[NEWS :
Focus on natural gas technologies

NEW PLANT PERFORMANCE TESTING SERVICE

Quantifying equipment efficiency and degradation

Laborelec has developed a performance testing service for power plants. The service gives new and existing plants a precise idea of the efficiency of major components and their degradation. Laborelec can also assist plants in taking required actions.

The performance tests are offered as a one-time service or at regular intervals. They accurately measure the performance of a component at a given moment using calibrated instrumentation. Performance monitoring, on the other hand, reveals performance trends over a period of time using only local plant instrumentation. Laborelec's performance tests initially focus on gas turbines, cooling towers and air-cooled condensers but they will be extended to boilers and heat recovery steam generators.

[Performance control and advice

'The primary aim of the tests is to verify whether the gas turbine efficiency and heat rate meet contractual levels under specific conditions,' says Serge Blockerye. 'In the case of a new plant, these tests can be part of the acceptance procedures. With existing plants, they can be carried out before and after programmed outages to measure the impact of a major overhaul. At a plant's request, we can also verify the results of performance tests carried out by other parties.' Regular performance tests enable to draw up a precise performance degradation curve.

'When a plant doubts the reliability of their permanent monitoring instruments, our calibrated tools confirm whether or not the plant-specific sensors are correct,' adds Stijn Wauters. 'If the performance level in a plant has dropped, we can offer technical advice to help improve it.'

[Pilot project and first official test

In 2008, a pilot project was carried out at the Drogenbos combined cycle gas turbine (CCGT) during an outage to develop competence. Between January and March 2009, the Saint-Ghislain CCGT power plant undertook important maintenance interventions. In order to quantify the influence of a compressor wash and major overhaul, Laborelec was asked to carry out three performance tests:

- One before the off-line compressor wash
- One after the off-line compressor wash, but before the overhaul
- One after the overhaul

This not only enabled to accurately measure performance before and after maintenance, but also to single out the effect on performance of a compressor wash.

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CONTINUOUSLY IMPROVING EXPERTISE IN GAS TURBINE TECHNOLOGIES

To cope with the rising demand for energy, we cannot rely solely on one particular fuel source. We need to utilize each known possibility. Laborelec continues to expand its knowledge in all domains related to fossil fuels and renewable sources. In this edition of Laborelec News, we address our efforts in materials research for the new generation of combined cycle gas turbines. We also focus on efficiency improvement and evaluation as well as condition monitoring of existing plants.

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"PLANTS BENEFIT FROM LABORELEC'S IN-HOUSE DEVELOPED KNOWLEDGE, TESTING AND ADVICE"

[In short

- Laborelec's performance testing service verifies whether plant performance is as guaranteed
- It also enables to evaluate the influence of maintenance operations on performance
- Plant-specific instrumentation can be verified by calibrated sensors
- Performance tests can identify a lack of performance and other potential problems to be investigated through further advice and troubleshooting

At Saint-Ghislain, Laborelec singled out the effects of a compressor wash and major overhaul on plant performance.

EXPERT ADVICE IN TUNING GAS TURBINES

Optimal balance between flame stability and NO_x emissions

Power plants today have to maximize their operability while limiting their NO_x emissions. This is a trade-off decision that requires careful tuning of the combustion process. Laborelec offers expert advice and technical assistance during tuning projects.

Improving combustion stability requires precise control of the fuel staging in the combustion chamber. This is done by adapting the fuel valve positions as a function of the power output. Unfortunately, improving flame stability also increases NO_x emissions. The difficulty in tuning thus lies in finding the optimal balance between flame stability and NO_x emissions. Laborelec has the specific gas turbine combustion expertise to assist power plant operators and service providers in determining the optimal combustion parameters.

[Combustion dynamics expertise

Laborelec has built up significant experience in combustion dynamics. Hannes Laget of Laborelec's Combustion Team confirms this. 'The development of our Combustion Dynamics Monitoring and Tuning Tool has provided us with valuable insight into this subject. This has enabled us to determine the various parameters affecting the combustion process of gas turbines. Based on this expertise, we can accurately advise power plant operators and service providers regarding which parameters to focus on during the tuning process.'

[In-depth gas turbine know-how

Insight into the general combustion parameters itself is not enough since the combustion process is highly dependent upon site-specific factors. The geometry of the combustion chamber certainly has a profound effect on the process. And even a slight variation in ambient parameters — such as pressure, temperature, and humidity — can result in different tuning requirements to achieve an optimal balance.

Evert Vanderhaegen, combustion specialist at Laborelec: 'Tuning experience can prevent future problems at similar power plants. The lessons we learn during a tuning project at a Belgian power plant can be beneficial for similar projects in for instance Italy. It can help spread best practices throughout the entire GDF SUEZ fleet.'

