# NEWS: focus on technologies for coal-fired power plants

## Optimizing coal mill control
### Developing a control structure to increase plant flexibility

**Increasing the flexibility of coal-fired power plants requires tackling a variety of challenges. One such challenge involves tuning the coal milling process to energy demand. With this goal in mind, the Laborelec Process Automation Team is developing a coal milling control structure.**

Little is known about the coal milling processes, especially coal pulverization. This process has a slow reaction speed—known as 'dead time'—which drastically reduces the plant's capacity for dynamic behaviour. 'In order to be able to increase plant flexibility, we first need to understand the behaviour of coal pulverization,' explains Thomas Museur, process automation expert at Laborelec. 'That is why we initiated a research project.'

#### Acquiring expertise on the vertical spindle mill

The Laborelec experts focused their research on the vertical spindle mill with a fixed classifier, the most commonly used coal mill within the GDF SUEZ Group. 'We decided to create a model of this type of coal mill from scratch,' states Museur. 'This enabled us to thoroughly study and comprehend the dynamic behaviour of the mill.'

Based on this research, our experts modelled the coal milling process around five zones, each having its specific role. The model aims to account for all interactions and non-linear relationships, such as heat exchange, particle flux, and force balance, in each of the mill's critical zones.

#### Simulating the mill's dynamic behaviour

The Laborelec model can effectively simulate a coal mill's dynamic behaviour. Museur: 'Our model calculates the coal's temperature, humidity level, and flow rate at the mill's outlet. These data determine mill performance and flexibility and, hence, offer a solid basis for creating an optimal control structure.'

In 2011, Laborelec aims to find a pilot plant to fine-tune and validate its coal mill model and to complete a control structure that enables the tuning of the milling process to energy demand.

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## Tackling the challenges for next-generation clean coal power plants

Coal-fired power plants need to increase their flexibility in order to tune their output to fluctuations in energy demand. To achieve this, more and more plants are switching from base load operation to cycling mode. In addition, legislation is demanding greater fuel flexibility, urging coal-fired power plants to increasingly co-fire both larger amounts and a wider variety of biomass blends. Each of these trends comes with various challenges. This newsletter shows how Laborelec is addressing them.

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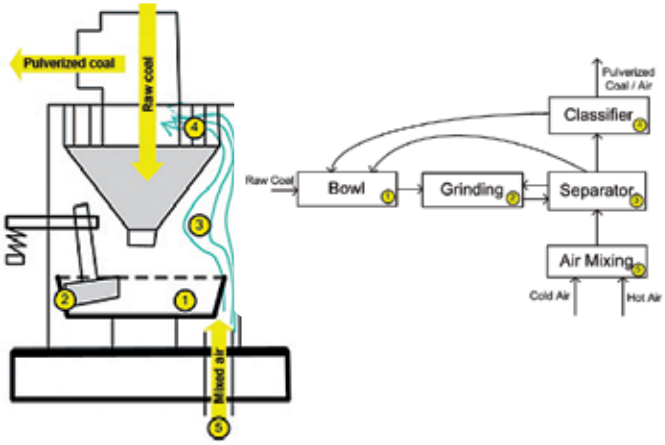


*Laborelec's model takes into account all the interactions for each of the defined zones inside the coal mill.*

## In short

- Coal milling is one of the main bottlenecks to increasing the flexibility of coal-fired power plants
- Laborelec has acquired a deeper understanding of the vertical spindle mill with fixed classifier, the most common coal mill
- Our research resulted in a model that calculates the coal's temperature, humidity level, and flow rate at the mill's outlet, offering a solid basis for developing a milling control structure

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## Co-firing complex blends of biomass and coal

### Assessing the integrity of boiler components

**What are the effects of burning complex blends of biomass and coal? Is it possible to protect boiler components against increased corrosion and to safeguard plant availability? Laborelec is conducting research focused on monitoring, understanding, and predicting the corrosion phenomena that occur inside a power plant boiler when firing different types of biomass.**

The European Union Renewable Energy Directive (EU-RED) is demanding power plants to co-fire an increasing amount of various biomass types. Some blends are considered to be highly corrosive. Laborelec has initiated a research program to determine the materials' corrosion rate and the most suitable protective materials to be used when co-firing specific blends of biomass and coal.

#### Online monitoring of corrosion rate

Laborelec has selected an online corrosion monitoring system that calculates the corrosion rate based on Linear Polarization Resistance Measurements. 'We have installed a probe in the boiler of a Belgian power plant,' states Tom Maes. 'During the course of a year, we will co-fire various blends of biomass and coal. Using the data that the probe gathers, we will determine the corrosion rate for each co-firing strategy.'

