LAND

AMETEK®

INDUSTRIAL BOILERS

APPLICATION NOTE

Industrial boilers are used to produce steam, which can be used to turn electrical turbines to generate power or provide heat in an industrial process.

In all cases, it is important to monitor and diagnose combustion conditions within the boiler to improve its operation, and safety.

Key measurements can support the optimisation of the combustion process and minimise emissions. Monitoring the boiler can also provide important information on the refractory or waterwall condition.

AMETEK Land's products support combustion efficiency and emissions control, helping lower process, and maintenance costs, and avoid fines for non-compliance. Our boiler monitoring solutions identify maintenance issues at an early stage, using mid-wavelength imaging that is not sensitive and can see through luminous flames.

INTRODUCTION

Industrial boilers are used for a range of applications, including the creation of process steam, electricity generation, and cogeneration.

They are built to withstand very high temperatures and consume large amounts of energy.

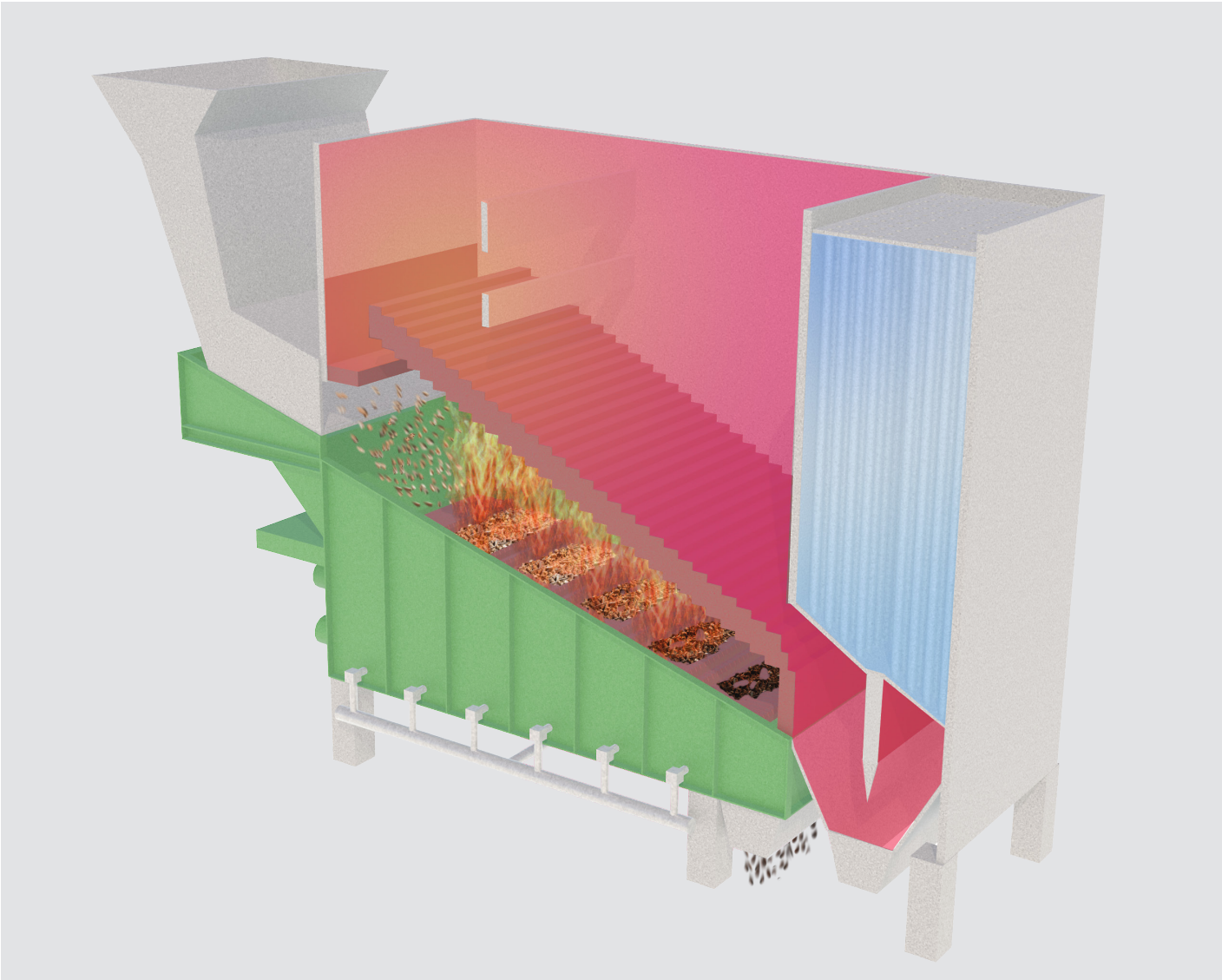
Accurate, real-time monitoring of many parameters is required to maintain safe and efficient boiler operations. These parameters include tube wall or refractory temperature, furnace exit gas temperature, boiler efficiency, slagging rates as well as the concentration of oxygen (O_2), carbon monoxide and nitrogen oxides (NOx) in the flue gases.

