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

ROOT CAUSE ANALYSIS AT ROSEN POWER PLANT, ITALY

Importance of shot peening confirmed

The gas turbine at the Rosen power plant in Italy broke down only 19,000 hours after a major overhaul. As a result, the operator was facing extensive repairs. He wanted to investigate the failure in order to evaluate the risks of a similar incident occurring at the neighbouring machine. The insurance company authorized an independent lab to perform a root cause analysis.

The University of Milan was selected to conduct the investigation. Its Materials Department conducted a series of analyses, followed closely by both the gas turbine manufacturer (OEM) and Laborelec.

[Milan University identifies fretting fatigue

Laborelec's Xavier Degive followed the university's investigation as a technical consultant for the Rosen power plant. 'Visual inspection immediately showed signs of fatigue. The subsequent fractography revealed fretting damage at the fracture location. Upon further examination of the broken blade, the university found a small soft layer around the fir-tree at the root of the blade that enabled the fretting damage to occur.'

[Shot peening could have prevented the incident

Laborelec, however, was wondering why there was a soft area to begin with. Our experts decided to analyse matters in greater detail and came to an astonishing conclusion. 'The roots of the rotor blades were not shot peened during their refurbishment,' states Sigrid Gijbels. 'Shot peening is a critical step after heat treatment in order to mitigate the risk of crack initiation. The sector considers this a best practice. We advised the OEM to make it an essential part of his refurbishment procedures.' The insurance company was convinced by the combined investigative results and decided to cover the costs caused by the breakdown.

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GROWING INTERNATIONAL ACTIVITIES FOR POWER PLANTS

Laborelec has profound expertise in materials technologies, condition assessment, and non-destructive testing. This enables us to assist power plants in improving availability and reliability as well as in analyzing root causes of incidents. This is earning us a rapidly growing international reputation for excellence. This past year, more than half of our department's services for traditional power generation were completed outside of Belgium. This newsletter highlights some of the services we have carried out around the world.

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A broken rotor blade caused significant damage inside the gas turbine at the Rosen power plant. The insurance company reimbursed the repair costs based on the investigative results of Milan University and Laborelec.

[In short

- One of the rotor blades at the Rosen power plant in Italy failed and caused significant secondary damage in the gas turbine
- Milan University's Materials Department revealed fretting fatigue in the crack, which initiated in a soft area around the blade's fir-tree
- Laborelec's investigation revealed that the blades had not been shot peened after refurbishment, although it is an essential process to mitigate the risk of crack initiation

NEW SOFTWARE ASSESSES DAMAGED PRESSURE COMPONENT RESISTANCE

Fitness for purpose rapidly identified

How long can a structurally damaged pressure component still be used without intolerable risk? Can its replacement wait until the next planned overhaul? Laborelec is helping to develop new software to answer these vital questions.

'A structural fault in a boiler tube, header, drum, or steam pipe does not necessarily require an immediate replacement. If the component can hold until the next scheduled maintenance or beyond, precious time and money can be saved,' says Sébastien Grégoire. 'With this idea in mind, we are developing the Crackfit software in partnership with ETD, a British company that specializes in R&D and product development for the energy sector.'

[Rapid diagnosis

Crackfit is based on a specified set of physical parameters in order to provide a rapid diagnosis. These include type of geometry, stress, operating pressure and temperature, as well as depth, length, and position of the crack. Other operating parameters, such as the number of starts and stops, are also taken into account. 'The software is designed to assess a large number of different geometries, including pipes, tubes, T-shapes and nozzles. It can be used for a wide range of dimensions, thicknesses, and types of structural faults,' adds Grégoire. 'Laborelec has validated the implementation of the software's mathematical formulas and geometries.'

[Clear graphs

Based on the given parameters, the software calculates how the crack will evolve. It graphically represents at what point in time the tube is virtually certain to break. The programme features a red, orange, or green light that immediately indicates the risk of continuing to use the tube as is. Laborelec has also tested the user-friendliness of the tool.

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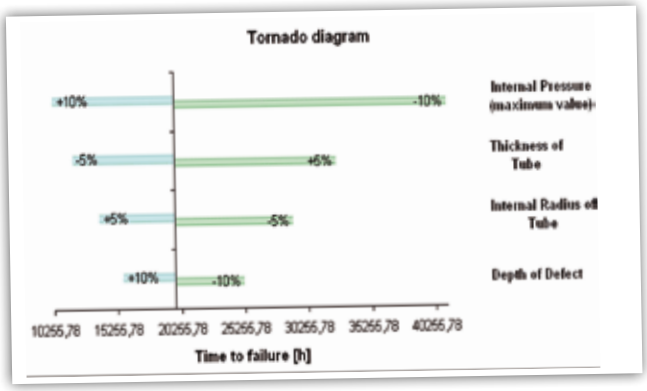

The software includes a sensitivity analysis which immediately compares the remaining time sensitivity with the input accuracy.

