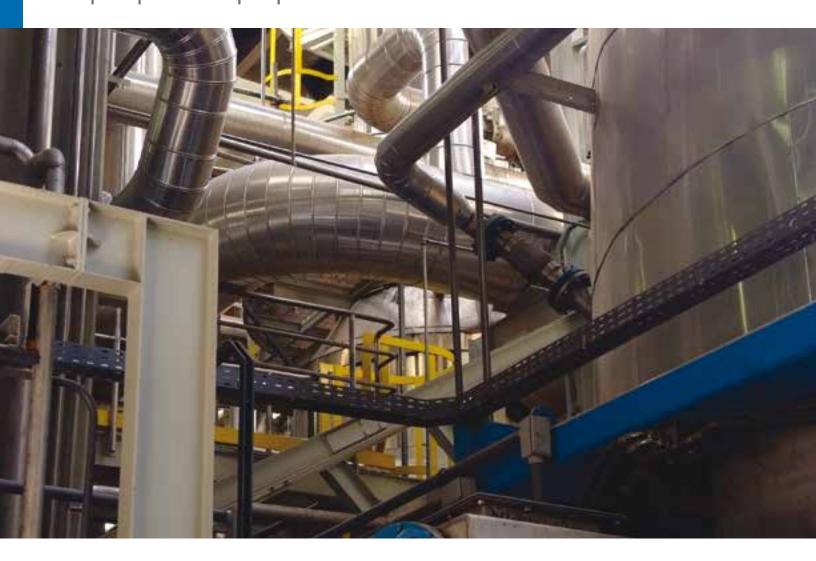# Advanced condition diagnostics
for pulp and paper mills

The challenge: To detect and avoid equipment failures

The solution: Advanced condition diagnostics

You've invested millions of dollars in your equipment. When it fails, your mill can be out of commission for hours, or even days, severely impacting your profit. In some cases, it can even mean a loss of life. That's why you need the most accurate measurement tools available on the market: Advanced condition diagnostic (ACD) systems.
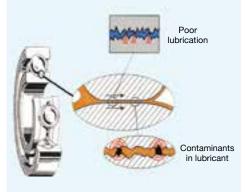
Vibration measurement tools are ineffective when it comes to slowly rotating equipment like lime kilns, hydraulic drives, and wash press bearings. With some equipment such as recovery boilers, by the time a problem is detected by a conventional measurement tool, it is simply too late.

ACD will change the way you think about equipment monitoring. These tools monitor machines that are difficult or impossible to observe and analyze, using new technology that is designed to detect and predict problems before they occur. ACD improves the overall availability of process time for pulp mill areas and equipment. These online diagnostics allow mills to plan maintenance and upgrades, and improve overall plant safety. The system is particularly valuable in detecting incipient failures.

The ACD system monitors friction levels and detects changes on bearing running conditions and lubrication before critical failures occur. In many cases, the source of the friction (for example, lubricant breakdown, metal in lubricant, lubricant cooling system failure,

improper loading) can be corrected, helping the mill to avoid equipment failure—and downtime. On pressure vessels, ACD detects active crack propagation and leaks online.

All ACD tools use ACU sensors developed and manufactured by ANDRITZ. They are completely remote-controlled and provide a complete diagnostic solution. We offer the tools for the following standard applications:
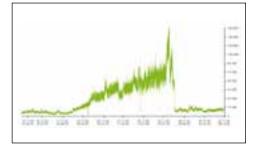
- Kilns
- Digesters
- Recovery boilers
- DD washers
- Wash presses
- Pulp dryers

We can also custom design a solution for any rotating equipment you wish to monitor.

▲ Poor lubrication or contaminants in lubricant cause increased emission levels.

▲ Acoustic emission count trend, indicating increasing friction and unstable function on a slowly rotating robust bearing on digester outlet device over several days.

Benefits

- Monitor machines that are difficult to analyze or observe
- Improve mill process time
- Plan maintenance and upgrades
- Improve overall plant safety

▲ The above photo shows the location of the ACU-230 sensor installed on a lime kiln carrying roller friction bearing. The sensor features a separate sensor head and electronics in separate aluminium enclosure, ideal for applications with high temperature at the monitoring area.

