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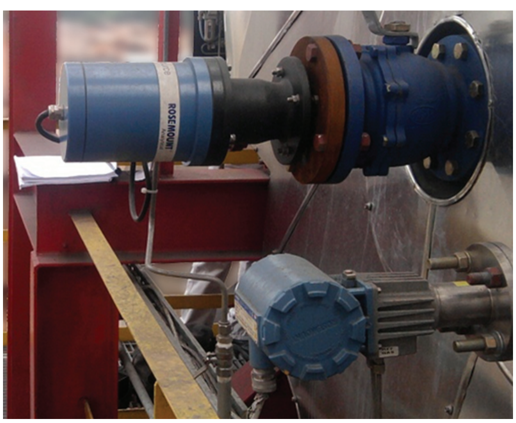
## An improved combustion analysis process has shown to protect electrostatic precipitators from explosive events

# REDUCE THE RISK

Bark boilers have been used by pulp and paper mills for many decades, but their importance is increasing. In bark boilers, the bark is burned along with other waste wood products to produce steam that is used in the pulping process, to drive the paper machine, and for many other uses. After combustion, the flue gases from the boilers are often passed through an electrostatic precipitator that uses static electricity to gather the fly ash, much as a TV set collects dust on the screen. An electrostatic charge is induced in the flowing particles and then the particles are collected onto the energized plates with a negative voltage through electrostatic attraction. The negative voltage on the collector plates can be several thousand volts and there is some potential for electrical arcing inside the precipitator. If a combustible gas mixture is allowed to flow through the unit, the result can be an explosion. This article will describe a best practice methodology for greatly reducing the chance of an explosion in bark or recovery boilers, a practice recently put into effect at two major paper mills in Brazil.




### METHOD FOR REDUCING EXPLOSION RISKS

The precipitator is a great benefit in reducing particulate emissions, but problems with incomplete combustion can generate carbon monoxides (CO) in potentially dangerous levels. If CO reaches lower explosive limits in the presence of oxygen, the high energy applied in the precipitator plates can be a source of ignition, resulting in an explosive event. It's important for this reason that the operator knows the condition of his or her flue gases passing through the precipitator. Combustion analyzers have long provided boiler operators with a good tool for optimizing efficiency, and balancing the combustion of large furnaces.

Monitoring the CO and oxygen concentrations and oxygen in the flue gases exiting the boiler is a good way to assure safe operational conditions, in addition to ensuring that combustion efficiency is optimized. If an operator sees the $O_2$ going down and the CO going up, that indicates there is a problem developing. The monitoring systems used are $O_2$ and combustibles

**Rosemount Analytical Model CCO 5500 CO analyzer and Oxymitter $O_2$ analyzer mounted to the precipitator inlet**

analyzers that are placed just ahead of the electrostatic precipitator in order to ensure that flue gases flowing through the precipitator have a low level of combustibles (CO) and a sufficiently high level of $O_2$.

The oxygen analyzers generally used are in situ analyzers with the sensor on the end of a stainless steel probe. Because these zirconium oxide oxygen analyzers are designed for in situ placement they work well when placed prior to the precipitator in most cases.

## INFRARED CO ANALYZERS

The CO analyzers, on the other hand, are often based on an infrared (IR) optical technology. Molecules are very discrete; every CO molecule is structurally identical to every other CO molecule. All structures (no matter how big or small) will vibrate at a particular frequency called the natural or resonant frequency, much like a tuning fork. The CO molecule absorbs IR energy very well at a wavelength around 4.5-4.9 microns, and 4.7 is a sweet spot where there is minimal interference from other components like water vapor or $CO_2$. This application uses a line-of-sight arrangement whereby an infrared source is placed on one side of the flue gas duct into or out of the precipitator and a receiver assembly with an IR detector is placed on the opposite side of the duct. The detector measures the amount of IR energy at the 4.7 micron wavelength that makes it across the duct. If a large amount of energy makes it across, there are few CO molecules absorbing the energy. If very little IR energy makes it across, then there is much CO in the duct absorbing the IR energy.

In some cases, extremely high particulate levels can negatively affect the measurement of the CO. If the IR energy does not flow across the duct through the fly ash, the performance is degraded. In these cases, the instrument can be mounted downstream of the precipitator after the fly ash is removed. While the location prior to the precipitator is the most desirable location, the downstream measurement can still be used effectively. Because explosive limits are normally reached gradually – in a much longer time than the typical residence time inside the precipitator and the passage of the flue gas through the precipitator requires only 30 seconds to a minute, there will generally be time for the operator to respond by adjusting fuel/air ratios, or by bypassing or shutting down the precipitator.

The response is first to attempt to add more oxygen to an increasing CO condition. To shut off the precipitator will cause an emission discharge which may result in a violation of environmental regulations and a fine. Therefore, the operator will usually choose such a shut-off only after adjustments of air have failed to solve the problem. Shutting off the precipitator will help prevent an explosion. Last resort, of course, is shutting off the boiler. A reliable set of $O_2$ and CO analyzers is the key to assist the operator to make the proper decisions. But throughout the decision-making process, the operator is armed with reliable, real-time data from the combustibles analyzers. Examples of the mounting of CO monitoring systems prior to the precipitator as used in two paper mills in Brazil are shown on the first page.

## IMPROVED EFFICIENCY AND FEWER GREENHOUSE GAS EMISSIONS

The importance of bark boilers in the reduction of greenhouse gases is also significant. The combustion of most fuels (oil, natural gas, or coal) produces greenhouse gases ($CO_2$ and CO), which increasingly is thought to contribute to climate change and global warming. The combustion of wood products is generally considered to be "carbon neutral". Combustion of wood does produce $CO_2$ and some traces of CO, but if the wood were not combusted and simply permitted to lie on the ground, it would naturally produce greenhouse gases as it rotted. Consequently, the combustion of the bark produces no more potential pollution than the natural decomposition, making the process increasingly desirable.

With the increasing use of bark boilers in paper mills throughout the world, operators require a method of increasing both safety and efficiency that is effective and cost-effective. The simple use of combustion analysis can accomplish both goals. **PPI**

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