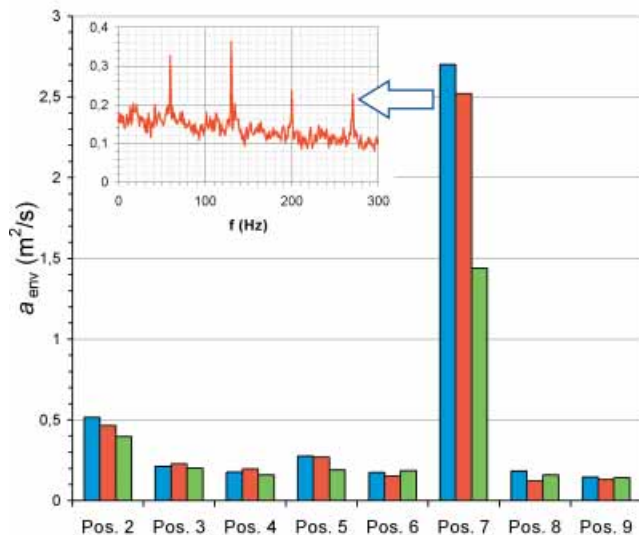


Figure 1: Of the nine vacuum pumps monitored, pump 7 shows increased bearing vibration values.

To record these parameters, pumps must be equipped with the appropriate sensors and the CMS system (Figure 2). PRÜFTECHNIK developed this monitoring system specifically for this application together with Gardner Denver Nash Deutschland GmbH, a manufacturer of vacuum pumps. The CMS system operates on a completely autonomous basis and offers the following special features:

Utilization of the efficiency factor

On the basis of the load-dependent characteristic lines for $\cos j_{load}$ and the efficiency factor η_{load} , the nominal power can be determined from the present operating condition and compared to the actual power consumption using the measured motor current. An increase in power consumption may, for example, be due to initial calcium deposits inside the pump and is thus a criterion for performing pump maintenance.

Threshold value violations

Violations of threshold values lead to warning and alarm conditions. To immediately inform plant operators, this status information is output directly to the control unit (PLC) by means of hardware signals or via a field bus interface.

Global service concepts

The forwarding of data by means of Web technology constitutes a further major advantage. Since an eMail client is already integrated in the monitoring system, additional parties can immedi-



Glossary of terms

Did you know?

GSM and GPRS

GSM (Global System for Mobile Communication) is the dominant standard for mobile networks today. GSM is particularly suitable for telephony because of its low rate of data transfer. However, extensions such as GPRS are available to enable more rapid data services (e.g. WAP). The data transmission rates cannot be compared to those achieved by UMTS.

GPRS (General Packet Radio Service) is a technology that enables more rapid data transmission in a GSM network. Data are divided into individual packets. Each packet contains additional information that tells the network how the packets are linked and the identity of the recipient. This method is based on IP (Internet Protocol) technology, which is also used in the Internet and which enables the transmission of data without having a direct circuit-switched connection to the recipient. GPRS is used to direct packets through various channels of the network, thereby fully utilizing available capacities. Upon arrival at the recipient, the packets are concatenated in the right order into the complete message.

Bluetooth

Bluetooth is an industrial standard for the wireless networking of devices over short distances. Bluetooth offers a wireless interface over which small mobile devices, such as cell phones and PDAs, computers and peripheral devices can communicate. This type of network is also referred to as a Wireless Personal Area Network (WPAN). Bluetooth devices transmit in the license-free ISM band (Industrial, Scientific and Medical Band) between 2.402 GHz and 2.480 GHz. They may be operated anywhere in the world without special licensing. However, they are subject to interference from WLAN networks, cordless telephones, remote garage door openers and microwave ovens that operate in the same frequency band. A special procedure called frequency hopping is employed to achieve resistance against interference. Bluetooth supports voice and data transmission. The transported data can be encrypted if necessary.

