NEWS: focus on environment and emissions

Sustainable solutions against macro- and micro-fouling

Laborelec is conducting research to find sustainable techniques to combat macro- and micro-fouling in power plants. While there are reliable generic techniques to effectively deal with macro-fouling, solutions against micro fouling are mostly site specific. One example is the chlorine dioxide based *Legionella* control system set up at the Ruien Power Plant.

Macro-fouling typically, but not exclusively, occurs in maritime environments where larvae of living organisms such as mussels, oysters, barnacles, and algae enter the cooling water circuit of the power plant. 'These organisms deposit themselves on internal pipe surfaces, filters, and valves where they grow and eventually impair the plant's performance and reliability,' reports Lieve Verelst. 'A very effective sustainable solution to repel this type of fouling is the use of non-toxic fouling release coatings that prevent the organisms from attaching to the surface.' Laborelec has tested a number of these coatings on a large scale at the Eems Power Plant with positive results. The principal drawback is the application cost.

In search of sustainable micro-fouling treatments

Micro-fouling is a very different and more complex matter. It is about microscopic organisms such as bacteria, amoebae, and viruses accumulating, developing, and multiplying into the plant's cooling water circuit, which means they have to be removed for environmental reasons. Currently, the development of micro organisms is usually controlled by using aggressive chemicals such as bleach. However, Laborelec is studying and testing more sustainable solutions such as physical treatments or the use of more environmentally friendly products such as monochloramine, chlorine dioxide, or ozone.

Keeping *Legionella* growth under control

A recent case in point was the control of the legionella bacteria growth in a specific wastewater stream, to be cooled in a cooling tower at the Ruien Power Plant. 'The water in this circuit is always about 35 to 40 °C, so it is very susceptible to *Legionella* growth,' observes Bart Verhasselt. 'In 2010, we implemented a chlorine dioxide dosing installation that constantly feeds the circuit with just enough ClO_2 to disinfect the water and keep the *Legionella* multiplication under control. This specific case requires more fine-tuning than a bleach treatment, but it certainly improves the microbiological quality of the wastewater.' In 2011, Laborelec will investigate how to better control the *Legionella* development and growth upstream in the Ruien circuit.

Lieve Verelst, Bart Verhasselt

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Ensuring compliance with environmental legislation - today and tomorrow

Environmental legislation in Europe is continuously evolving. Constraints on atmospheric emissions and water treatments are becoming increasingly stricter. Laborelec assists power plants in meeting both current and future requirements. We evaluate and anticipate new legislation, and we investigate new, more environmentally friendly treatments. We also pursue the development and improvement of emission measurement and monitoring systems. This edition of Laborelec News gives an overview of our activities in these domains.

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A chlorine dioxide dosing installation constantly feeds the circuit to disinfect the water and keep the Legionella growth under control.

Key facts

- An effective sustainable solution to repel macro-fouling is the use of non-toxic fouling release coatings
- Micro-fouling is usually a more complex matter, often dealt with by using aggressive chemicals such as bleach
- Laborelec is conducting research to find more sustainable and appropriate solutions to control micro-fouling such as the legionella growth

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NEWS: focus on environment and emissions

Helping PCCC plants reduce atmospheric emissions

Post-Combustion Carbon Capture (PCCC) power plants present a risk of emitting organic substances into the atmosphere. PCCC plants can minimize these emissions by fine-tuning their operational settings. Laborelec offers advice on these settings based on monitoring data of its Fourier Transformed Infra Red (FTIR) system.

PCCC plants capture CO_2 inside an absorber tower where the flue gas is washed with an organic solvent that absorbs CO_2. Then the CO_2 poor flue gas passes through a water wash to remove any residual organic substances before being released into the atmosphere.

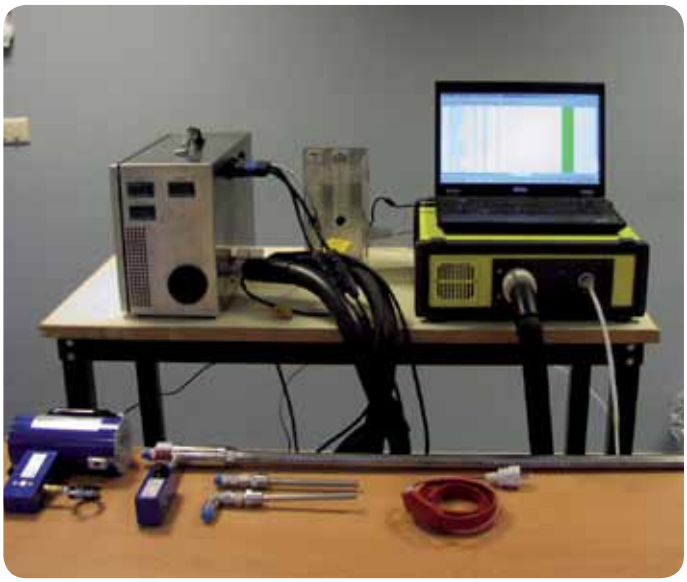
Online monitoring of organic substances in flue gas emissions

Controlling and reducing the emission of organic substances requires their continuous monitoring. Laborelec set up an internal research project to identify the best equipment available for monitoring those types of substances in flue gases.

