NEWS: focus on material technologies, non-destructive testing and condition assessment

Identifying corrosion in power plant circuits

Corrosion in closed cooling circuits can generate costly leaks in the piping. Laborelec has developed a comprehensive methodology to assess and monitor corrosion in such circuits. It utilizes our multidisciplinary expertise and has already been successfully implemented at various nuclear and thermal power plants.

The assessment starts with identifying which parts of the cooling circuit are most likely to experience corrosion. This evaluation is based on our experience, the history of the local piping, and operational data. Our experts then determine the feasibility of inspections that need to be carried out and at what locations. They also ascertain where permanent monitoring could be appropriate.

Multiple condition assessment techniques

Laborelec has mastered a vast array of non-destructive testing (NDT) and chemical analysis techniques. Ultrasonic measurements and eddy current tests are among the NDT inspections often carried out to detect indications of potentially corroded areas.

'When necessary, we also conduct analyses of available chemical data to determine metal concentration levels in cooling water,' notes Pascale Absil. 'Together with Laborelec's chemistry experts, we establish recommendations regarding chemical treatments to be implemented.'

Multidisciplinary approach

'Our assessments incorporate our competency in multiple disciplines,' continues Absil. 'In addition to our knowledge of NDT measurements, material and chemical expertise are also frequently involved. This multidisciplinary approach has led to optimal results.'

Evaluating appropriate monitoring systems

The need and feasibility of installing an online condition monitoring system are also assessed. Such a system is useful in monitoring the speed at which circuit materials are corroding. In addition, it enables us to link corrosion data with any modification of leakage parameters observed in the circuit.

'While a condition monitoring system provides a continuous view of corrosion evolutions, other techniques can also be used for regular follow-up,' adds Séverine De Vroey. 'These include small metallic samples, or corrosion coupons, that can be designed for easy removal from the circuit at the most appropriate inspection points.' Because these samples are made of the same material as the circuit, they reveal the circuit's average overall corrosion behaviour.

Pascale Absil, Séverine De Vroey

For more information, contact *pascale.absil@laborelec.com.*

Materials expertise ensures continuity of energy generation

Investment in new power generating capacity continues to grow and ageing units are increasingly being renewed. These trends have stretched manufacturer delivery times for all types of components. As a result, it has become even more crucial to detect degradation and defects as early as possible. This newsletter reveals how Laborelec extends its knowledge of material degradation mechanisms and non-destructive assessment techniques. Our goal is to make sure that new components answer quality assurance claims and that they are ordered well before replacement becomes critical. In this way, we help ensure the continuity of a plant's energy generation.

Contact

steven.goedseels@laborelec.com

Corrosion on cooling circuit piping can lead to costly leaks and stoppages.

Key facts

- Laborelec has developed a methodology for the condition assessment and monitoring of closed cooling circuits
- The methodology evaluates which areas require investigation, ad hoc inspections, and permanent monitoring
- It utilizes Laborelec's multidisciplinary expertise

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New light on creep and fatigue ageing

Studies prove that each mechanism reinforces the other

Laborelec carried out experiments that shed important new light on creep and fatigue ageing mechanisms in gas turbine units that run in cycling mode. It turns out that creep and fatigue reinforce each other. Although manufacturers usually work with appropriate safety margins, their recommendations have to be observed very cautiously.

In order to follow demand more closely, many power production units are switching from base load to cycling mode. As a result, the Hot Gas Path (HGP) components are increasingly subjected to thermo-mechanical fatigue due to frequent start-stop sequences. Previously they were typically majorly subject to long-term creep. Steven Keyzer notes: 'Cycling will shorten the lifespan of HGP components. The equipment manufacturers take this into account, but in fact may be using a model based on a simplified philosophy to determine the remaining lifetime of HGP components. Their models reflect the use of a linear summation of creep and fatigue and are gradually updated in accordance with fleet experience. However, is this a reliable model? That is the question we wanted to answer.'

