DETECTION
MEASUREMENT
MONITORING
AND SOLUTIONS
FOR THE BIOMASS FUEL PROCESS
Welcome to this special supplement focusing on the use of biomass fuels in the power generation industry. You’ll find features on safety monitoring at all stages in the biomass plant, and the importance of combustion control. We also highlight the AMETEK Land solutions that deliver the key measurements for safety, efficiency and emissions control throughout biomass operations.

AMETEK Land has been a key part of the AMETEK Process and Analytical Instruments Division since 2006. As part of this group, alongside our sister company AMETEK Process Instruments, we are able to deliver a comprehensive solution for measurements across the biomass process. It also means our customers have access to the services of the global AMETEK sales and support team.

Enjoy this supplement and learn more about how your biomass process can benefit from our expertise and applications knowledge.

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Our comprehensive range of after-sales services ensures you get the highest performance from your AMETEK Land instruments and systems. Dedicated service centres and on-site personnel across the world deliver:

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- Details of our extensive product range
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**CONTENT OVERVIEW**

**EARLY STAGE COMBUSTION IN BIOMASS PROCESS**

**AMETEK LAND CO MONITORS**

**TEMPERATURE MEASUREMENT IN THE PROCESS**

**AMETEK LAND THERMAL IMAGING**

**ENHANCING SAFETY, EFFICIENCY AND ENVIRONMENTAL PERFORMANCE IN THE BIOMASS PROCESS**

**MEASURING AND MONITORING COMBUSTION EFFICIENCY**

**YOUR GUIDE TO BIOMASS INDUSTRY SOLUTIONS**

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Biomass is a fuel source based on growing materials such as forest products and agricultural residues. Provided the sources are replanted and managed sustainably, biomass is a renewable, carbon-neutral fuel. Compared to coal, biomass combustion produces 90% less carbon dioxide emissions, and can be burned in existing power plants.

**Carbon Monoxide Detection**

Carbon monoxide (CO) detection provides a fast and unambiguous indication of spontaneous combustion in an enclosed space. Ambient air has a very low concentration of CO, but a large amount of CO is produced as spontaneous combustion begins. A rapid rise in CO concentration is therefore a clear sign that preventative action is required.

CO measurement is especially important in pulverisers, where there is a risk that burning material may be introduced. In addition, the mill performs a great deal of mechanical work in crushing the fuel, which can lead to a fire or explosion.

This explosion risk is low when the mill is in operation, because the particle concentration is above the upper explosive limit. However, when the mill is started or stopped, the concentration inevitably passes through the explosion range. If burning material is present at this stage, an explosion is highly likely.

Most CO monitors used in biomass applications use electrochemical sensors. These are compact, highly specific and sensitive devices, with detection limits typically in the region of two parts per million. However, when an electrochemical sensor fails, it returns a zero output, making it indistinguishable from a safe condition. It is essential to perform regular calibration checks to verify the sensor is functioning correctly, usually on a weekly basis.

While verification can be performed manually, an automatic check ensures consistent monitoring, and eliminates the possibility that it may be neglected if plant staff have other priorities. Continuous exposure to the target gas reduces the sensor response over time, so some systems use paired sensors which are alternately exposed to the sample and ambient air. This allows a continuous measurement without any loss of accuracy.

As it measures gas concentration, CO monitoring is only effective in enclosed spaces such as silos and pulverisers. In open areas, wind and other air movements disperse the gas before the concentration reaches a measurable level.

**Millwatch/Silowatch**

Millwatch detects the rapid build-up of carbon monoxide (CO) inside coal or biomass mills, while the Silowatch performs the same function for storage silos. They continuously monitor the atmosphere, responding quickly to significant increases in CO levels.

Millwatch and Silowatch extract sample gases from the mill outlet and silo headspace respectively, using a unique dual-sensor detection system to monitor CO levels. If CO levels reach pre-set limits, then alarms are triggered and preventative action can be taken before a fire starts or an explosion occurs, increasing plant safety and reducing downtime.