Jan Mertens reports that, 'Based on our research, we decided to purchase a FTIR-based analyzer. The system enables to link the concentration of organic substances to operational settings such as the water wash flow rate, water wash temperature and the temperature inside the absorber. This makes it possible to identify the optimal plant settings that will minimize the emission of organic substances.'

In 2010, FTIR was used to determine amine concentration in the TNO pilot unit at the E.ON Maasvlakte Power Plant in Rotterdam. At least four additional measurements are planned for 2011.

Jan Mertens



The FTIR monitoring tool enables Laborelec to measure organic substances in the flue gas emissions of PCCC plants.

Assessing environmental performance using life cycle analysis

Life cycle analysis (LCA) is a useful starting point for reducing a technology's environmental footprint. It helps pinpoint hot spots and investigate the overall effectiveness of operational changes to minimize the impact on the environment. Laborelec has applied LCA to water demineralization and Post-Combustion Carbon Capture (PCCC).

LCA calculates a technology's environmental performance in terms of climate change, acidification, ecotoxicity, fossil fuel use and other impact categories. It takes into account all resources used and all emissions generated, from cradle to grave — from manufacture to final decommissioning and disposal.

Electricity generation technology influences impact of water demineralization

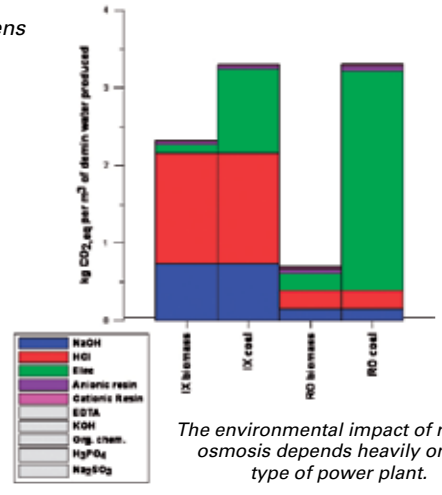
Laborelec has used LCA to assess the environmental impact of ion exchange (IX) and reverse osmosis (RO) water demineralization. Our assessment showed that RO has a lower environmental impact in general.

The investigation also revealed that the type of power plant plays an important role. 'When coal is used, the positive effect of RO is marginal compared to the results achieved by biomass plants. The reason is the higher level of electricity consumption of RO as compared to IX,' reports Jan Mertens.

Evaluating solutions for PCCC energy penalty reduction

When applied to PCCC, LCA confirmed that the steam and electricity consumption of the CO_2 absorption process weigh heavily on a power plant's efficiency. 'LCA enabled the validation of the effect of low-steam and/or low-electricity consumption through better technologies on plant efficiency,' says Mertens. 'Moreover, the analysis revealed that upstream processes such as coal mining and transport dominate the PCCC plant's life cycle carbon and acid emissions.'

Jan Mertens



The environmental impact of reverse osmosis depends heavily on the type of power plant.

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Helping power plants comply with emission monitoring directives

PEMS and assistance with quality assurance

The monitoring of atmospheric emissions is subject to strict guidelines. The Large Combustion Plant Directive (LCPD) obliges large power plants to monitor emissions continuously. The EN 14181 standard establishes quality assurance (QA) requirements for automated monitoring systems. Laborelec emission experts assist power plants in achieving compliance with these guidelines.

Simulating accurate emission data with PEMS

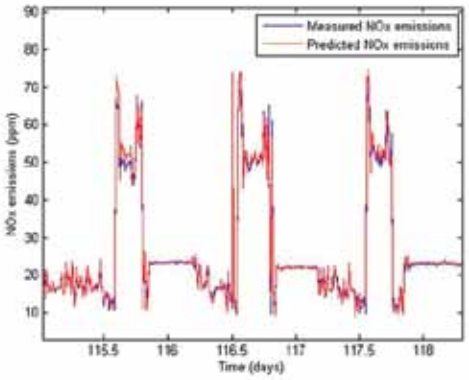
The LCPD standard for emission monitoring states that plants can miss only ten days of emission data per year. Laborelec developed the Predictive Emission Monitoring System (PEMS) to ensure compliance, even during periods when actual monitoring is impossible. 'The PEMS simulates a gas turbine's CO and NO_x emissions based on the plant's operational data. It enables to accurately predict emissions during maintenance, unforeseen incidents, or data transfer problems,' explains Jan Mertens. Feasibility tests at power plants in the Netherlands and Belgium have already confirmed PEMS accuracy.

Currently, PEMS is awaiting national legislative approval. Laborelec is contributing to the development of guidelines in the Netherlands and France.

Ensuring quality of emission monitoring

Power plants must also comply with EN 14181, the standard setting out QA guidelines for emission monitoring. As members of the EN 14181 workgroup, our experts offer plants comprehensive advice to ensure compliance. 'We are also able to fine-tune the standard to actual circumstances, based on feedback from plant operators,' continues Mertens.

Jan Mertens



Feasibility tests have confirmed PEMS accuracy.

