LABORELEC

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DOSSIER ON COAL



Post-combustion capture of CO_2

Involved in the CASTOR and CESAR projects

The European CASTOR and CESAR projects study, among other things, the post-combustion capture of CO_2 based on absorption by solvents. Laborelec is involved in both projects.

In the CASTOR project industrial companies, research centres, and universities investigate CO_2 from capture to storage. The studies being made by these partners include the feasibility of storing CO_2 and the determination of whether existing sites are able to store CO_2 safely and securely. The CASTOR project also explores methods of reducing the costs of post-combustion CO_2 capture. Laborelec is focusing solely upon the capture part.

Finding the appropriate solvent

One of the main objectives of the CASTOR project is the development of solvents that require a minimum of energy to be regenerated. After literature studies and suggestions by chemical companies, thirty solvents were chosen. During a pre-selection study this number was reduced to eight. Subsequently, these pre-selected solvents were evaluated based on a number of criteria, including the energy necessary for the regeneration of the solvent, the reaction rate, the quantity of CO_2 absorbed by the solvent, the degradation of the solvent, and the corrosion. The most promising solvents were then tested at lab-scale. In the end, two solvents were selected for tests in the CASTOR pilot plant located in Denmark at the Esbjerg coal-fired power plant. Laborelec participated as an observer throughout the selection process. Our team was also given the opportunity to participate in a test campaign at the CASTOR pilot plant.

Further testing in CESAR project

The scope of the CASTOR project will be continued in the CESAR project. In this new programme, new hybrid solvents will be researched and tested based on the same methodology as in the CASTOR project. Laborelec is actively involved in the CESAR project. As of 2009, our experts will initiate the testing of the corrosion behaviour of new materials for packing and tower construction, with a particular emphasis on fibre reinforced polymers.

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Coal remains important in energy mix

Responding to the ever-increasing demand for electricity in an ecologically-friendly manner poses a major challenge for electricity generators. Meeting this challenge will certainly be a matter of grasping the full benefit of all available energy sources, including coal. Laborelec has been actively investigating coal-based electricity production and how to make it more efficient and cleaner. This edition of Laborelec News is dedicated to the various efforts of our experts in that domain.

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The technical Competence Centre
in energy processes and energy use.
From innovation to operational assistance.

Can online coal analyzers be used for biomass?

Biomass burned in power plants must be of good quality to avoid boiler slagging. The Ruien power plant asked Laborelec to assess whether online coal analyzers could be used to measure biomass quality. After a thorough review of available products, Laborelec concluded that this technique is currently not mature enough to be applied to biomass.

Power plants using biomass need to know the caloric value and ash fusion temperature of their biofuels in order to properly manage plant performance. These parameters can be very inconsistent since they depend on such elements as the ash and moisture content of biomass, and on its elemental composition. The origin of the biomass is also important. Recycled wood, for instance, will not impact a boiler in the same way as fresh wood. Since no biomass analyzers are available on the market, the Ruien power plant asked Laborelec to determine if coal analyzers could measure biomass quality. Online coal analyzers evaluate the quality of coal as it passes on a boiler feeding line. They are able to precisely measure the coal's sulphur, carbon, and moisture content, among other things. Coal mines and some coal-fired power plants are using online coal analyzers with good results. Following Ruien's request, Laborelec assessed the potential of coal analyzers for biomass measurements. The result was that the technique is not yet mature enough to be applied to biomass: the concentration of certain specific elements in biomass is smaller than in coal, preventing the detection of elements known to have an impact on slagging. In addition, coal analyzers are calibrated for coal, which has a more constant composition than biomass. It is therefore likely that a coal analyzer will be unreliable when applied to biomass. Given this lack of reliability and the current high price of coal analyzers, Laborelec advised Ruien not to rely on this technology for biomass analysis yet.

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Recommendations for SCR management at coal-fired power plants

Helping plants comply with stricter NO_x legislation

To comply with the new Large Combustion Plant (LCP) directive, coal-fired power plants must be equipped with Selective Catalytic Reactors (SCR) to reduce NO_x emissions. Managing SCR catalysts centrally enables economies of scale and the optimization of maintenance planning. Laborelec has recommended a number of best practices in this area to Electrabel and its power plant operators.

The European LCP directive went into effect on 1 January 2008. One of its primary targets is to reduce NO_x emissions. Coal-fired power plants must comply with LCP regulations by installing Selective Catalytic Reactors (SCRs). SCRs contain several layers of catalysts, which are costly and need to be replaced every four to five years.

