NEWS: focus on combined cycle power plants

Root cause of vane damage identified: inadequate filter design

The turbine vanes of the GDF SUEZ Enersur Power Plant in Chilca, Peru suffered from early degradation. Laborelec was called in for comprehensive analysis and discovered that an inadequate filter design was at the root of the problem. Our experts then provided the design specifications for a new filter.

After 24,000 hours of operation, the turbine manufacturer had replaced the first-stage vanes due to overheating at the trailing edge. However, the cause of the overheating was unclear and, what's more, the problem seemed to reoccur after less than 10,000 operating hours. Therefore, the plant operator feared that replacing the vanes was a treatment of the symptoms rather than a sound solution to the underlying problem. Consequently, the maintenance team called in Laborelec for a second opinion.

Various investigations to determine the root cause

First, Laborelec materials and chemical experts carried out visual inspections and chemical analyses of compressor samples. Roughness measurements confirmed that the erosion rate of the compressor blades was higher than expected. We then inspected the turbine section and the filter compartment, which revealed that many cooling holes on the vanes were clogged by iron oxide and sulphur-containing material. The vanes themselves were affected by oxidation and corrosion. More important, puddles of brackish water were found in the filter compartment. Our experts subsequently analyzed the filter design and determined that it was inadequate for draining humidity.

Adapting filter to coastal conditions

Kurt Boschmans explains, 'Our investigations showed that while the coalescent filter material itself was adequate, the overall compartment was designed for a dry environment. This was a mistake. Although it rarely rains in Chilca, the air there is humid due to the coastal location. Without proper drainage, the filter material gets soaked and becomes useless. This discovery was crucial to the implementation of a new, effective filter design.'

As a result, the plant owner decided to invest in a new filter compartment and asked Laborelec to define the filter's specifications.

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Field experience drives research activities

For many years, Laborelec has been assisting power plants in various aspects of their combined cycle gas turbine (CCGT). In doing so, our experts have gained valuable insight into all types of equipment and processes used in CCGTs. This revealed that there is still plenty of room for improvement; especially outside the hot gas path, which was the initial focus. Consequently, Laborelec is advancing its research activities in complementary domains in order to optimize plant availability and efficiency and reduce operation and maintenance costs. This edition highlights some recent achievements, as well as our readiness for knowledge transfer and training.

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Quality control of turbine spare parts

When a turbine component needs to be replaced, a spare part must be readily available in order to minimize power plant downtime. Sharepart ensures this. The company holds shared strategic stocks and relies upon Laborelec to make sure that the spare components are in optimal condition.

In December 2010, GDF SUEZ pooling company Sharepart received new sets of spare blades, vanes, and combustion pieces for gas turbines such as the ones installed in the CyCoFos and Flevo Power Plants. Sharepart contacted Laborelec to assess the quality of these new parts.

Visual inspection

The Laborelec experts first carried out a number of visual inspections on the equipment in order to detect any irregularities or quality deviations. 'We recorded all of our findings and requested feedback on them from the manufacturer,' explains Xavier Degive. 'For example, we discovered that a number of cooling holes were clogged on several vanes. As this can cause overheating, the manufacturer decided to replace the vanes.'

Non-destructive coating tests

Another important characteristic of the equipment is coating quality. Laborelec therefore carried out several non-destructive tests to assess the coatings applied on a variety of components. 'For instance, using eddy current technology, we measured the ceramic coating thickness. For components with metallic coatings, we made ultrasonic measurements to verify that the coating correctly adhered to the surface. We also used FSECT technology to assess the quality of the bond coat in between the ceramic layer and the material,' elaborates Degive. These tests revealed no abnormalities, thus ensuring Sharepart that the spare part coatings complied with quality standards.

Our experts carried out a number of tests to assess coating quality and other characteristics.

Monitoring repair activities reduces scrap rates

When manufacturers evaluate the actual condition of their used equipment, they tend to routinely propose replacement. In order to improve the condition assessment, Laborelec supports GDF SUEZ power plants during hot gas path (HGP) refurbishment campaigns. Thanks to our well-established equipment expertise, our detailed material investigations, and our resulting expert advice, operators are often able to significantly reduce plant scrap rates.

Our experts attend meetings, analyze the manufacturers' reports, and scrupulously audit manufacturers' repair facilities. 'Through these activities, and thanks to our yearlong work on HGP components, our experts are able to determine whether or not repair is technically feasible for a given component,' says Sigrid Gijbels, Technology Manager Gas Turbine Materials.

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Second opinion to ensure correct scrap rate

Laborelec monitors the manufacturer's activities and critically evaluates its findings and proposals. 'The subsequent discussions with the manufacturer are very fruitful,' states Gijbels. 'For example, at the Senoco Power Plant in Singapore, we both agreed that about half of the proposed renewals were not actually necessary.' Sometimes, however, defects are discovered at the repair shop, leading to the scrapping of the damaged components. In such cases, Laborelec always recommends further investigations in order to ensure that similar problems are avoided in the future.

Laborelec's approach enables plant operators to determine whether components can be repaired or must be replaced.

How and when to install catalysts in CCGT power plants

NO_x and CO emission standards are becoming stricter, including those for combined cycle gas turbine (CCGT) units. In some countries, maximum emission levels are already much lower than in Europe. Laborelec is researching methods to ensure that power plants continue complying with NO_x and CO emission standards.