The Silowatch is ideal for monitoring storage silos to detect spontaneous heating and combustion, while the Millwatch is perfectly suited to monitoring biomass pulverisers for the same purpose.

**Carbon Monoxide**

CO measurement is a sensitive method for early detection of spontaneous combustion. In complete, efficient combustion, carbon from the fuel source reacts with oxygen from the air to form carbon dioxide (CO₂). However, during the incomplete process that typically marks early-stage combustion, the carbon does not take up as much oxygen, and so produces CO.

Since there is very little CO in ambient air, a sudden increase is a strong indicator that combustion is under way.

In addition, because CO is produced while the combustion process is still at the incomplete stage, CO levels will rise before CO₂ levels, and more quickly than any temperature rise.

This means CO detection will provide a warning of combustion much earlier than methods that monitor for increases in temperature.

**Advantage of CO Detection Over Temperature Monitoring**

The graph (Fire Advanced Warning - CO vs Temperature) shows that CO measurement can detect spontaneous heating much earlier than temperature monitoring. If CO levels reach pre-set limits, then alarms are triggered and preventative action can be taken before a fire starts or an explosion occurs, increasing plant safety and reducing downtime.
**TEMPERATURE MEASUREMENT**

Bacteria and fungi act to cause the temperature of a storage pile to increase, whether the pile is open or enclosed. It is generally impractical to detect this temperature rise by direct measurements with thermometers or thermocouples because the material is regularly moved to the combustor and because of the size of the piles. So, a non-contact infrared temperature measurement is preferred.

Although this type of measurement only looks at the surface of the stored material, it does provide an indication of its temperature and, therefore, of the heat being generated inside the storage pile. The simplest method for scanning a storage pile is by using a hand-held thermal imager. Such devices are relatively inexpensive, but intermittent measurement means that spontaneous heating can go undetected. A fixed imaging system is preferable since this allows images to be stored and compared over time. Image processing software further allows the temperature to be measured over different zones of the storage pile. The software also can exclude short-term fluctuations, such as a vehicle passing through the field-of-view. A highly effective conveyor temperature measurement can be made by a line-scanning infrared pyrometer using a single detector with a high-speed scanning mirror that can make up to 1000 discrete temperature measurements across the width of the conveyor. The conveyor’s movement allows the scanner software to build up a two-dimensional image of the material on the belt and show any hot spots associated with burning material.

Thermal imaging also can be used inside a silo to measure the surface temperature of stored biomass fuels. Although this method cannot measure the temperature of hot material deep within the silo, the hot gases produced by spontaneous heating carry heat to the top of the pile, allowing a thermal imager to detect an abnormal temperature profile.

**REMEDIAL ACTIONS**

Once spontaneous heating or spontaneous combustion is detected, appropriate remedial action must be taken. The best course of action depends on the location and severity of the problem: for example, a storage vessel can be inerted with nitrogen or steam. Burning material can be diverted from a conveyor so that it does no more harm. In some cases, the best action can be to burn the fuel in the boiler in order to empty a storage vessel.

The compact, high-speed HotSpotIR scanning system is used to detect these emerging hot spots before damage occurs. The rapid-response infrared technology scans 100 high resolution temperature lines every second, while the hottest point measured is updated and output to the alarm processor every one-hundredth of a second. Connected to a Landmark signal processor, the scanner can measure across the entire conveyor surface, covering a measuring range of 20-250 °C (68-482 °F).

**THE SOLUTION**

Many materials that are transported on conveyors contain hot inclusions. These hot objects can damage belts or cause belt or material fires. If any areas register above the safe temperature range, an alarm is activated which can be set to either alert plant operators, or to automatically trigger fire suppression systems. With a highly compact design and the ability to withstand high ambient temperatures (up to 150 °C (300 °F) with additional cooling), the HotSpotIR is ideal for monitoring conveyor belt operations in biomass operations.