Web service

A Web service makes services available via networks (LAN, Intranet, Internet). W3C protocols are used for communication and support. Web services have the special advantage that, because they all use the same open standards for communication, they are mutually compatible and can be interlinked.

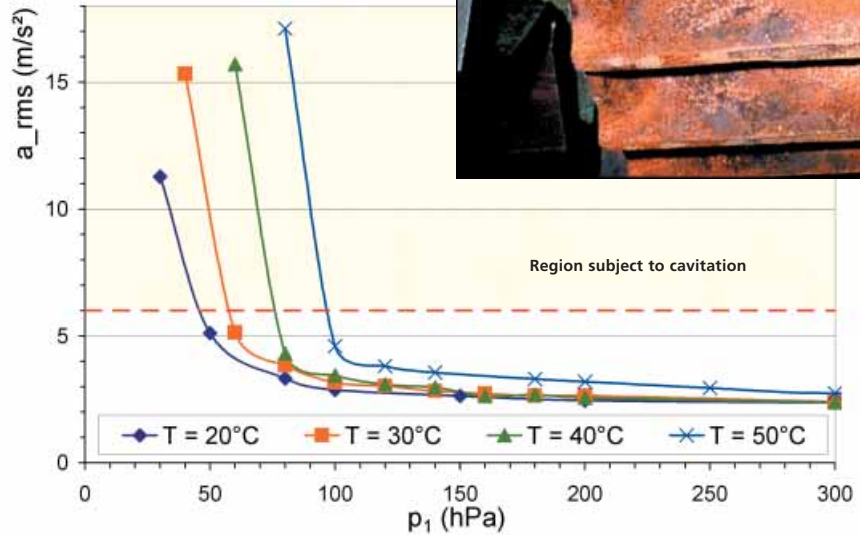


Figure 3: The influence of temperature on cavitation and vibration signals.

ately be notified by eMail. Important measurement data are also sent out by eMail and are thus able to reach maintenance and service personnel promptly, even if the monitored system is far way on another continent.

Detecting cavitation

Targeted vibration monitoring helps prevent premature rotor disk wear caused by cavitation processes. Figure 3 shows the influence of temperature on cavitation and vibration signals.

Conclusion

As are paper machines themselves, secondary supply machines, too, are increasingly benefiting from permanent condition monitoring thanks to the more favorable price-performance ratios now being achieved by new monitoring systems. When used with vacuum pumps, which are essential for plant operation, the advantages for the operator are clear:

- Energy cost reduction
- Product quality assurance
- Service and maintenance cost reductions
- System availability assurance
- Avoidance of unscheduled downtime.

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- [3] DIN ISO 10816-3: Mechanische Schwingungen - Bewertung der Schwingungen von Maschinen durch Messungen an nicht-rotierenden Teilen - Teil 3: Industrielle Maschinen mit Nennleistungen über 15 kW und Nenndrehzahlen zwischen 120 min⁻¹ und 15000 min⁻¹ bei Messungen am Aufstellungsort, Edition 1998

- [4] VDI 3832: Körperschallmessungen zur Zustandsbeurteilung von Wälzlagern in Maschinen und Anlagen, Edition 2006.

Alignment application report

Do we need to align cardan shafts?

Hans Lenz

A question often posed, and with some validity, is whether cardan shafts need aligning. Aren't cardan drives installed to operate with a large offset between the driver and the driven shaft?

Cardan shafts are designed to level out offset but cannot accommodate large angular misalignment between the driver and the driven shaft. This situation generates excessive vibration. For this reason, it is necessary that cardan shafts be aligned.

Lubricant circulation

Cardan shafts are constructed and installed in such a manner that they level off both horizontal and vertical offset. The drive spacer shaft is set at an angle of between 4° – 6° to ensure sufficient lubricant circulation to the universal joints. Experience shows that offset has no real influence in the alignment condi-

tion, a condition that further limits the machine life-time.

How accurate must alignment be?