Gas analysis systems can be installed from the furnace exit to the stack exit, measuring a wide range of emissions.

A thermal imager can provide important information on conditions within the boiler. This can measure tube temperatures and detect slag build-up, allowing operators to optimise combustion conditions and soot-blowing operations.

A high resolution, infrared borescope employing a wide-angle lens allows the operator to see a large portion of the boiler wall with only a small penetration and allows the sensitive imager to be located outside the boiler. A heavy duty water-cooled and air-purged lens permits continuous 24/7 operation even in this aggressive environment.

Non-contact pyrometers employing specific wavelengths are available which can measure the furnace exit gas temperature whilst being unaffected by the cold gases outside the furnace.

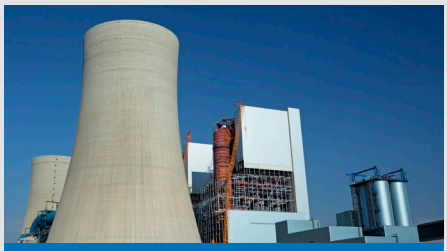


RECIPROCATING GRATE INCINERATOR WITHIN A BIOMASS BOILER

TYPES OF BOILER

FIRETUBE BOILERS

In a firetube boiler, the fuel is burned inside the furnace, and the hot gases pass through tubes surrounded by water, transferring the heat through conduction and ultimately generating steam. Firetube boilers are reliable and robust, but typically require high levels of maintenance to ensure safe, efficient operation. They have a simple design but are limited to small-scale, medium-pressure applications.



PULVERISED FUEL BOILERS

Pulverising coal to a fine powder increases the ease and efficiency of burning. In this type of boiler, the fuel is pulverised before being transported to the burner by a flow of hot air. Steam is produced from this process, which is capable of driving large-scale turbines for power generation. The process can also be applied to biomass and other fuels, though coal remains the most common. The residual mineral matter within the fuel remains as ash, which must be dealt with correctly to ensure efficient boiler operation. The coarse ash particles fall to the bottom of the boiler where they can be removed relatively easily. Finer particles become fly ash, transported out of the boiler along with the flue gases. These must be removed by dedicated dust arrestment plant, usually a baghouse or electrostatic precipitator.

GRATE BOILERS

This type of boiler uses solid fuel. It is mostly used for burning waste and biomass but can also be used for smaller coal furnaces. Typically, a moving grate is covered with a layer of the fuel, which is ignited as it passes into the hot part of the boiler. The heat output can be controlled by adjusting the speed of the grate. Sloping grates operate in a similar fashion, but the fuel moves over a fixed grate under the influence of gravity.

FUEL TYPES

Coal – is the traditional fuel for industrial boilers, though it typically has a greater negative impact on the environment than other fuel types. For industrial use, it is often pulverised into a fine powder, ensuring it burns more easily and efficiently than solid bricks of coal.

Biomass – renewable fuel sources such as wood pellets, bagasse and hog fuels can be burned to generate power. They offer greater environmental performance than fossil fuels but can be more susceptible to spontaneous combustion, and so require careful monitoring.

Gas and oil – natural gas can be used to fuel boilers, as can gasoline and other petroleum-based liquids. These fuels emit less carbon dioxide than coal, but still require emissions monitoring to meet environmental regulations.

ASSESSING BOILER OPERATION

Solid-fuel boilers are susceptible to slagging, where ash from the fuel builds up on the heat transfer surfaces. Biomass boilers are especially prone to slagging because of the nature of the residues from the fuels.

Many boilers use soot blowing systems to remove any deposits and ensure continued efficient operation. Monitoring the boiler interior with an infrared borescope can be helpful in guiding the frequency of soot blowing and helps determine the success of the operation in removing deposits.

Fuel flow can also affect the efficiency of heating. Combustion depends on the reaction between oxygen and the fuel, so if there are inconsistent levels, there will be a negative impact on the quality of combustion.