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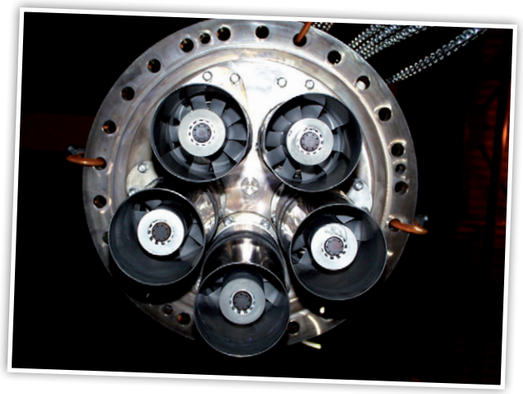
[Permanently monitoring combustion dynamics

In 2005, Laborelec developed its own Combustion Dynamics Monitoring and Tuning Tool. 'The system enables us to permanently monitor all vital combustion parameters such as pressure, temperature, and combustion dynamics,' explains Hannes Laget of the Laborelec Combustion Team. 'Readings from any possible location can be consulted on site as well as on-line.' The system's implementation has already led to positive results in the Benelux region.

"LABORELEC COMBINES EXPERT KNOW-HOW IN COMBUSTION DYNAMICS AND INSIGHT IN THE SITE SPECIFICS OF A WIDE ARRAY OF GAS TURBINES"

[In short

- The difficulty in tuning gas turbines lies in finding the optimal balance between flame stability and NO_x emissions
- Laborelec has expertise in combustion dynamics and site specifics for various gas turbine technologies



Tuning involves adjusting the amount of natural gas which is supplied to each of the burners in order to stabilize combustion and reduce NO_x emissions.

ROTOR DYNAMIC MODELLING DIAGNOSES EXCITATIONS AT LOW FREQUENCIES

V94.2 gas turbines are known to show excessive shaft vibrations at low frequencies. Rotor Dynamic Modelling (RDM) has proven to be a perfect diagnostic tool in such cases. This was illustrated for the Herdersbrug combined cycle gas turbines (CCGT).

A RDM is a computer model of a rotor. Based on a reduced finite elements model, it can, among other things, simulate modal rotor deformations at critical speeds. Laborelec was asked to build such a RDM for a V94.2 gas turbine.

The project demonstrated that the RDM can serve as a diagnostic tool for the excitation of vibrations at low frequencies. 'The Laborelec Vibration Monitoring System (LVMS) revealed shaft vibration amplitudes with a frequency between 18 and 19 Hz during operation,' explains Kris Matthys. 'The RDM confirms that this low frequency corresponds with a low damped bending mode of the gas turbine rotor. This results directly in high amplitudes when this mode is excited.'

It is not easy to determine the right solution for this particular problem. Tuning the combustion process, re-designing the combustion chamber, or adjusting the rotor's design are all valid — but far-reaching — options. Further research is necessary to determine the best approach. Efficient monitoring is already a very good starting point.

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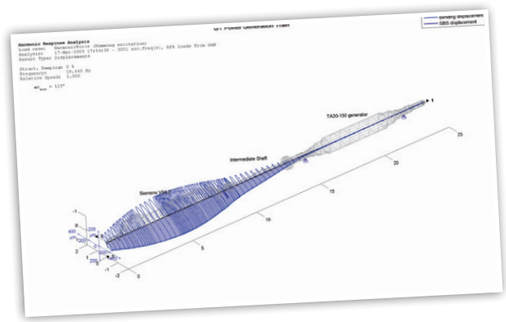
[In short

- V94.2 gas turbines are known to suffer from high vibrations at low frequencies
- Rotor dynamic modeling can be used as diagnostic tool for excitations at low frequencies



The RDM of the Herdersbrug shaft line reveals that excitations between 18 and 19 Hz lead to high amplitudes and the automatic shutdown of the gas turbine.

TECHNICAL ASSISTANCE DURING ROOT CAUSE ANALYSIS IN CHILE

In August 2008, the Tocopilla power plant in Chile was out of operation for three months. An incident at the gas turbine caused significant damage inside the compressor and turbine section. The manufacturer (OEM) is conducting a root cause analysis. Laborelec assists the owner of the power plant by witnessing this investigation and by evaluating the outcome.

After dismantlement, the gas turbine showed a partly liberated compressor and turbine blade as well as severe secondary damage. A detached blade can have several reasons. To make sure the OEM does not overlook any possibility, Laborelec sent a multidisciplinary team to Chile. 'Evidence material was inspected on site and plant information was gathered,' explains coordinator Guido Van de Vyvere. 'At the same time, operational and specific vibration data were recovered and analyzed.'

The OEM collected all damaged engine hardware, sealed it, and sent it off to its own laboratory for metallurgical analysis. 'One of our metallurgists closely followed the investigation,' says Van de Vyvere.