Our technology

ACD tools use acoustic emission (AE) technology. Rapid changes in micro-structures of material generate elastic waves (acoustic emission). Ultra-sensitive piezo sensors then detect and continuously record the amount of energy generated. Acoustic emission technology is very adept at detecting overload, lubrication problems, crack propagation, and incipient machine faults. Low-frequency background noise and audible noise have no effect on measurement.

ACU sensors are typically located at bearing housings, and on gearboxes and pressure vessels. Data produced by ACU sensors is sent to our ACD-server, which offers a web-based human-machine interface (HMI). Sensor indicators on the HMI are marked with colors corresponding to the level of acoustic emission. For example, green indicates normal running conditions, yellow indicates an alert that requires attention and correction, and red indicates an alarm with critical running conditions.

Browser-based HMI data is available for all users in the plant's network. ANDRITZ experts can help you interpret the data to identify the problem being detected. Remote user and diagnostics support is also available.

Universal features

- Acoustic emission-based measuring principle
- Online diagnostics
- Fault detection before any vibration can be detected by other means
- Friction and lubrication condition monitoring
- Alarms and warning

Find out more:

The challenge: To achieve an accurate picture of your kiln's condition

The solution: Kiln ACD

Kiln ACD is an effective tool for monitoring the operation of calciners and kilns, and for providing predictive maintenance diagnostics.

In particular, Kiln ACD can be used to diagnose product ring plugging, carrying roller alignment, and thrust roller and gearbox load. It is also an ideal tool for condition monitoring.

It helps reduce the risk of costly shutdowns by detecting damage in drive operations. It can help with maintenance procedures by putting a damaged gearbox and bearings into the maintenance cycle in a proactive, controlled manner.

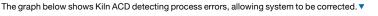Condition diagnostics are conducted during regular operation.

Features

Kiln ACD has a number of features to monitor kilns, including:
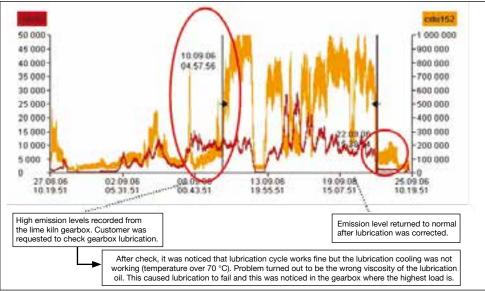
- Acoustic emission-based measuring principle
- Online diagnostics
- Fault detection before any detectable vibration
- Detection of ring formation

- Provision of kiln alignment information
- Bearing diagnostics
- Thrust roller load condition monitoring
- Friction and lubrication condition monitoring

Benefits

- Detect potential damage in drive operations — reduce risk of costly disruptions to operations
- Avoid disruption to the operation by putting damaged gearbox/bearings into maintenance cycle in a controlled manner
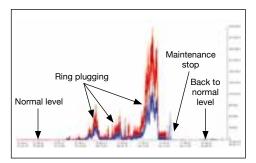- Conduct condition diagnostics during regular operation

The graph below shows Kiln ACD detecting process errors, allowing system to be corrected. ▼

High emission levels recorded from the lime kiln gearbox. Customer was requested to check gearbox lubrication.

Emission level returned to normal after lubrication was corrected.

After check, it was noticed that lubrication cycle works fine but the lubrication cooling was not working (temperature over 70 °C). Problem turned out to be the wrong viscosity of the lubrication oil. This caused lubrication to fail and this was noticed in the gearbox where the highest load is.

Kiln condition monitoring – application scenarios

Scenario 1: Product ring plugging

Product ring plugging can be detected as acoustic emission levels increase in specific carrying roller bearings. An example of product ring plugging is shown in the figure below.

Formation of the ring was detected several days before the kiln was stopped for maintenance. This gave mill personnel valuable time to organize maintenance activities.