Managing catalysts as a fleet

Laborelec has initiated an SCR Management project to encourage Electrabel to manage all catalysts as a fleet. Monitoring catalyst wear and ensuring their timely replacement is essential for ensuring continuous compliance with LCP regulations and maintaining plant performance. Organizing this management at fleet level has multiple benefits:

- It puts Electrabel in a stronger position to negotiate catalyst prices with suppliers. This is an important element, since the introduction of the LCP directive has raised the demand for catalysts and increased the price.
- By standardizing the type of catalysts used across the fleet, a plant can call upon the spare elements of another plant in case a new catalyst is needed quickly. This is a key factor since delivery delays for catalysts are becoming longer due to growing market demand.
- Experience and know-how related to catalysts can be shared more easily across the company. Best practices can be identified and implemented in all Electrabel power plants.

Nowadays deNO_x installations are equipped with Selective Catalytic Reactors (SCR) in order to comply with the new Large Combustion Plant (LCP) directive.

Centralized coordination

Laborelec has established a series of recommendations for power plants as a basis for SCR management. They provide information on best practices in terms of task definitions, inspection frequencies, and maintenance and replacement planning. Laborelec has also recommended the appointment of an SCR coordinator within Electrabel. The role of this person would be to follow up catalyst wear and remaining lifetime across the company, and to manage spare parts centrally.

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Optimizing alloys in pellet crushers

Assessing milling issues at co-combustion power plants

Wood pellets are used as biofuels in a growing number of power plants. Crushing these pellets to prepare them for combustion creates wear problems in the coal milling facilities of co-combustion plants. Laborelec has initiated a comprehensive investigation of these issues and is evaluating how wear varies depending on the metal alloys used in the milling hammers. The goal is to develop new expertise and provide plant operators with valuable recommendations in this area.

Milling wood pellets and coal to the right size and granularity greatly improves the combustion of these fuels. Wood pellets are milled in crushers that were originally designed for milling coal. These crushers consist of hammers that are attached to a rotating spindle. The quality of pellets directly influences hammer wear. Choosing durable materials for hammers is therefore essential, since the cost of replacing and maintaining these hammers is high.

Collecting data on hammer wear

There has been only very limited data available on this topic until now. Laborelec has set out to study which metal alloys provide the best resistance to hammer wear. We have begun identifying major milling issues at Electrabel power plants throughout Europe. This involves collecting information on the loss of hammer weight after a certain time of operation, and on the types of crushers, alloys, and pellets used. Based on the input gathered, we intend to identify the alloys offering the best durability.

Laborelec has also started testing different types of alloys for their ability to avoid causing explosions. Wood pellets present a greater risk of overheating during milling than coal. Therefore, the selection of the appropriate alloys is essential to help guarantee staff safety.

Encouraging knowledge sharing

Laborelec is also fostering knowledge sharing among power plants under the umbrella of this project. Comparing problems and discussing various solutions is an efficient method of developing know-how in this area. Laborelec encourages the sharing of knowledge by gathering all of the experiences of power plants into a central document. It expects to complete this study of metal alloys by the end of 2009. Based on the results of this assessment, Laborelec will also be able to provide advice to power plants on the design specifications of milling systems and to organize training in this field for power plant staff.

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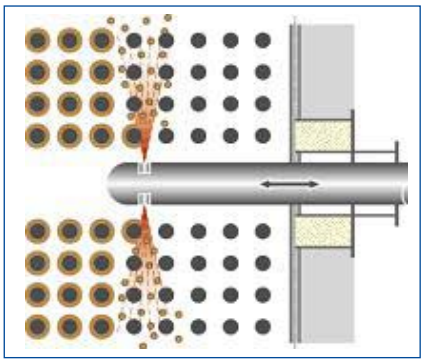

Improving boiler performance through soot blowing

Cleaning the boiler via soot blowing is not applied in every solid fuel-fired power plants. Nevertheless, it has the potential to enhance a plant's efficiency, availability, and lifetime if managed properly. Laborelec advises on the most appropriate soot blowing system for a specific site.

During combustion of solid fuels, ash sticks to the evaporator walls and other heat transfer tubes inside the boiler of a power plant. This can cause the boiler to clog up, hampering heat transfer. Soot blowing is used to remove these ash deposits. Unfortunately, it is not optimized in the majority of power plants; in some power plants the soot blowing equipment is even taken out of service in order to save on operating and maintenance costs. In recent years however, soot blowing technology has improved significantly.