The OEM provided the plant owner and Laborelec a preliminary report, including the results and a failure scenario. Discussions are still ongoing on the incident's scenario.

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[In short

- A broken blade caused massive secondary damage in the gas turbine of the Tocopilla power plant in Chile
- The OEM is investigating the root cause of the problem
- Laborelec's material and vibration experts provided technical assistance during the root cause analysis

Laborelec assisted a Chilean power plant operator during a root cause analysis of a compressor blade incident.

NON-DESTRUCTIVE TESTING ON GAS TURBINES

Laborelec expertise proves decisive in numerous situations

Laborelec carries out a wide range of non-destructive tests on gas turbines. By inventively applying advanced techniques and conventional testing methods, it is able to rapidly address the growing number of requests from power plants around the world. Interventions include solving discussions with suppliers, recommending replacement or repair decisions, and assessing the impact of cycling on power group materials.

[Ultrasonic Testing (UT) reveals imperfect end cap welding

An incident involving loose burner tubes recently occurred within a gas turbine burner at the Eems power plant. The plant called in Laborelec to inspect the quality of the tube welds on the end caps. 'By smartly using a conventional UT technique, we revealed major shortcomings in many components supplied by the manufacturer,' explains Eric Van der Heyden. 'The supplier recognized the relevance of our technique and findings, and has started improving its tube welds.'

[Inspecting deviating thermal barrier coatings on stator blades

The Sohar power and desalination plant in Oman contacted Laborelec when it noticed that part of the thermal barrier coating (TBC) had disappeared on a first row of turbine stator blades. 'The TBC is a porous ceramic layer on the blade that prevents overheating,' explains Alain Braeckman. 'TBC damage is often invisible and can induce substantial costs if the evolution of the damage is not accurately assessed. Despite the low permeability of TBC to sound waves, we succeeded in swiftly designing an effective UT inspection technique. This enabled us to provide the plant with accurate results and precise follow-up recommendations.'

[Replicas and hardness tests on turbine materials

The Teesside combined cycle gas turbine in the United Kingdom recently switched from a baseload generation mode to a flexible one. Hence, operators wanted to know whether the turbine materials would resist the increased load fluctuations. 'We undertook non-destructive hardness tests on the turbine materials and took morphological surface replicas for a structural analysis,' recalls Steve Nardone. 'Previous inspections carried out by suppliers had identified corrosion and hardness issues that might lead to a material breakage. The plant also asked us to compare our results with those of the suppliers and to comment on their reports.'

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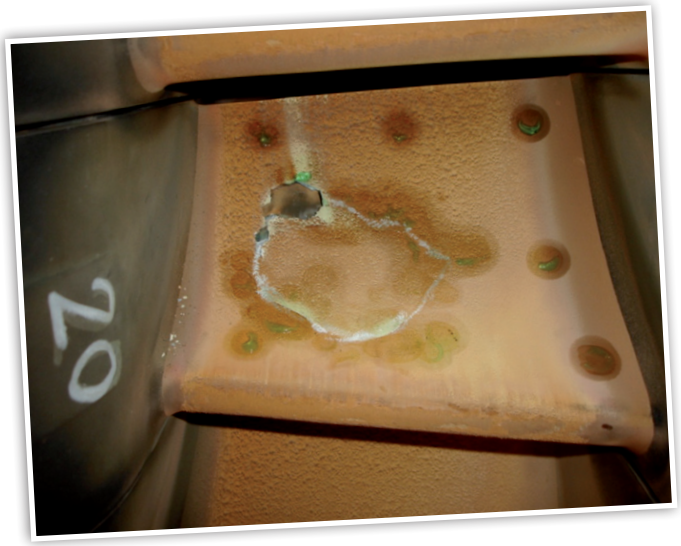
[Pyrometry for precise blade inspection

Laborelec has started using pyrometry to assess the remaining lifetime of turbine blades. 'The lifetime of blades strongly depends on the temperature distribution across the blades,' explains Marc Van Caillie. 'Pyrometry enables to measure this parameter on-line and to validate lifetime model predictions. Because the thermal profile of each blade is measured every three milliseconds, the impact of transients (e.g. start/stop) can also be evaluated. As each blade is measured individually, pyrometry also helps avoiding failures since it detects any blade that runs too hot due to failing internal cooling channels, for instance.'

[In short

- Laborelec offers a wide range of non-destructive testing and characterization techniques for gas turbines
- Techniques range from conventional ultrasonic testing to advanced eddy current techniques or on-line pyrometry
- The flair and expertise of Laborelec experts produces precise test results and recommendations



An accurate mapping of failing TBC on blades is essential to assess any further damage evolution. The extent of the actual hidden damage (indicated by the white line) is significantly larger than the visible damage (exfoliated area).

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