Precise alignment will extend machine availability as the Mean Time Between Failure (MTBF) increases. The maximum difference between the driver and driven shaft in correlation to each other, should, in our experience, not exceed 0.25° ($\beta_1 - \beta_2 < 0.25^\circ$).

Alignment procedure

To be able to align machines joined by

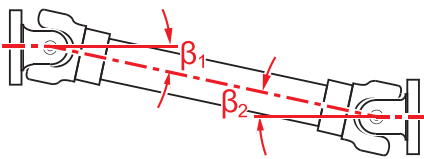


Figure 1: A certain degree of angular misalignment is required to ensure sufficient lubricant circulation in universal joints.

tion. Angularity does however affect the alignment condition. Angular misalignment of such a configuration leads to rapid fluctuation of the driven shaft RPM during operation, which holds grave consequences for electronically-controlled synchronous and asynchronous AC drive motors. Due to the misalignment, the load on the bearings

cardan shafts using a laser alignment system, a specially constructed cardan shaft bracket is required. After dismounting the shafts, this special assembly is mounted on the coupling flange of the stationary machine using a face-plate.



Figure 3: The specially designed cardan shaft bracket. The assembly allows the laser & receiver to be mounted with an offset to each other.

The specialized cardan shaft bracket enables the virtual positioning of the rotational axis of the stationary machine (in this case the roller) in line with the rotational axis of the machine to be moved (the motor).

After mounting both the laser and the receiver, and carrying out laser beam adjustment, both rotational axes may be measured and misalignment corrected.

ROTALIGN® Ultra is an ideal system for cardan applications as 'Cardan' may especially be selected as coupling type. The measurement results may be evaluated using the 0.25° (4.36 mrad) or 0.5° tolerance table. ROTALIGN® Ultra possesses a feature that enables any feet pair on the moveable machine to be set as static. Angularity can be corrected by moving only a single feet pair. The align-

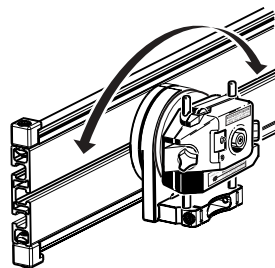


Figure 2: The cardan bracket with the laser holder assembly including the laser.

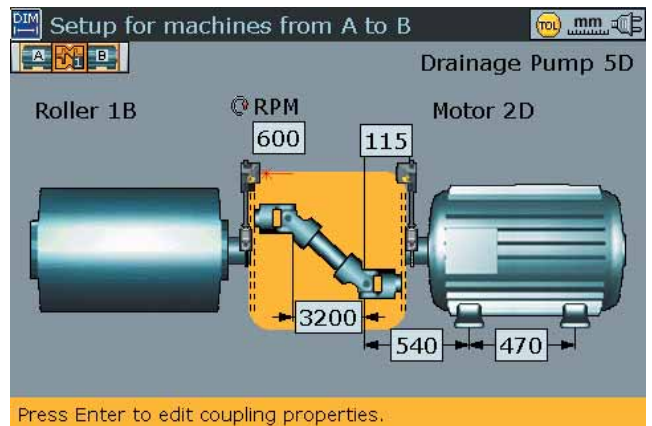
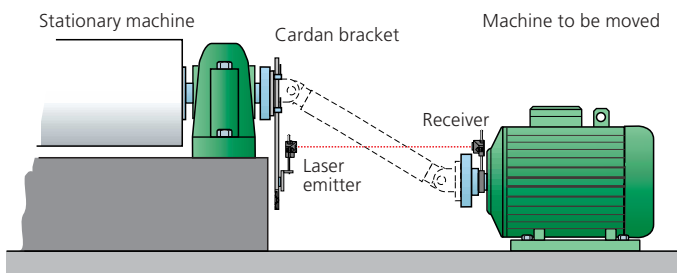


Figure 4: ROTALIGN® Ultra possesses a feature for the alignment of cardan shafts.