[Developing knowledge of aged steam turbine materials

The condition of aged steam turbine materials is still not known with a high degree of precision. Incorrectly assessing the remaining lifetime can lead to potential safety issues, reliability and availability problems, as well as unnecessary maintenance or replacement costs. Laborelec is therefore proactively setting up a database of steam turbine material samples that have been submitted to more than 200,000 operating hours. The goal is to carry out a series of destructive tests to gain deeper insight into specific material condition and ageing. By developing knowledge of the tensile, creep, and toughness characteristics, remaining lifetime predictions will become more precise and reliable.

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CALCULATING THE REMAINING LIFE OF 9FA+E BLADES

Laborelec and a third party partner have developed a model that calculates the remaining life of 9FA+e gas turbine blades. The model predicts bucket degradation and evaluates repair-replacement intervals conservatively. This has been validated by destructive tests.

9FA+e blades have a thermal barrier coating (TBC) to withstand higher temperatures than common 9FA blades. In recent years, the GDF SUEZ Group has installed these upgraded blades in several of its 9FA engines. Power plant operators now wonder whether these upgraded blades will last longer than their predecessors.

To find out, Laborelec and its partner developed a 9FA+e blade lifetime calculation model. Laborelec validated the model through destructive tests on 9FA+e blades that have been operating in 9FA engines for the past three years. 'The tests showed only marginal signs of degradation. So, the upgraded blades can clearly last longer,' concludes Jean-Pierre Keustermans.

'Our model's predictions were more conservative than the destructive tests,' explains Xavier Degive. 'The model predicts bucket degradation and evaluates repair-replacement intervals conservatively, ensuring maximum security at all times. Experience teaches that conservative action helps avoid unplanned unavailability and costly repairs in case of an incident.'

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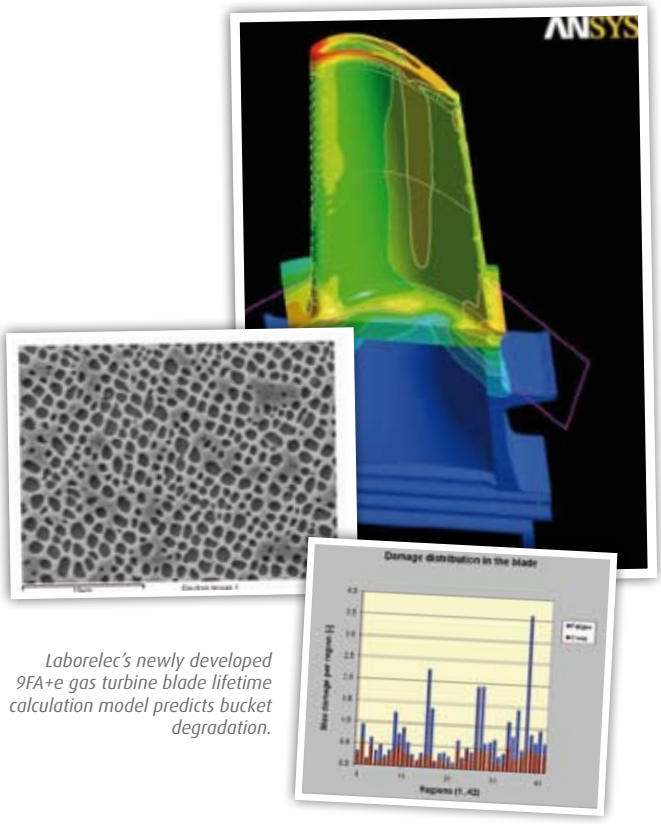

Laborelec's newly developed 9FA+e gas turbine blade lifetime calculation model predicts bucket degradation.

APPROPRIATE PAINTING GREATLY REDUCES CORROSION RISK

Laborelec provides quality checks and consulting services

Correctly painting industrial structures and equipment is important in fighting corrosion and ensuring structural integrity. Through its Paint & Corrosion Services, Laborelec assists power plants in preventing such issues by carrying out quality checks and providing unbiased advice.

'Too often, paint jobs in power plants are not done carefully enough, although it might take several months before subsequent problems appear,' observes Joël Girboux. 'Painting must be carried out under appropriate humidity and temperature conditions. It is equally important to prepare the surface, to select the right type of coating, and to apply the right paint thickness.'

[Quality inspections at Herdersbrug

'The Herdersbrug power plant recently contacted us regarding new anti-corrosion paints in its air intake, condensate, and oil pipes,' explains Maarten Vos. 'We first verified that the rust and dirt on the pipe surfaces were eliminated according to the specifications. We then suggested applying a layer of aluminium primer, followed by an intermediate and top paint layer. Such a coating system guarantees very low permeability and excellent corrosion resistance. The painting works were carried out by external painters under our supervision. During and after these works, we undertook quality checks. We measured the temperature, relative humidity, and thickness of the paint layer using magnetic induction equipment. We also carried out visual inspections to detect any pores or areas with a lack of adhesion.'