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Analyzing a plant's chemical impact on the ecosystem

The new European REACH regulation requires European companies producing or importing more than ten tons of chemicals per year to assess whether the environmental and human risks are acceptable. Moreover, in several new power plant projects, an environmental risk assessment is necessary to obtain statutory operating permits. Laborelec executes such chemical risk analyses according to European guidelines.

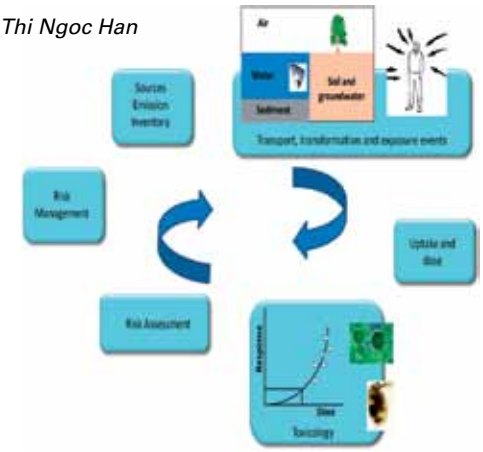
Assessing the chemical environmental risk

Laborelec analyzes chemical risks following the methodology prescribed by the European Chemicals Bureau. 'We first collect all physical, chemical and toxicity data related to a particular chemical,' explains Huynh Thi Ngoc Han. 'This includes pH, vapour pressure, bioaccumulation factor, biodegradability, and lethal concentration. Based on this information, we calculate the product's expected concentration when dispersed in the environment as well as its impact on the ecosystem. We then establish whether the risk related to the release of that substance in the environment is acceptable.'

Wide variety of risk analysis projects

Laborelec's chemical experts have the knowledge necessary to correctly interpret the data and determine the durable impact of a chemical substance. 'The chemical risk analysis requests that we receive are numerous and varied,' observes Huynh Thi. 'For instance, we recently carried out an ecotoxicity analysis of an anti-foam product at a combined cycle gas turbine in France. Based on our findings, we recommended an action plan that will reduce the environmental impact of the plant.'

Huynh Thi Ngoc Han



Laborelec's chemical risk analysis complies with European requirements.

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Improving effluent and emission control

Research on flue gas desulphurization and carbon capture and storage

For a number of years, Laborelec has been conducting research to minimize plant emissions. For example, various methods have been studied and tested to purify flue gas desulphurization (FGD) effluents, with promising results. For carbon capture and storage (CCS) however, technologies have not yet matured.

The in-situ forced oxidation limestone-gypsum process is currently the most widely applied FGD method. It has proved that it not only successfully keeps sulphate from the waste stream, but also captures heavy metals and fluoride. However, the method leaves considerable amounts of nitrogen compounds, selenium 6, thallium, and boron in the effluent. It is a virtual certainty that European regulations on effluents will become more stringent and improved FGD systems and other improved effluent treatments are bound to become necessary.

Various methods to improve FGD and its effluents

Laborelec has studied and tested various techniques to remove these impurities. Frans van Dijen: 'We investigated various methods to improve things by modifying the FGD process itself and/or by adding wastewater treatment processes.' Tests with a pilot ABMet installation proved promising. However, the engineering of this biological anaerobic wastewater treatment system clearly needs further optimization. Equally promising is a hydrothermal process developed in Japan, which successfully removes fluoride and boron. Another solution is adding a Zero Liquid Discharge System, although this is very expensive and needs to be carefully engineered.

Carbon capture technologies still developing

Carbon capture technologies for large coal-fired power plants are less mature and still require technical development. Today, the most advanced technology for capturing CO_2 in large coal-fired power plants is the post-combustion CO_2 capture with amine-based solvents (see also page 2). However, the amine CO_2 absorption process consumes a great deal of energy and induces an efficiency loss of approximately 10%. This process can also induce additional emissions in the flue gas and waste streams through amine degradation. Further technical developments are therefore needed before its deployment on a large industrial scale.

Laboratory tests are ongoing to study the amine degradation rate. These tests also aim to identify alternative amines and solvents which are more stable and capable of reducing the energy penalty of the entire carbon capture process. Large-scale pilot tests are also required to optimize this process, test promising solvents, quantify the energy penalty, and acquire both operational and hands-on experience. In addition, demonstration plants are needed to test the process on an industrial scale. The main challenges here are upscaling and integration within the power plant.

Frans van Dijen

Tests with a pilot biological anaerobic FGD wastewater treatment system proved promising, although the engineering clearly needed optimization.

Key facts

- As European regulations on effluents become more stringent, FGD systems and subsequent effluent treatment must improve
- Laborelec has studied and tested various techniques to remove remaining impurities, either by modifying the FGD process and/or by adding wastewater treatment processes

Predicting the purity of residual products

Laborelec has developed a chemical-mathematical model that predicts the purity of the residues expected to be produced by new power plants. The model estimates flue gas and effluent contamination as well as impurities that will be found in the ash, sludge, and gypsum that are produced. The calculations help assess whether these residues will be suitable products for industrial valorisation and enable to justify the fine-tuning of power plant designs for improved sustainability.

Frans van Dijen

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