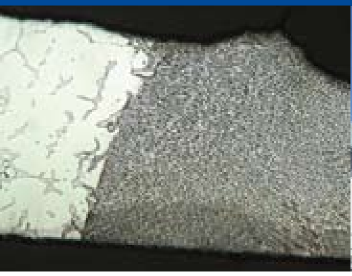
LABORELEC

NEWS

JOURNAL NINTH YEAR
N° 91 / JANUARY 2008

DOSSIER ON MATERIAL TECHNOLOGY AND NON-DESTRUCTIVE TESTING



Extending the lifetime of a power plant

A core competence of Laborelec

Operators want to prolong their plant's safe and cost-effective operation for as long as possible. But the choice between lifetime extension and new investments is not to be taken lightly. That is why power plants turn to Laborelec, their experienced partner.

Retaining existing energy generating capacity is critical in meeting the ever-growing demand for energy. Unfortunately, many power plants are reaching end-of-life status and not enough new plants are expected to be online any time soon.

Quick and accurate diagnosis

Lifetime extension has been a core competence of Laborelec since its inception. Our team has built a vast experience in determining the remaining lifetime of a plant's critical components using different assessment techniques. Based on historical operating data, they can quickly identify the most critical components and calculate the plant's useful remaining life. Backed by such information, Laborelec is able to support operators in planning maintenance and inspection works and ordering spare parts timely to prevent incidents.

Condition monitoring and assessment without production loss

If there is insufficient historical data available, Laborelec can conduct non-destructive testing techniques. It enables our team to quickly determine the condition of a plant's component without having to cut it open.
For safety and operational reasons, plant operators and Laborelec can decide to continuously monitor the condition of specific critical components. By inputting selected data from the control system into our Diagnostic Centre, our team can immediately assess the condition of the components and advise on preventive actions.

Objective repair and replacement specifications

Components that have reached end-of-life status and cannot continue safe and reliable operation, have to be repaired or replaced. Based on its vast experience and its relevant know-how in materials technology, Laborelec assists plants in formulating correct repair procedures or a qualitative set of technical specifications for the purchase of new equipment, free of any commercial bias. As an independent partner, Laborelec focuses on optimizing the total lifecycle cost.

steven.goedseels@laborelec.com

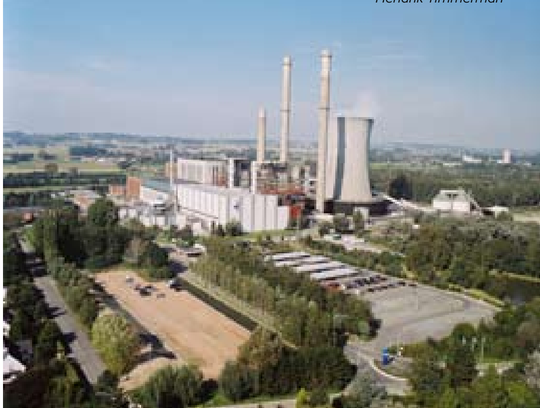
Laborelec's expanding experience in lifetime extension

More and more operators are turning to Laborelec for trustworthy lifetime extension of their power plants. Lifetime extension is a core competence of Laborelec. Over the years, we have enlarged our staff of specialized engineers and invested in state-of-the-art research tools. We have expanded our scope in non-destructive testing as well as in remaining up-to-date with the latest research in other testing technologies. In short, we are continuously enhancing our expertise to offer clients added value in lifetime extension research.

steven.goedseels@laborelec.com

CONTENTS

Hendrik Timmerman



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

Bundling knowledge on the ageing of nuclear power plants

What types of material degradations are most likely to occur on each nuclear plant component? How have these been dealt with in the past? How can we best learn from them? Laborelec aims to address these questions with its Nuclear Ageing Report. A valuable tool for decision making and knowledge sharing.

Keeping track of how power plants age

A number of fossil and nuclear power plants in Belgium have now been operating for many years. Knowing how their materials react over time is an important issue and one that the SUEZ Group currently addresses through its Ageing Programme. Since 2005, part of this programme has focused on nuclear ageing. But until now, no central database had been kept on material degradations investigated by Laborelec that have occurred in nuclear power plants since they first entered service. Nor was there a central record of the way these degradations were handled. Laborelec's materials experts have recently filled that void by putting together an overview of all material degradations that they have dealt with since the early 70s.

Encouraging knowledge sharing

A summary report of this research is now available. It classifies information by plant, type of material, and type of degradation. The report aims to meet several goals:

- Provide better insight into the ageing process of nuclear power plants. This will enable maintenance investments to be planned more efficiently. It should also help define appropriate strategies to tackle ageing problems that are almost certain to occur.
- Encourage knowledge sharing within the SUEZ Group and support benchmarking among nuclear power plants.