[Assessment and advice on corrosion protection at Vilvoorde

'At the Vilvoorde power plant, the maintenance team had observed that a vital steel cooling pipe was corroded on the outside as well as on the inside,' comments Barbara Geukens. 'We were asked to carry out an internal and external corrosion assessment of the piping and to advise on a proper repair system. Part of the piping was below ground and there was a large area of corrosion at the point where it comes out of the earth. Based on our observations, an integrity check of the piping wall was carried out first. We provided advice on the best way to clean the surfaces and suggested the most appropriate paint to use, taking into account the different exposure conditions inside and outside the pipe.'

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Measuring dry film thickness is one of the quality checks carried out by Laborelec.

Removing rust during surface preparation is critical in ensuring a long paint lifetime.

[In short

- Correct painting is crucial in avoiding corrosion
- Laborelec's Paint & Corrosion Services assist power plants in checking the quality of paint jobs
- We also advise on the appropriate paint conditions and corrosion repair works

EVALUATING LATEST NDT TECHNOLOGIES

Innovations for improved material inspections

Technological evolutions are particularly frequent and rapid in the area of non-destructive testing (NDT). To remain current with the latest available technologies, Laborelec has been implementing its own NDT scouting programme. This has led to the discovery of a number of potentially interesting tools.

'When we receive specific NDT requests from clients, we need to ensure that the technology we recommend or put in place is the best performing one available on the market,' says Pascale Absil. 'This requires advanced knowledge of both traditional and innovative NDT tools and applications. Our NDT scouting programme ensures that our know-how is always up-to-date.'

[Discovering the most promising technologies

'Our approach generally starts with a search in professional media. We regularly search the Internet and specialized publications for new NDT technologies and filter out the most serious and promising ones for further study. We then define possible applications for these technologies and contact potentially interested plants to carry out tests. In most cases, these tests are carried out by the supplier in our presence, at a customer's site or in our laboratory.'

[Programme yields interesting results

The NDT scouting programme has already led to the testing of 17 new technologies since the programme was initiated in 2006. These tests have found the following tools to have the greatest potential:

- An **X-ray tomography tool** useful for inspecting volume defaults in sections with a complex geometry.
- A combination of two techniques for the rapid NDT of steam or high temperature pipes: the **pulsed eddy current technique** enables local inspections without removing the thermal insulation layer, while the **ultrasonic guided waves technique** enables rapid and global wall thickness measurements.
- A combination of the **alternating current potential drop (ACPD)** technique and an **ultrasonic testing time of light diffraction** for the precise measurement of a crack depth in various components.
- The ACPD technology is also showing potential for creep remaining lifetime assessments of boiler tubes in USC power plants.
- A **giant magneto-resistive (GMR)** probe for more precise in-depth inspections of very thick metallic tubes with complex geometries.

These tools are currently undergoing further tests.

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[Feasibility studies of gas turbine inspection tools

Laborelec has been testing the use of various non-destructive testing tools for improved inspection of specific gas turbine components. A power plant recently requested an inspection of the tube to end plate welds in the burner tubes of 9FA end caps. After testing several techniques, Laborelec concluded that an improved version of ultrasound inspection generated the most accurate results.

Our experts have also investigated the use of pulsed infrared thermography to identify early debonding of thermal barrier coatings on turbine blades.

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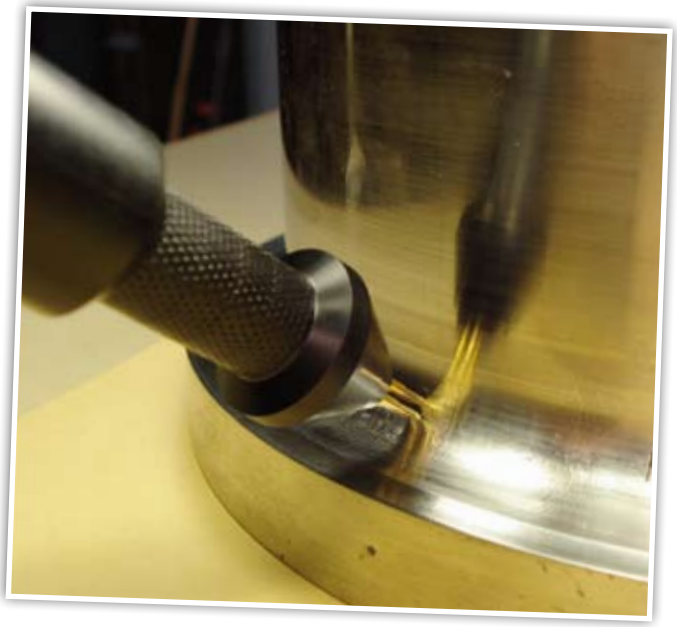

The alternating current potential drop is one of the tools showing potential for a number of NDT applications.

[In short

- Laborelec is running a scouting programme to identify the best available non-destructive testing (NDT) techniques
- The programme has revealed 17 promising techniques since 2006
- 6 of them are undergoing further testing

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