As a result of alarms given by Kiln ACD, the kiln was stopped early enough to avoid irreparable damage to the kiln and bearings. After the kiln shutdown and completion of maintenance, acoustic emission levels returned to normal. Inspection of the kiln's condition revealed that no damage occurred.
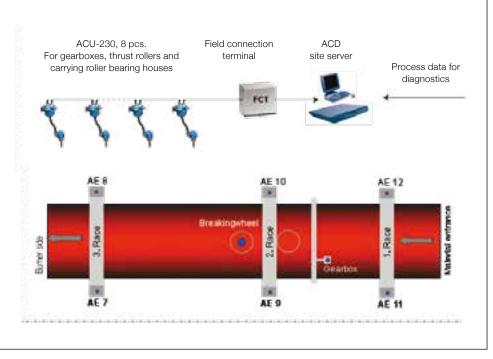

▲ A typical Kiln ACD system configuration

▲ Formation of product ring plugging as seen by Kiln ACD
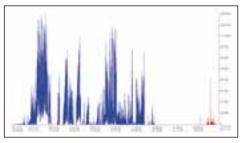
Scenario 2: Kiln alignment

Sensors on carrying roller bearing housings indicate load on the bearings. Changes in loading conditions are detected online as they occur. This makes alignment of the carrying rollers faster and more accurate compared to traditional alignment methods.

In cases where kiln rotation speed is changed but no further adjustments are made, consequent kiln behavior will change.

In one case, a heavy load on the upper thrust roller occurred over four months. Due to sensitive detection, the excessive load was found and corrected before any damage could occur. The lime kiln was resting on the lower thrust roller at certain intervals, as can be seen in the figure below.
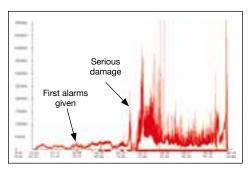

▲ Effect of lime kiln alignment on thrust roller load

Before new roller alignment, the load on the lower thrust roller was much lower than on the upper thrust roller. Since the adjustments, the kiln has been running well and in-line. Continuous lime kiln diagnostics reveal whether additional alignment is needed over time.

Scenario 3: Carrying roller bearing condition monitoring and diagnostics payback

Sensors mounted on carrying rollers can reveal bearing fault development over several months, as seen in the figure below. This is an example of long-term diagnostics.

▲ Development of serious carrying roller bearing fault over a long period

The challenge: To achieve an accurate picture of your digester outlet device's condition

The solution: Digester ACD

Digester ACD is an effective tool for monitoring the operation of digester and impregnation vessel outlet devices, and for providing predictive maintenance diagnostics.

In particular, Digester ACD can be used to diagnose bearing overload periods, lubrication problems, and incipient bearing failures. It is also an ideal tool for condition diagnostics of gearboxes and hydraulic drives.

By detecting damage in drive operations, Digester ACD helps reduce the risk of costly shutdowns. It can also help with maintenance procedures by putting a damaged gearbox, drive, and bearings into the maintenance cycle in a proactive, controlled manner. Condition diagnostics are conducted during regular operation.

Benefits

- Detect potential damage in drive operations — reduce risk of costly disruptions to operations

- Avoid disruption to the operation by putting damaged gearbox/ bearings and devices into maintenance cycle in a controlled manner

- Conduct condition diagnostics during regular operation

- Predictive, user friendly, continuous condition information

Features

Digester ACD has a number of features to monitor outlet devices, including:

- Acoustic emission-based measuring principle
- Online diagnostics
- Fault detection before any detectable vibration
- Overload detection
- Provision of continuous condition status information
- Bearing diagnostics
- Hydraulic drive and gear box condition monitoring
- Friction and lubrication condition monitoring
- Oil contamination detection
- Detection of serious crack development at early stage

▲ ACU sensors installed on a digester

Digester condition monitoring – application scenarios

Scenario 1: Bearing failure

Failures in bearing can be detected with increased emissions. Figure 1 shows Digester ACD detecting incipient bearing failure at an early stage, giving plant personnel time to take corrective action in order to continue normal production in November, without a break. The trend also shows a final alarm in March, which occurred early enough so that plant personnel could make a controlled shutdown.

Scenario 2: Crack detection on outlet device

Figure 2 shows high-energy emissions recorded from a digester outlet device upper bearing. The emissions do not correlate with bearing rotation speed and load. Emissions are periodic and the level is increasing.