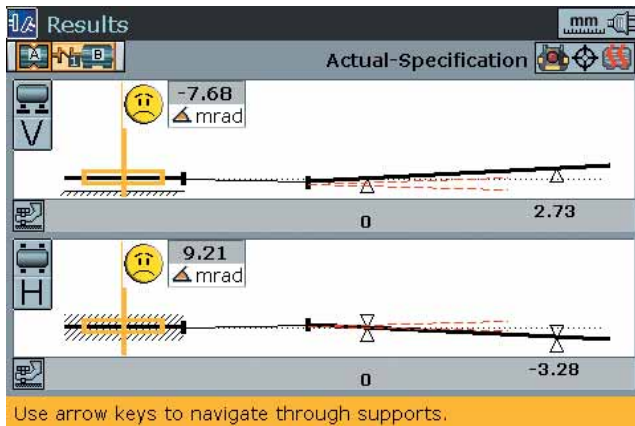


Figure 5: The ROTALIGN® Ultra result screen shows both the vertical and horizontal offset values.

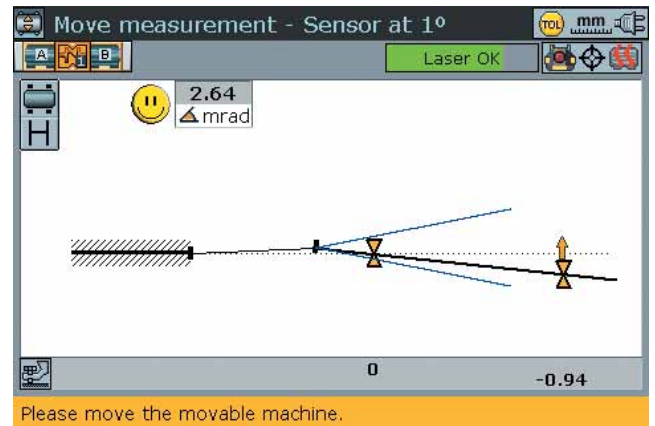


Figure 6: Live move can be followed on the display.

ment is simplified by the move function as both horizontal and vertical live move can be monitored on the display. Using the Bluetooth® RF module for stable wireless data transmission ensures secure, convenient und flexible

operation. The user can observe the live move while positioned at the machine feet being moved. If you are interested, our exclusive service teams are available to carry out cardan shaft alignment at your premises. ■

Condition monitoring technology

Torque and torsional vibration measurement

Florian Buder

In paper machines, as in other equipment, torque vibrations are an undesirable phenomenon that is detrimental to operating reliability, drive life and the quality of manufactured products.

In an effort to reduce vibrations, vibration analyses and torque measurements can be used if vibrations increase at specific rotational speeds. Such was the case with the dry section drives shown here, where systematic torque measurements and changes in the electrical drive configuration succeeded in lowering the vibration level.

Measuring torque and torsional vibration

Torque vibrations can be classed as mechanical, electrical, hydraulic or thermodynamic torque and torsional vibrations, depending on the drive and machine type. General practice in machine construction is to use strain gauges or telemetric measurement signal transmission to measure torque and torsional



Figure 1: Torque measurements in a dry section.

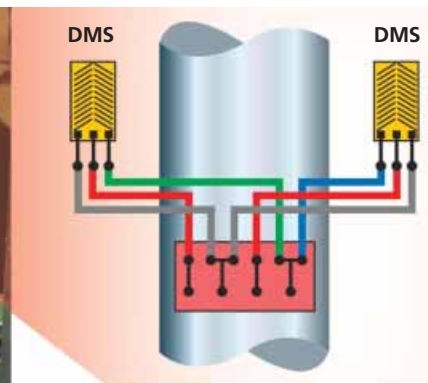


Figure 2: Strain gauges were applied to the drive shaft tube and connected as a full bridge.

vibration. In gears running at operating speed, the oscillating torque should not exceed 30% of the average torque.