Selecting the optimal technique

There are various types of soot blowing techniques. They vary by medium — compressed air, steam, or water — and by blowing direction — horizontal, vertical, or rotating. The preferred combination depends on the area inside the boiler as well as the specific site. Laborelec offers advice based on the characteristics of the deposits, the boiler design, and the operating temperature.

Elaborating an intelligent system

In most older soot blowing systems, the trigger to start soot blowing is given manually or based on a fixed time module. Recent technologies however, enable full automation of soot blowing. Laborelec experts can advise on a soot blowing control system that triggers operation based on fouling detection by heat flux sensors, retractable infra-red cameras, and strain gages and the program that precisely controls the fouled area. The combination of both improvements greatly enhances the soot blowing system's efficiency.

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Avoiding, minimizing, and removing ABS deposits in air pre-heaters

Power plants equipped with a catalytic deNO$_x$ system are often faced with sticky deposits of ammonium bisulphate (ABS) in the air pre-heaters. Laborelec offers site-specific advice to cost-efficiently prevent, minimize, and when necessary remove these deposits.

The Selective Catalytic Reduction (SCR) process removes NO_x from flue gases by injecting ammonia. A non-desired side-effect is the formation of ABS. This ABS causes for sticky deposits in the air pre-heater which is situated in the cold flue gas path downstream from the SCR. These deposits must be removed frequently to guarantee the equipment's efficient performance. Laborelec provides site-specific advice.

Site-specific advice for cost-efficient ABS control

Laborelec closely collaborates with manufacturers of air pre-heaters, performs its own research, and follows up on expert literature. Based on this expertise, our team is able to offer accurate advice in order to:

- **Prevent the formation of ABS:** our team assists in the selection of a SCR catalyst to ensure ABS-poor deNO$_x$.
- **Minimize ABS deposits:** Laborelec advises in the design of the air pre-heaters and the choice of coated materials to prevent ABS from sticking to the piping or walls. Power plants that operate old air pre-heaters can count on Laborelec for expert advice on applying an anti-fouling coating.
- **Remove ABS deposits:** ABS deposits can be removed efficiently with an appropriate soot blowing system. Our team gives advice on the cleaning frequency and the blowing medium (water, steam, or compressed air), taking into account the availability and the price of the medium, the recommendations of the pre-heater manufacturer, and the nature of the deposits.

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Boiler R&D for coal-fired power plants

Requirements for new power plants, lifetime extension, and fuel switching

Climate issues, rising demand for energy, and increasing prices for traditional fuels pose new challenges. In this context, the domain of coal-fired power plants (CFPP) has seen several evolutions: new and more efficient power plants, lifetime extension of existing plants, and (co-)combustion of biomass fuels.

Laborelec experts remain at the forefront of each of these evolutions. They perform original research, collaborate in international research projects, and build new solutions.

Selecting heat-resistant materials and reducing oxidation

By increasing the steam temperature inside the boiler, CFPPs can raise efficiency up to 50% and more. But the boiler materials need to withstand higher temperatures and pressures. Laborelec experts study various types of materials and how they respond to high temperatures in the COMTES700 project, the P91 Users Group, and other workgroups. This enables them to offer the power plant design team expert advice in the selection of appropriate boiler materials. Since higher steam temperatures increase oxidation, our chemical team investigates how to ensure ultra pure process water and how to minimize oxidation at the steam-side of the boiler.

Maximizing boiler lifetime

Laborelec also remains at the forefront of investigation in lifetime extension of CFPPs. One of our main areas of focus is boiler lifecycle management. In this regard, our experts investigate, among other things, how to refurbish existing boilers with new materials in order to raise the steam temperature and, consequently, overall efficiency. Fitness for service is another important issue of CFPP boilers. Our experts are developing a software model that will quickly determine the appropriate remedy in the event of a crack or failure in a boiler pipe, taking into account cost and future maintenance. In addition, they are elaborating new and improved non-destructive and online monitoring techniques in order to closely follow up on the conditions of critical boiler components.

Combustion of straw leads to rather aggressive flue gases.

Optimizing a fuel type switch

Rising prices for traditional fuel types and climate change mitigation open the door for renewable fuels. Straw, cereals, coffee husk, olive pits, poultry litter, and other biofuels however, cause rather aggressive flue gases when burned. Laborelec investigates coating and cladding techniques in order to increase corrosion and erosion resistance of boiler materials. In addition, our experts offer advice on the selection of appropriate materials and on the control of the combustion process.

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