A check revealed serious cracks on the outlet device steel constructions. These cracks caused high-energy acoustic emission bursts and were shown on ACD online trends. Emission levels returned to normal after repairs were undertaken.
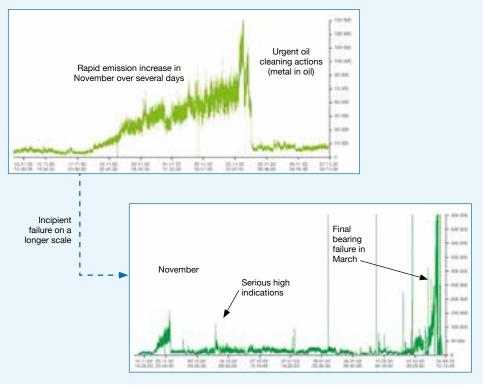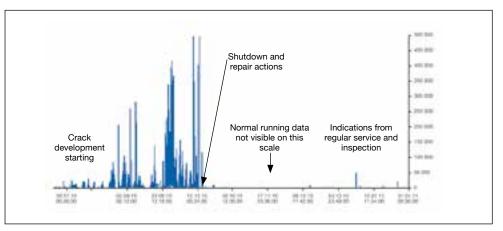

▲ Figure 1: Indications of incipient bearing failure and final breakdown as detected by Digester ACD

▲ Figure 2: Crack formation on a digester outlet device as detected by Digester ACD

The challenge: To achieve an accurate picture of your recovery boiler condition

The solution: Recovery Boiler ACD

Recovery boiler ACD is an effective tool for monitoring the operation of recovery boiler economizers and boiler banks, and for providing predictive maintenance diagnostics.

In particular, Recovery Boiler ACD can identify and pinpoint leaks. It helps reduce the risk of additional damage by detecting incipient issues and leaks at an early stage, long before water is visible in the ash. It can help determine required repairs by identifying the area where the leak is located. Condition diagnostics are conducted during regular operation.

Features

Recovery Boiler ACD has a number of features to monitor economizers and boiler banks:

- Acoustic emission-based measuring principle
- Online diagnostics
- Fault detection at early stage
- Overload detection
- Provision of continuous condition status

- information
- Leak detection and location
- Detection of fatigue and serious crack development at early stage

Recovery boiler condition monitoring – application scenario

Leaks in the recovery boiler economizers can be detected by ACD recording higher acoustic emissions. As shown in Figure 3, sensors are located on the upper and lower headers on the boiler banks and economizers to provide continuous, online diagnostics of pressure vessel to detect overload, abnormal vibration, crack development, and leaks. Figure 4 shows high-energy emissions recorded from the economizer between and during soot blower working cycles, indicating typical fatigue and crack development. Location prediction is based on several ACU sensors' data—this helps operators to find the leak quickly and remarkably shortens the shutdown time. In this case, emission levels returned to normal after repairs were undertaken.

▲ ACU sensors installed on recovery boiler

▲ Figure 3: Recovery Boiler ACD HMI graphic

Benefits

- Detect potential damage in pressure vessel—reduce risk of costly disruptions to operations
- Avoid disruption to the operation by receiving predictive online load information
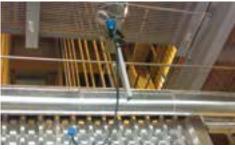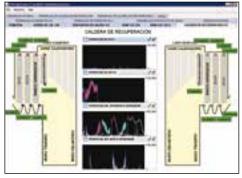- Conduct condition diagnostics during regular operation
- Online leak detection

Increasing acoustic emission levels due to crack development; typically one to two weeks before first leak

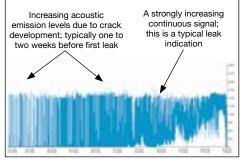A strongly increasing continuous signal; this is a typical leak indication

▲ Figure 4: Crack formation and leak on economizer as detected by Recovery Boiler ACD

The challenge: To achieve an accurate picture of your DD washer hydraulic drives' condition

The solution: DD Washer ACD

DD Washer ACD is an online predictive diagnostic tool for detecting incipient condition issues on slowly rotating hydraulic drives.

Continuous ACD trends provide a clear indication of changes in motor condition, giving plant personnel valuable time to plan and prepare service actions. Significant savings are realized through increased production up-time and emergency shutdowns can be avoided.

Regular service costs are remarkably lower when drives are serviced before severe damage occurs, as opposed to having experienced significant damage or wear.