To ensure combustion efficiency, the optimum ratio of oxygen to fuel must be achieved. Obviously, if fuel flow fluctuates, it is difficult to adjust the oxygen level to maintain this optimisation. A real-time monitoring solution is required to keep the levels at the right balance.

With thermal imaging, boiler tube conditions can be assessed, tube temperatures can be measured, and slag build-up can be detected. This allows boiler operators to achieve ideal combustion conditions and to optimise soot-blowing operations.

MONITORING BOILER CONDITIONS

Thermal imaging can deliver clear, live images of the boiler interior, even through heavy smoke and hot furnace atmospheres which would obscure visual furnace camera systems. It requires advanced spectral filtering and a high thermal and spatial resolution to ensure accurate measurements in the presence of flames and smoke.

AMETEK Land's solution for this application is the MWIR-B-640, a mid-wavelength infrared thermal imager using a borescope design which builds upon more than 20 years of experience with this type of technology.

The MWIR-B-640 allows highly accurate and fully radiometric temperature measurements to be taken, stored, and trended over the lifetime of the boiler.

It utilises advanced IMAGEPro thermal imaging-processing software for long term data trending and analysis, enabling the early detection of leaks and temperature variations, and achieving effective process optimisation.

Operators are provided with a clear view of the critical boiler areas, with more than 300,000 accurate point temperatures, measuring in the range of 500-1800 °C (932-3272 °F).

IMAGEPro software also facilitates advanced digital communications, allowing easy monitoring of the boiler to identify hot and cold areas and visualise any uneven heating in real-time.

The MWIR-B-640's high-resolution image, combined with its wide-angle field of view (90°), allows multiple areas to be imaged and measured simultaneously, with the live image data viewed from the safety of the control room.

Only a small opening in the wall is required for the MWIR-B-640 to accurately profile the temperature of the entire furnace wall, so the furnace atmosphere and energy consumption are not affected.

The MWIR-B-640 is an invaluable tool in prolonging furnace and boiler lifetime, optimising production throughput and reducing energy consumption, and improving stock temperatures.

Distance	1 m			5 m			10 m			15 m			20 m		
	Width	Height	IFOV	Width	Height	IFOV	Width	Height	IFOV	Width	Height	IFOV	Width	Height	IFOV
90° x 67.5°	2.0 m	1.3 m	3.1 mm	10.0 m	6.6 m	15.6 mm	20.0 m	13.3 m	31.3 mm	30.0 m	20.0 m	46.9 mm	40.0 m	26.7 m	62.5 mm

Optical data for the MWIR-B-640, showing the instantaneous field of view (IFOV) at a range of distances.

MWIR-B-640 FEATURES

- Advanced spectral filtering
- High-temperature measurement accuracy
- High spatial resolution
- Real-time thermal data
- Advanced image processing software

MWIR-B-640 BENEFITS

- Clear views through dusty/smoky/luminous flames/hot conditions
- Allows optimum boiler control in real-time
- Resolves fine details within the boiler
- Improves energy efficiency without degrading boiler lifetime
- Continuous monitoring from a safe operator location

EMISSIONS CONTROL AND MEASUREMENT

As with any combustion system, boilers emit toxic pollutants that need to be controlled and monitored to ensure compliance with environmental directives and protect public health.

Continuous emissions monitors provide essential feedback for optimising the process and for demonstrating compliance with relevant emissions rules. Within the European Union, compliance monitors must be certified as meeting the QAL1 standard according to EN 15267, and this has become a de facto requirement in many other countries. In the United States, analysers must meet performance specifications defined by the US EPA.

Highly accurate and reliable non-contact opacity and dust monitors are required to ensure emissions compliance.

Low-level measurements of particulate matter (PM) generally use laser light scattering, which can achieve a lower detection limit than is possible with an opacity monitor.

AMETEK LAND EMISSIONS

4500 MkIII

Combustion & Emission Monitoring

A high-specification opacity and dust monitor meeting US and European standards for monitoring combustion processes, the 4500 MkIII is the most accurate and reliable continuous opacity monitor available.

Using a highly homogenous LED light source to minimise sensitivity to optical misalignment, the monitor ensures compliance limits are met with confidence, avoiding the risk of regulator fines, and lowering costs through operational efficiencies.

- Unmatched, class-leading opacity monitoring
- EN 15267 and QAL1 approvals through MCERTS and UBA
- Meets the requirements of ASTM D6216 and US EPA PS-1
- Easy operation with intuitive built-in display
- Multi-prism retroreflector reduces thermal drift
- No continuously moving parts
- Simple design for problem-free operation

4650-PM

Combustion & Emission Monitoring

Providing a high-sensitivity, forward-scatter laser measurement for particulate matter, the 4650-PM delivers stable, accurate low-range measurements in stacks and ducts where water droplets are not present in the flue gas.