Any creep damage drastically reduces the fatigue limit

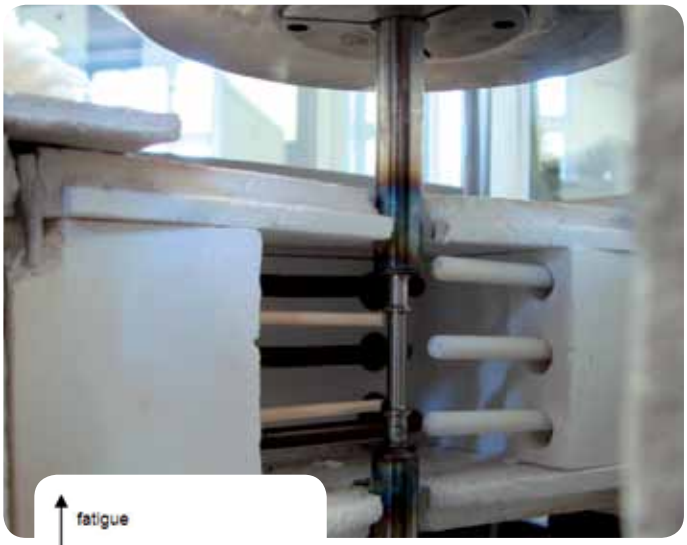
Laborelec conducted material tests to determine the effect of creep and fatigue interaction. They simulated creep and fatigue degradation in consecutive order and determined the point of material rupture. 'Our stochastic data clearly show a non-linear function which does not appear in the manufacturer's model,' reports Keyzer. 'We have definitively demonstrated that even a small amount of creep damage halves the number of possible remaining fatigue sequences. Consequently, HGP components of older engines are very susceptible to accelerated creep/fatigue interaction when switched to daily start and stop mode.'

Strictly obey the boundary on cycling events

Keyzer concludes that the manufacturer's model is safe but their philosophy is not conservative. He says plant operators need to be aware of the risks involved: 'Maintenance programmes prescribed by the equipment manufacturers are on the safe side only because they apply a large safety factor. We know there is a high scatter on fatigue data, so with engines in cycling mode, we quickly enter into a domain of uncertainty. Therefore we advise the strict observance of the boundary on cycling events.'

Steven Keyzer

For more information, contact *sigrid.gijbels@laborelec.com*.



Laborelec experimental data clearly show a non-linear characteristic. Even a small amount of creep damage halves the number of possible remaining fatigue sequences.

Key facts

- Data resulting from Laborelec experiments clearly indicate a combined effect of creep and fatigue damage in engines running in cycling mode
- Tests proved that any creep damage immediately halves the material's fatigue limit
- The maintenance programmes of units that switch to cycling mode must be strictly observed

New facility for creep testing at higher temperatures

Laborelec has invested in new state-of-the-art equipment for creep testing at high temperatures. The new dead-weight lever arm systems allow for higher stress loads at higher temperatures (up to 1,100 °C), which makes them perfectly suited for testing gas turbine materials and materials for the new generation of coal power plants. The systems are also easier to use. The equipment will become operational in March 2011.

Evy De Bruycker

Large stock of components for testing purposes

Over the years, Laborelec has received numerous gas turbine components from power plants for root cause analyses, visual inspections or destructive examinations. All of these components and metallographic sample remains have now been classified and systematically stored to better share available knowledge. The traceability of parts for future research and analyses has also been optimized.

Database enables the rapid location of specific components

Laborelec has developed a database that enables users to rapidly trace a specific component currently in storage. 'Searches can be conducted based on a large number of criteria,' notes Steve Nardone. 'These include elements such as which plant the item came from, the base material and coatings used in the component, the operating conditions and the history of the parts.' The database also covers reference pieces that are used as a benchmark when carrying out ageing analyses.

Links with previous test reports

Laborelec tracks all knowledge accumulated during previous tests. The database includes all report references related to each inspected part that is stored at Laborelec. This enables optimal knowledge sharing and proper preparation of future research and analyses programmes. 'These components are therefore valuable,' stresses Nardone. 'Keeping them is extremely useful for future testing requirements.'

If your power plant has reference components or metallographic remains of previous root cause analyses, do not hesitate to inform us.

Steve Nardone

For more information, contact
sigrid.gijbels@laborelec.com.

Laborelec has gathered a large number of components over the years. They are extremely useful for carrying out future research.

Assessing the impact of syngas on turbine materials

Laborelec is taking part in the European H_2-IGCC project on the use of undiluted hydrogen-rich syngas in Integrated Gasification Combined Cycle plants. Our experts will analyze the effect of H_2-rich syngas on turbine material degradation using non-destructive testing techniques.

H_2-rich syngas can be produced from a pre-combustion carbon capture process. This man-made alternative to natural gas is designed to reduce emissions. It is likely to be used in next-generation high temperature gas turbines. 'With H_2-rich syngas, the temperature inside the turbine is 100 to 150°C higher than with natural gas,' explains Sébastien Nauroy. 'This leads to higher efficiency, but it is still unknown what the effect will be on turbine hot gas path materials. Advanced coatings will be developed to protect components against the exhaust gas contaminants and higher temperatures that are anticipated.'