#### Evaluating corrosion resistance of coating and cladding

Laborelec has also invested in a material testing probe so that our experts can evaluate the corrosion resistance of various coating and cladding materials. This probe will be installed in the same boiler as where the online corrosion monitoring system is used. 'The material testing probe allows us to investigate four types of materials at a time,' explains Maes. 'The goal is to evaluate the corrosion resistance of this set of materials for two to three months. Then, over an entire year, we will repeat this test with other types of coating and cladding materials, using different temperatures and co-firing strategies. This will enable us to identify the materials with the best protective qualities for specific biomass blends for each heat exchanger.'

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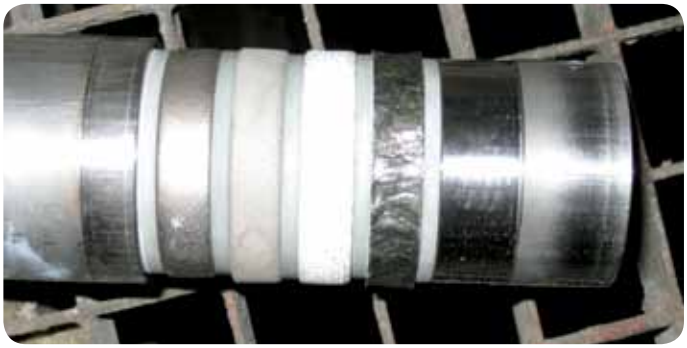

*Laborelec invested in an online corrosion monitoring system to determine the corrosion rate of boiler materials when co-firing various biomass and coal blends.*

### In short

- The EU-RED urges power plants to co-fire larger amounts of various types of biomass
- Laborelec is in the process of determining the corrosion rate of boiler materials when co-firing certain biomass and coal blends
- We are also evaluating the corrosion resistance of coating and cladding materials during different co-firing strategies

### New tool to analyze slagging risk

Laborelec purchased a tool that can simultaneously carry out thermogravimetric analyses (TGA) and differential scanning calorimetry (DSC). The equipment provides more detailed insight into the thermal behaviour of boiler ash, which enables us to more accurately evaluate the risk of slagging when firing specific types of biomass and/or coal. The new measuring equipment can also be used for non-metallic material analyses on cables, generators, and electrical insulation systems.

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# Minimizing power fleet maintenance costs

## Return on experience from valve condition assessments

**Over the years, Laborelec has assessed the condition of various steam turbine valves. Our experts use this experience to help minimize the maintenance costs throughout the GDF SUEZ power generation fleet. A recent project for a coal-fired power plant in Germany illustrates this.**

The steam turbine valves of a German GDF SUEZ coal-fired power plant are undergoing an assessment. The original equipment manufacturer (OEM) initiated this inspection as part of a worldwide campaign following the detection of cracks in this specific type of valve. The goal is to assess the condition of the valves and define the actions to avoid major damage.

### Technical support during OEM condition assessment

The team of the German plant contacted Laborelec to monitor and evaluate the OEM's assessment, because of our experience with condition assessments for similar types of valves. Marc Jason explains, 'It was our job to verify that the OEM was carrying out the most appropriate non-destructive inspections.'

Knowing the type and position of the cracks, the Laborelec experts already had a good idea of what the cause of these cracks could be and how to investigate them. 'In general, this type of crack indicates low cycle fatigue,' states Fabien Thielemans. 'In parallel with the OEM's non-destructive testing, we made metallurgic replicas of the valve and performed hardness measurements to evaluate the material's condition.'

The inspection is still ongoing.

### Sharing experience throughout the GDF SUEZ fleet

The condition assessment at this coal-fired power plant will also be useful for other power plants within the GDF SUEZ Group. Nuclear plants, for example, are equipped with a similar type of valve. 'Based on the results and the feedback from the German project, we will assist Electrabel in defining the appropriate inspections that need to be executed. This will, in turn, improve the efficiency of the assessment,' concludes Thielemans.

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*Through the return on experience from valve condition assessments, Laborelec is helping reduce the Group's maintenance costs.*

### In short

- Laborelec has vast experience with the condition assessment of steam turbine valves
- A German coal-fired power plant asked our experts to evaluate the OEM's condition assessment of the steam turbine valves
- We were also asked to assess the valves' creep and fatigue condition

### Analyzing cycling risks requires multidisciplinary expertise

Most power plants were designed to operate at base load. Today's energy sector, however, requires more flexibility. Hence, more and more plants are switching to cycling mode. But what are the associated risks? Power plants are increasingly calling upon Laborelec to answer this question. 'Evaluating the risks of cycling requires in-depth knowledge of multiple subjects, such as processes, vibrations, chemistry, and materials. At Laborelec, we have experts in each of these domains', explains Fabien Thielemans. 'We are also building experience in investigating cycling issues at power plants in the Benelux and Germany. Moreover, we are continuously expanding our know-how through research projects.'