Features
DD Washer ACD has a number of features to monitor hydraulic drives:

- Acoustic emission-based measuring principle
- Online diagnostics
- Fault detection at early stage
- Overload detection
- Provision of continuous condition status information

DD washer condition monitoring — application scenario
Figure 5 shows how DD Washer ACD information is used to make adjustments to affect the friction level on each of the four shafts of a washer seal bar. ACD's continuous monitoring means it can find the ideal setting for the seal bars—and maintain those settings. Ideal adjustments result in increased production rates and better washing results. During production changes, the seal bar setting can be easily and quickly changed. There is no unnecessary tightening of the seal bars, resulting in longer seal bar life.

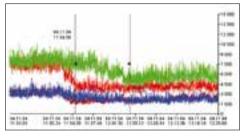▲ ACU sensors are installed on hydraulic motors for continuous condition diagnostics.

▲ Figure 5: Emission value change during seal bar adjustment

Benefits

- Detect potential damage to motors
- Reduce risk of costly disruptions to operations
- Damaged motor can be taken into maintenance cycle in a controlled manner
- Conduct condition diagnostics during regular operation
- Accurate seal bar adjustment means increased production rate and improved washing

The challenge: To achieve an accurate picture of your pulp dryer bearing condition

The solution:
Pulp Dryer ACD

Pulp Dryer ACD is an online predictive diagnostic tool for detecting incipient condition issues with the bearings on slowly rotating drying machines.

In particular, Pulp Dryer ACD can be used to diagnose bearing overload periods, lubrication problems and incipient bearing failures on press section slowly rotating bearings. By detecting damage, Pulp Dryer ACD helps reduce the risk of costly shutdowns.

It can also help with maintenance procedures by putting a damaged bearing into the maintenance cycle in a proactive, controlled manner. Condition diagnostics are conducted continuously during regular operation.
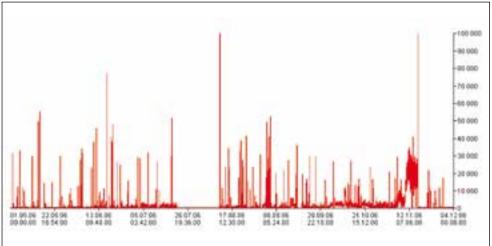

Features

Pulp Dryer ACD has a number of features to monitor drying machines:

- Acoustic emission-based measuring principle
- Online diagnostics
- Fault detection at early stage
- Provision of continuous condition status information

Benefits

- Detect incipient failure development in bearings — reduce risk of costly disruptions to operations
- Put damaged bearings and devices into maintenance cycle in a controlled manner
- Conduct condition diagnostics during regular operation
- Predictive, user friendly, continuous condition information
- Easy to confirm successful bearing change — long history data available

▲ Figure 6: Pulp Dryer ACD diagnostics over a seven-month period

Pulp dryer condition monitoring – application scenario

Faults in slowly rotating roller bearings can be detected with ACD acoustic emission monitoring.

Figure 6 shows Pulp Dryer ACD trend monitoring of press section bearings over seven months, in which the base value is slowly increasing from May to October and showing a rapid increase in November (the short high peaks are production start/stop peaks).

▲ Figure 7: Detailed view of the trend, showing serious fault development in roller bearing as detected by Pulp Dryer ACD

The plant condition monitoring team noticed this trend development and started on September 22 to organize predictive actions. On October 4, they performed an extra check of lubrication conditions, but increased lubrication did not improve the situation.

By November 9, the ACD trend was rapidly increasing and the first serious ACD alarm was triggered. The trend remained at a high level, indicating that the bearing was receiving significant damage. Plant personnel completed their actions on November 12 by measuring the temperature on all bearings.

The bearing in question had a higher temperature than other similar ones. On November 14, a vibration measurement and comparison between bearing values was made; values were within normal range on all bearings, including the bearing with alarming ACD values. Based on the information provided by ACD, the maintenance team decided to make a planned shutdown and the bearing was replaced on November 16 under controlled conditions. There was minimum production downtime, and only the one bearing was damaged. The shaft and bearing house received no damage. Once the damaged bearing was replaced, the ACD trend returned to minimal levels, as shown in Figure 7.

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