This central record of material degradations will be continually updated by Laborelec's materials experts.

pascale.absil@laborelec.com

Innovative repair technique for T91

Saving time and money by avoiding PWHT and inert gas backing

Laborelec developed an innovative repair technique for 9% chrome tubes (T91) used in power plant boilers and steam turbines. This technique enables our team to reduce repair time, minimizing the plant's shutdown and production loss.

After an incident, a power plant needs to be up and running again as quickly as possible to minimize production losses. Repairing a failed T91 boiler tube rather than replacing it, enables the safe but more rapid resumption of full-scale operations. Laborelec, in collaboration with the Belgian Welding Institute (BWI), developed a repair technique that resolves such a problem in a fast, cost-effective, and equally safe manner.

A time-saving alternative for PWHT

The Laborelec methodology is based on the use of a well-defined temper bead technique as an alternative to Post-Weld Heat Treatment (PWHT). As a result our team was able to save time while tempering the martensite. Laborelec however, first had to overcome a number of difficulties. For instance, without PWHT, hardness increased to 440 Vickers, while the norm without PWHT is 350. Gleeble simulations revealed that an increase in pre-heat temperature from 150°C to 250°C decreased hardness by 20 to 30 Vickers. In addition, applying the temper bead technique still required a post-bake at 650°C for 10 to 15 minutes to realize the same conditions as with PWHT. This prolongs the repair time and is difficult to control in practice. Laborelec discovered that optimizing the temper bead technique enables the avoidance of both the increased pre-heat temperature and the application of a post-bake. Currently, Laborelec is fine-tuning the temper bead technique. Mechanical tests are ongoing.

Low alloy T22 avoids inert gas backing

The use of a rather expensive purging and backing technique hampers the repair process. But materials containing more than 9% chrome require inert gas backing to prevent oxidation. By using low alloy T22 – a tube containing only 2.25% chrome – Laborelec is able to avoid such inert gas backing, while keeping the risk of oxidation low. T22 however, has the disadvantage of having rather low creep strength. Laborelec therefore decided to select a modified T24 – 2.25% chrome micro-alloyed with vanadium, titanium, and boron – in the weld. This brings the weld's creep strength close to that of (new) T91, ensuring high quality repairs. Further testing in order to qualify the procedure is ongoing.

staf.huysmans@laborelec.com

New materials for Ultra Supercritical power plants

Expert advice in every step of the project

The SUEZ Group is planning the construction of several Ultra Super Critical (USC) Coal-Fired Power Plants (CFPP). Laborelec performed preliminary material studies, formulated technical specifications for the manufacturing and fabrication of the appropriate materials, and will confirm the quality of the delivered materials.

USC CFPPs realize higher efficiency rates (46%) than traditional CFPPs (38%). Future plants however, will operate with increased steam temperatures and pressures of up to 750°C and 350 bar respectively. The reference design of new CFPPs, on the other hand, is based on currently available technology which is limited to withstand temperatures and pressures of 620°C and 300 bar. The increase in steam temperature creates an entirely new set of conditions for the selection of appropriate high temperature materials.

Large background and preliminary studies

Laborelec performed its own preliminary analyses in order to advise the SUEZ Group in the selection of appropriate materials – predominantly martensitics and stainless steels – for its new USC power plants.

LBE called upon its experience as a member of international workgroups such as the European Creep Collaborative Committee (ECCC), the P91 Users Group, and COMTES700. These memberships enable Laborelec experts to study the impact of increased heat and pressure on the characteristics of various materials. It also keeps them informed on findings from other research centres.
In addition, Laborelec's collaboration with the Belgian Welding Institute (BWI) since the 1990s has provided our experts with detailed knowledge of the evolution and characteristics of 9 and 12% chrome creep-resisting steels at high temperatures.

Providing technical specifications

Laborelec was also involved during the pre-contract meetings with the selected contractor. Our team provided detailed criteria and technical specifications for the manufacturing and fabrication, including the bending and welding of the materials appropriate for use in USC plants. Laborelec experts participated as technical advisors during the negotiations.

Quality control of supplied materials

In the meantime the contract has been awarded. As soon as the materials are delivered, Laborelec will carry out tests to ensure that the supplied materials meet the criteria as specified. During this investigation, our experts will take into account the latest research results – for instance those regarding important new degradation parameters such as reduced creep strength values, the Z phase, and dissimilar welding – to ensure a safe and long-lasting operation of USC power plants.

staf.huysmans@laborelec.com

Miniature probe used to inspect turbine blades

Recently, the high pressure (HP) steam turbine blades at Ruien 3 had to be inspected. The restricted space however, meant that traditional ultrasonic inspections were not possible. Laborelec developed a miniature probe to solve the problem. The integration of phased array technology enables multiple angles to be inspected from a single point.