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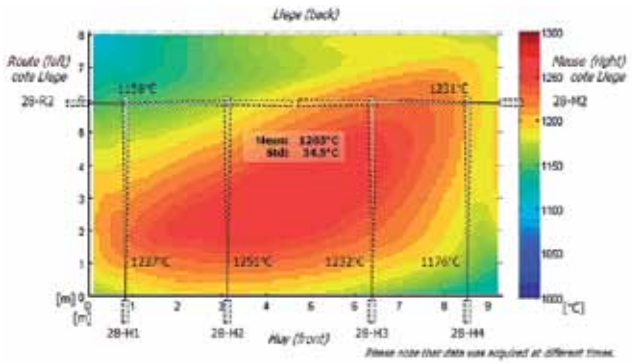
## Mapping a boiler's temperature distribution to enhance performance

**The flame structure and temperature distribution inside a power plant boiler are good indicators of combustion efficiency. Monitoring these parameters can, for instance, help avoid overheating of the boiler walls, reduce slagging, and minimize thermal stress. Laborelec offers a full service package, from pyrometer installation to advice on readjusting the combustion process.**

Laborelec assists power plants in homogenizing the temperature distribution and in optimizing the position of the flame inside a power plant's boiler. 'First, we need to measure the temperature inside the furnace,' explains Karim Van Maele. 'To do so, we install six pyrometers around the boiler, all at the same height.'

Next, the EUflame software analyzes the online temperature data. 'The tool generates a two-dimensional mapping of the temperature,' explains Héloïse Gennart. 'Based on this mapping, we can advise how to adjust the combustion settings for an optimal position of the flame and a homogenous temperature distribution.'




*Laborelec has the tools and the expertise to map the temperature distribution inside a power plant's furnace.*

## Accurately predicting atmospheric emissions when (co-)firing biomass

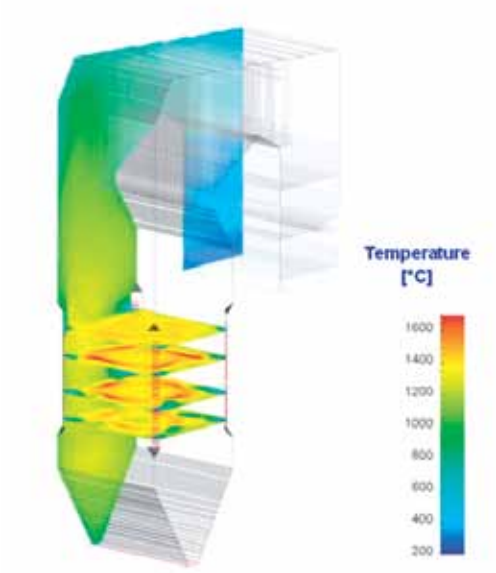
**The share of biomass being co-fired in power plants is growing; some coal-fired plants are even retrofitted to fire 100% biomass. But how does an increase in the biomass co-firing rate impact atmospheric emissions with respect to unburned fractions? Laborelec tested a new biomass pyrolysis model that accurately predicts these emissions.**

This detailed pyrolysis model, coupled to a physical model for a single biomass particle, was developed by the Université Catholique de Louvain-la-Neuve (UCL/EPL). The model takes into account internal heat transfer, particle size, shape, composition, and temperature encountered by the particle. The results of this detailed model have been integrated into a computational fluid dynamics (CFD) simulation of a boiler to accurately calculate $NO_x$ and CO emissions from a power plant.

### Simulations confirm model accuracy

'We used this model to carry out combustion simulations of the Awirs Power Plant in order to predict temperature distribution as well as CO and $NO_x$ emissions,' states David Rochaya. 'We modelled the Awirs boiler and fed the CFD code with the resulting data from the biomass pyrolysis model. These tests revealed that both the temperature distribution and the $NO_x$ and CO emissions can be accurately predicted.'

The results indicate that the model has useful potential. It will, for instance, enable Laborelec to calculate the effect of increasing the biomass co-firing rate on a power plant's emissions and to check whether a plant still meets regulatory requirements.




*The biomass pyrolysis model accurately quantifies atmospheric emissions released during the (co-)firing of biomass.*

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