By coupling these torque measurements with vibration simulations, it is even possible to calculate dynamic load conditions for specific components and to diagnose excessive loads early on. ■

Diagnosis experience

Natural frequencies with enormous damage potential

Dr. Edwin Becker

It is not unusual in paper manufacturing for 30 year old paper machines to be operated at 200% of nominal speed – with success. To achieve this, static tolerances, e.g. in roller parallelism, and dynamic tolerances, e.g. in roller balancing, must be adjusted for these higher speeds. However, what is to be done if natural frequencies are excited unexpectedly?

Types of natural frequencies

The type and cause of natural frequencies must be identified, excitation frequencies must be minimized and, if these measures do not help, costly reconstructions will be necessary to shift the natural frequencies.

What exactly are natural frequencies? All structures that are capable of vibrat-

of the fundamental bending vibration may lie below 50 Hz, which is why bending vibration analyses become necessary. The vibration system to be calculated consists of a shaft with ring-shaped cross-sections that can be adjusted in the axial direction and a number of 'disks' – see Figure 1. Additional elasticity due to bushings, elastic housings or supports, and roller bearing stiffness must be considered as well. They will further lower the natural frequency.

Roller bearing stiffness

The stiffness properties of pure radial bearings depend on the static load, the bearing type, the inner and outer diameters, the diameter of the rolling elements, their number and position, and bearing clearance.

Resonance risk

Once all of this information is available, calculations can be made on the computer to determine whether there is a risk of resonance. Calculations can also be made to simulate, for example, whether a speed-synchronous imbalance is exciting the system. However, before these types of calculations are made, the vibrations should be analyzed on the basis of the measurements.

Experience of Mr. Hildebrand of Proctor & Gamble in Witzenhausen,

Temporary telediagnosis

To confirm this diagnosis, a temporary telediagnosis system with five accelerometers was installed for four weeks. The filtered vibration velocities were measured continuously and the frequency spectra were recorded every four hours. Figure 3 shows three of the sensors mounted in vertical, horizontal and axial directions.

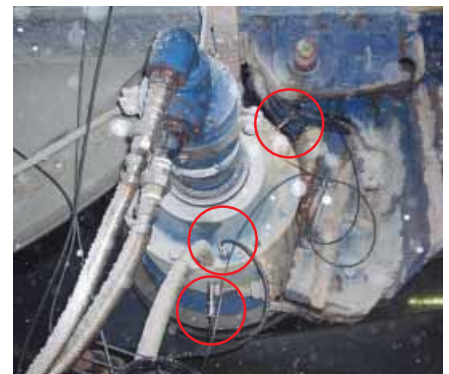


Figure 3: Accelerometers on the press roller – installed in vertical, horizontal and axial directions.

Because vibrations increased while the roller was being monitored, a replacement roller with new bearings was installed.

Figure 3 shows the time signals from the old and new press rollers. The strong fluctuations in the vibration values and the high vibration level disappeared with the new roller. They also did not appear at higher speeds. The natural frequencies were no longer excited after the new roller was installed. ■

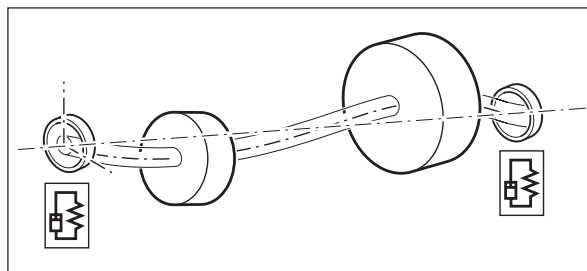


Figure 1: Model for calculating bending vibration

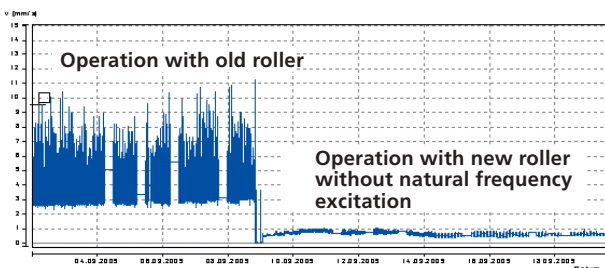


Figure 2: Time signal of press roller

ing and all rollers have natural frequencies. The types of vibration that can arise are bending vibration (transverse to roller axis), torsional vibration (around the roller axis), longitudinal vibration (along the roller axis) and coupled vibration.