**ARC IMAGER**

ARC is a rugged radiometric thermal process imager, offering unsurpassed temperature accuracy across a wide range of applications. Using cutting-edge, high-resolution technology, the flexible, option-rich ARC delivers detailed thermal images with unrivalled precision. With four lens options, it views any target at any distance, with outstanding clarity, providing early hotspot detection. Data-processing is performed within the imager, with no separate signal processor required, allowing for continuous and fully-automated monitoring of remote storage areas.

A simple alarm output alerts operators when hotspots are detected, allowing preventative action by plant personnel. Variable warning levels and smart false alarm prevention ensure action is only taken when needed.

The ARC Imager is designed specifically for outdoor industrial environments, delivering the ultimate in reliability and measurement availability. This makes it ideal for monitoring the biomass raw material storage pile to discover spontaneous heating and combustion at an early stage.

**HotSpotIR**

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**PROCESS IMAGING**

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**LINESCANNING**

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**Download the Brochures for more information at AMETEK-LAND.COM**

SEE THE PROCESS ON PAGE 08
Combustion efficiency is important to all boilers, regardless of the fuel used. The process depends on the reaction between fuel and air (providing oxygen) to produce high temperatures. The drawbacks to industrial-scale combustion include large-scale fuel consumption, the production of harmful emissions and potential safety hazards. Well-controlled combustion requires the best possible air-to-fuel ratio in order to maximise the heat capture of the furnace. Too much oxygen creates cooler burning conditions and combines with nitrogen to produce unwanted emissions.

When the amount of oxygen is perfectly balanced by the amount of fuel in the reaction, the air-fuel ratio is said to be stoichiometric. If the combustion reaction is complete, all of the hydrocarbons are converted to carbon dioxide and water. If there is insufficient oxygen to convert all the hydrocarbons, the combustion is incomplete, leaving unburned combustibles in the exhaust gas. In addition, high-fuel, low-oxygen conditions create a risk of dangerous explosions. Achieving the optimum ratio between fuel and air is challenging, as it is constantly affected by changes in loading conditions, fuel composition, fuel particle size, and content of the ash produced.

**EXCESS FUEL**

- Fuel + O₂ + N₂ = CO₂ + H₂O + N₂ + CO + ppm NOx
- Combustion Inefficiencies (due to Unburned Fuel Combustibility)

**EXCESS AIR**

- Fuel + O₂ + N₂ = CO₂ + H₂O + N₂ + O₂ + ppm CO + ppm NOx
- Wasted Heat due to Excess Air

**STOICHIOMETRIC COMBUSTION**

- Fuel Maximum Useful Heat Transfer
- Useful Heat Transfer Reduced

**THE KEY OBJECTIVES OF EFFICIENT COMBUSTION CONTROL IN A BIOMASS BOILER ARE TO:**

- Maximise steam (heat) production
- Minimise fuel consumption
- Maximise thermal efficiency throughout load swings

**THE BENEFITS OF COMBUSTION CONTROL**

- Optimising the efficiency of a combustion process reduces fuel costs, reduces NOx emissions and increases the operational safety of a boiler.
- Measurements of both oxygen and combustibles are necessary to prevent the boiler from inadvertently being placed into an unstable, fuel-rich condition.
- AMETEK Land provides complete solutions using analysers which measure both oxygen and combustibles in one device. These products deliver the required safety and process control measurements in a single package, making installation easier.

**INSTRUMENTS FOR INDUSTRY**

**WDG-VC  O₂ AND COMBUSTIBLES ANALYSER**

- For low to moderate dust concentrations

**WDG-HPIIC  O₂ AND COMBUSTIBLES ANALYSER**

- For very high dust concentrations

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COMPREHENSIVE SOLUTIONS FOR SAFETY, EFFICIENCY AND ENVIRONMENTAL COMPLIANCE IN THE STORAGE AND USE OF BIOMASS FUELS

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