Non-destructive tests for coating assessment

Laborelec was called in because of its expertise in materials and non-destructive testing techniques, such as the Frequency Scanning Eddy Current (F-SECT) method. F-SECT enables to assess the quality of metallic layers deposited on alloy substrates underneath external ceramic coatings.

For more information, contact
jean-pierre.keustermans@laborelec.com.

'Our role is to assess the endurance of new turbine materials by testing their resistance to degradation,' adds Jos Maris. 'To accomplish this, we will simulate operating conditions using a variety of samples and assess the quality of coatings and materials through endurance tests.'

International networking on key technologies

The project also allows for intensive networking with key players. In addition, it fosters developments in our non-destructive testing technologies. As such, it is a valuable approach to optimize the operational excellence of our current gas turbine technologies.

Jos Maris, Sébastien Nauroy

Using the F-SECT technology, Laborelec can assess the effect of burning syngas on a metallic coating underneath a ceramic layer.

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P92 supplier quality meticulously verified

Laborelec has conducted an in-depth verification of the piping supplier for the new GDF SUEZ power plants being built in Wilhelmshaven (Germany) and Rotterdam (the Netherlands). Although the supplier is already subject to quality control by the appropriate bodies, GDF SUEZ requested an additional check.

Laborelec qualified the manufacturing procedures of the P92 steel pipes utilized between the boiler and steam turbine. Both the plant owner and the supplier have plenty of experience with high temperature steel. However, neither is accustomed to the thicker sections of P92 required to withstand the higher pressure and temperatures in these new ultrahigh efficiency units.

GDF SUEZ asked us to focus on long-term quality and availability of the piping. Therefore, Laborelec experts meticulously verified critical manufacturing procedures such as inductive bending, post bending heat treatment, non-destructive testing, and welding. They checked that manufacturing procedures and temperatures were strictly observed during all manufacturing steps. Their report confirmed that correct procedures were being followed.

Frédéric Vanderlinden

Laborelec verified manufacturing procedures to assure long-term integrity and availability of the piping.

For more information, contact *sigrid.gijbels@laborelec.com.*

Growing demand for NDT assistance during overhauls

Laborelec is increasingly being asked to support on-site non-destructive inspections during overhauls. During such campaigns, our experts assist and perform non-destructive tests (NDT) to detect signs of wear and material defects, with a clear focus on long-term reliability.

The demands often include:

- Verifying the NDT procedures followed by the manufacturer or by NDT inspection subcontractors. Laborelec provides expertise and special advice on how to improve the inspection methods and applications according to specified recommendations.
- Reviewing the reports of the NDT inspections performed by the manufacturers' inspection teams or by NDT companies. By providing high level NDT expertise and assistance, Laborelec supports and unburdens the plant's maintenance management during overhauls.
- Giving advice on the refurbishment, renewal, and/or replacement of parts on special request.

Laborelec has recently conducted such campaigns at power plants in Belgium, France, and the Netherlands.

Eric Van der Heyden

During overhauls, Laborelec experts conduct specialized non-destructive testing with a clear focus on long-term reliability.

For more information, contact *eric.vanderheyden@laborelec.com.*

Knowledge exchange regarding coating systems

In December, Laborelec organized a one-day GDF SUEZ coordination meeting on coating systems. The goal was to encourage knowledge exchange.

Laborelec experts presented a series of technical lectures. These provided advice and practical guidelines for choosing the most appropriate paint and coating system to protect various power plant installations. They reported, among other things, on key lessons learned recently at the power plants in Herdersbrug, Doel, Ruien, Tihange, and Zandvliet. They also demonstrated the added value of Laborelec's on-site inspections during paintwork. The attendees, mostly maintenance managers from these plants, found the meeting very helpful. Many expressed the desire to meet more regularly. One topic they would like to discuss in the future is water-based coating systems that comply with the newest VOC emission standards.

Barbara Geukens

Laborelec experts reported key lessons learned recently at power plants in Belgium and Netherlands.

For more information, contact *joel.girboux@laborelec.com.*

Laborelec Belgium • Rodestraat 125 • 1630 Linkebeek • Belgium • T. +32 2 382 02 11 • F. +32 2 382 02 41 • Responsible editor: Bart Boesmans