Damage potential

The worst type of vibration is the bending vibration. When a machine is operating in the bending-critical range ($f_{crit} \pm 30\%$), the shafts and bearings are at risk of being damaged. In very long, thin press rollers, the natural frequency

Germany, will illustrate this method. By improving the balance and alignment of rollers and drives, Mr. Hildebrand was able to bring his somewhat dated machines up to the higher speeds required for production today. In parallel, he regularly monitored vibration behavior using a VIBSCANNER®. At a press roller in the Yankee cylinder, he discovered unusually high vibrations and therefore consulted the PRÜFTECHNIK Diagnostic Center, which determined through analysis that a natural frequency was being excited.

Preview

Our next issue will focus on marine technology:

Diagnosis experience: Iron wear in thruster gears

Technology: Gaging of bearing gap after crank shaft bearing failure

Application: Acceptance measurement of structure-borne noise in ships

Basics: Cepstra as a new diagnostic method

News

New PC software platform for all alignment systems

Alignment CENTER is the new single software platform for all current PRÜFTECHNIK alignment systems. It supports shaft, straightness and flatness applications. Support for bore applications is due in September 2006.

The software possesses a database structure with wide ranging 'Sort' and 'Search' functions. Alignment CENTER also allows the backup of measurement



Alignment CENTER

files and the detailed preview of measurement results and general file information. Measurement files may be edited as necessary and professional measurement reports generated.

In parallel with Alignment CENTER, a new freeware, Alignment REPORTER, will also be introduced. This software supports most PRÜFTECHNIK alignment systems. It may be used to print detailed customized measurement reports, backup measurement files on a PC, and generate measurement reports. ■

Dates

For current dates for our seminars and specialized topics, including trade fairs, please visit our website at www.pruftechnik.com

Dedicated maintenance services



Our objective remains to service all the condition monitoring and alignment needs of our customers worldwide. In this connection, we have established exclusive PRÜFTECHNIK service teams based in Europe, South East Asia and the USA. In addition, a diagnostic service center has been set up at our headquarters in Ismaning. Detailed information regarding our unrivalled service in the fields of troubleshooting, diagnosis service, alignment of rotating machinery, turbines, rollers and bores, including flatness, straightness and continuous displacement measurements is outlined in our service folder that is available either directly from PRÜFTECHNIK or any of our subsidiaries. ■

Improving shaft alignment know-how

As both market leaders and inventors of laser shaft alignment, we feel obliged and therefore continuously strive to not only improve the quality of our measurement instruments, but also the alignment knowledge of our customers and all those involved in the world of laser shaft alignment. Our presence at trade fairs worldwide, and the various training courses that we offer bear witness to our commitment to industry. In addition to the many manuals and brochures that we continue to produce, we have now published a new 88-page technical handbook that dwells on shaft alignment. This document can be ordered directly from PRÜFTECHNIK. ■



PARALIGN® wins the Golden Palm

A gratifying honour, the Golden Palm, was recently bestowed to PARALIGN® by ATIP, the French paper industry technical association, at its annual conference held in Grenoble. The award was presented to the most innovative product that was on display at the 2005 conference. Stiff competition notwithstanding, the top ranking jury was overwhelmed by the revolutionary performance



of PARALIGN® – a precision laser gyros based measuring instrument – in determining the parallelism of rolls in rolling mill machinery. PARALIGN® service is presently offered in the whole of Europe, the USA, and in South East Asia. PARALIGN® was first used for measurement two years ago in a paper mill, and since then, the recognition of our service teams has continued to grow, with the result that in March 2006 we carried out the 400th PARALIGN® measurement. Using PARALIGN®, complete production plant measurements are often carried out within a day. ■

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