Growing cavities inside turbine blades

During a programmed revision of the Ruien 3 power plant, staff from Electrabel MCC found unusual linear indications on certain HP steam turbine rotor blades. A sample was immediately sent to Vinçotte for destructive testing. These tests revealed that the blades contained cavities, probably there since they were manufactured. Over time, because of steam erosion and successive blade washings, the cavities had come in contact with the exterior, thus presenting a higher risk of the blade breaking.

Miniature inspection tool required

Laborelec was then asked to develop a tool for the ultrasonic inspection of all Ruien 3 HP turbine blades in order to assess the percentage of blades with undesired cavities. Since HP blades are mounted with only a narrow interval of several mm between each, the inspection tool had to be extremely small. This problem was compounded by the fact that the curvature of the blades also makes it difficult to firmly position a probe.

Multiple angles of inspection from a single point

Laborelec developed a miniature probe integrating phased array technology. This technology enables sectorial scans at different angles and depths from a single probe position. The large number of angles of propagation of the ultrasonic waves within the blade volume has resulted in precise and efficient inspections despite the limited space available. Laborelec and MCC are now in talks to extend the inspections to Ruien 4, which uses the same type of HP blades.

marc.jason@laborelec.com
dominique.moussebois@laborelec.com

Safe operation of CVC pumps at Tihange 1

The maintenance team at the Tihange nuclear power plant called in Laborelec when they noticed abnormally high vibration on one of three Chemical and Volume Control (CVC) pumps. The Laborelec team investigated and discovered the root cause of the incident, and ensured the other pumps were safe as well.

Water in the primary circuit of a nuclear power plant is kept under high pressure and specific chemical conditions at all times. The Tihange 1 CVC pumps enable the purification and chemical control of water in the primary circuit. They also ensure the safe injection of water into the primary circuit under high pressure during incidents.
Recently, one of the CVC pumps showed abnormally high vibration. One of nine impellers in the pump appeared to be damaged. The Tihange maintenance team immediately removed the impeller and sent this damaged part to the laboratory in the nuclear area at Doel for detailed analysis.
The Laborelec team discovered that fatigue had caused the impeller to break and that manufacturing defects were at the root of the incident. A stress study, conducted by Tractebel, revealed that the fracture could not have been caused by operational stresses, without any initial defects.
Based on these findings, our team investigated the material structure of all other impellers in the pump as well as those in the two backup CVC pumps. No additional flaws were found and the power plant was able to re-establish operation with safe rotors in all three CVC pumps.

charles.laire@laborelec.com

Joining manufacturers in root cause analysis

Adding objectivity, multidisciplinary skills, and full coverage

A growing number of plant managers have seen the benefits of Laborelec and manufacturers collaborating during root cause analyses. Objectivity, multidisciplinary skills, and full coverage of all possible causes are among the main benefits Laborelec adds to such projects.

When an incident occurs at a gas turbine, the damaged parts are replaced swiftly to get the installation up and running again with minimum downtime. On the other hand the incident requires detailed investigation to ensure that it is prevented from happening again.

Ensuring objectivity

In most cases, the damaged parts and debris will be collected and sent to the manufacturer for investigation. Including an independent third party in this research greatly enhances the objectivity of the results. Laborelec ensures that commercial interests do not bias any investigation.

Multidisciplinary expertise

Laborelec can bank on a multidisciplinary team of specialized engineers. The root cause of a problem can occur in many different areas. A damaged turbine through bolt can, for instance, stem from the design of the part, its operational conditions, or the material's composition. Laborelec has experts in every field, working with the latest high-tech research tools in their area of expertise.

Ensuring full coverage of the problem

During each root cause analysis, experts from the manufacturer bring their experience to the table and formulate a number of probable causes. The Laborelec team can verify and complete this list with additional possible sources that can account for the damage, but without making any presumptions. Together with the manufacturer, they put together a list of all possibilities – for instance via the Fishbone or Apollo methodology – and set out an action plan to narrow down that list based on experimental evidence.

Partner in the investigation

Recently, Laborelec collaborated in a root cause analysis of a turbine through bolt failure at a gas turbine in the United States. Our team assisted the manufacturer of the turbine in every step of the project – from collecting debris to investigating the damaged parts in the manufacturer's laboratories. This hands-on approach was greatly appreciated by the manufacturer who understood that our team is helping them make progress. And that this in turn helps them offer their customers an even better service.

bea.ghys@laborelec.com
sigrid.gijbels@laborelec.com

Responsible editor: Michaël De Koster

Rodestraat 125
B-1630 Linkebeek
Belgium
Tel: + 32 (0)2 382 02 11
Fax: + 32 (0)2 382 02 41

www.laborelec.com