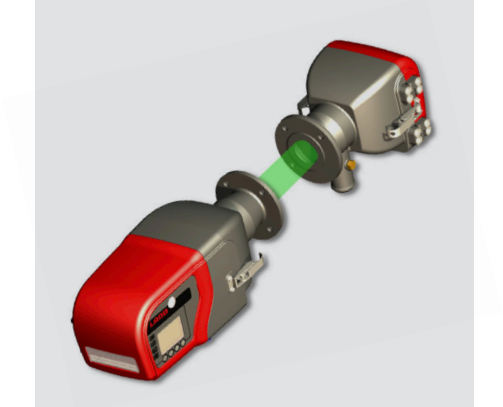
Consisting of a stack-mounted probe and separate control unit, the 4650-PM enables closer emissions control, with a lower detection limit than similar PM monitoring systems.

- Very low detection limit
- Reduced sensitivity to changes in particle size
- EN 15267 and QAL1 approvals through MCERTS
- Meets US EPA PS-11
- Large collection area optics for highest sensitivity
- No moving parts in the measurement path
- Comprehensive control options

MONITORING SOLUTIONS

Combustion & Emission Monitoring

4400



Combustion & Emission Monitoring

A robust, accurate opacity monitor, the 4400 combines the unique features of three patented technologies to deliver high performance and reliable operation for opacity or dust measurements.

Complying with EN 15267 Part 3, the monitor is easy to use and has no moving parts, ensuring it will provide many years of trouble-free operation in combustion applications requiring emissions monitoring to a high standard where an automatic calibration check is not needed.

- Long lifetime LED light source
- No moving parts
- Patented, all-glass, multi-prism retroreflector
- Wide operating temperature range
- EN 15267 approval through TUVdotCOM

Lancom 4

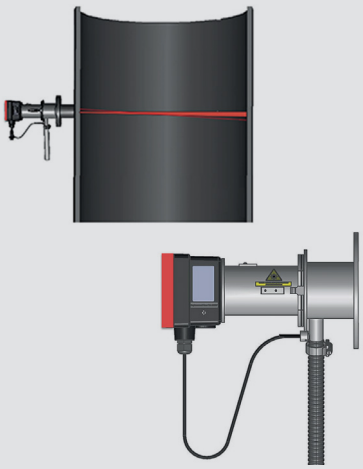
Combustion & Emission Monitoring

A portable multi-gas analyser, the Lancom 4 is able to measure up to eight flue gases in a range of combustion and emissions processes. It supports combustion efficiency with simultaneous measurements for O_2 and CO.

These can be combined with a true NOx measurement (including both NO and NO_2) and SO_2 monitoring for emissions reduction and a hydrocarbons measurement to support safety.

- Monitors up to 17 combustion parameters
- One instrument for all measurement needs
- Easy to carry around and operate
- High-quality colour display and USB support
- Configurable to match varying application needs

4750-PM



Combustion & Emission Monitoring

Utilising a back-scatter laser technique, the 4750-PM provides accurate, reliable measurements of particulate matter in stacks and ducts. It can be used in all combustion processes where condensed water is not present.

With a rugged design suitable for a range of applications, it features a highly stable optical system offering a low detection limit and can be used as a continuous emissions monitor for compliance or process monitoring.

- Low cost
- Large area collection optics
- Stable and reliable
- Non-intrusive sensor
- Wide measurement range
- EN 15267 approval through TUVdotCOM

INDUSTRIAL BOILERS

AMECARE® PERFORMANCE SERVICES

Our global service centres provide after-sales services to ensure you get the best performance from your system. This includes technical support, certification, calibration, commissioning, repairs, servicing, preventative maintenance and training. Our highly trained technicians/engineers can also attend your site to cover planned maintenance schedules and repair emergency breakdowns.

4500 MKIII

Combustion & Emission Monitoring

4650-PM

Combustion & Emission Monitoring

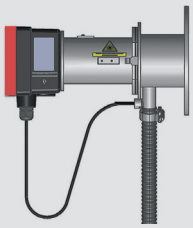
4400

Combustion & Emission Monitoring

LANCOM 4

Combustion & Emission Monitoring

4750-PM



Combustion & Emission Monitoring

MWIR-BORESCOPE-640

Process Imaging

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