Burner adjustments or catalysts?

Nowadays, power plants must increasingly operate flexibly and maximize turbine efficiency. Unfortunately, this can result in higher NO_x and CO emissions. These emissions can be reduced either by optimizing burner design or by installing catalysts. Based on a plant's specific situation, our experts help operators determine whether burner technology is sufficient for compliance with standards or whether a catalyst is required. 'If local emission standards are too strict, then an SCR (selective catalytic reduction) and/or SCO (selective catalytic oxidation) unit may need to be installed,' notes Xavier Henry. 'SCR lowers NO_x emissions in flue gases, while SCO reduces CO emissions.'

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Optimizing ACC performance

Wind on air-cooled condensers (ACCs) can significantly affect steam cycle efficiency in thermal power plants. Controlling the wind's impact on ACCs is vital to maximizing their performance. Laborelec has assessed methods to reduce this impact and has developed an ACC performance monitoring tool that incorporates the wind's effects.

Windscreens increase performance

Wind generally reduces the quantity of air that is taken in by the ventilators, thus decreasing ACC performance. 'Optimizing ACC operation requires the impact of wind to be taken into account,' explains Serge Blockerye. 'We developed a computational fluid dynamics (CFD) model of a combined cycle power plant's ACC and its surroundings. This enabled us to simulate various types of windscreens and check their ability to mitigate the wind's effects.' The CFD investigation revealed that the first row of fans directly exposed to the wind is particularly impacted and that windscreens provide an effective remedy to this issue. The windscreen also proved to be a good solution to the problem of hot air recirculation at the entrance of ACCs.

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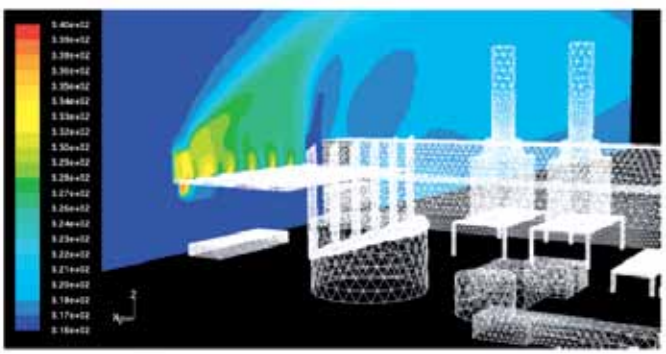
On-site study in the USA

Laborelec has extensively studied the on-site use of SCR and SCO technology in the USA. 'When regulation limits NO_x emission to a few ppmv, as is the case in several states in the USA, CCGT units often need catalyst technology,' adds Henry. 'Because of this study, we are now able to better determine when an SCR or SCO is necessary, where to install it, how to size it, and how to operate and maintain it.'

Catalysts may be necessary in CCGT units when emission standards are too strict.

Monitoring tool identifies performance loss

To optimize windscreen effectiveness, one needs a tool that can rigorously assess their impact on ACC performance. Laborelec has developed such a monitoring tool, which rapidly detects any variation in the thermal performance of an ACC. 'The tool compares operating conditions to a reference performance for a given set of operational parameters,' details Blockerye. 'Based on this comparison, it calculates any performance gap in terms of lost MWh. During this calculation, the tool automatically takes the effects of wind into account.' The tool is already being used at a combined cycle power plant within GDF SUEZ.



Laborelec developed a CFD model of an ACC and its surroundings to simulate various types of windscreens and their impact on ACC performance.

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Tuning low-NO_x burners: addressing the plant's concerns

Laborelec focuses its investigations and advice on optimizing the performance, stability, and lifespan of plant equipment. For instance, we are supporting power plants during the tuning of their low-NO_x burners and are urging equipment manufacturers to fully take into account the plants' concerns. We also provide guidelines for specific burners in order to improve operators' insight into the tuning process.

The tuning of low-NO_x equipment is a highly complicated technical process. 'It involves optimizing the gas flow in all supply lines,' details Hannes Laget, 'while factoring in many parameters, such as turbine type, fuel quality, and ambient temperatures throughout different seasons. That's why the tuning is frequently done entirely by the original equipment manufacturer.'

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On-site support and comprehensive guidelines

However, operators are increasingly keen on understanding more about the tuning process. Laget explains, 'Tuning always involves a compromise between reducing emissions and providing a stable, reliable flame. When the tuning is too tight, the flame can become unstable, inducing fluctuations in pressure in the combustion chamber, and ultimately decreasing the equipment's life expectancy. There is thus a balance to be struck between production efficiency and eco-efficiency.' For this reason, Laborelec provides on-site support during tuning works. 'We analyze the manufacturer's proposals and ensure that the plant's priorities are taken into account,' states Laget. Additionally, Laborelec provides plant operators with comprehensive tuning guidelines for a number of well-known burners.

When the tuning is too tight, the flame can become unstable, inducing fluctuations in pressure in the combustion chamber.

Early detection of valve malfunction

One of the gas turbines at the Eems Power Plant in the Netherlands experienced an abnormal temperature increase. Using the SmartSignal monitoring tool, the Laborelec Diagnostic Centre was able to identify this increase and advise the plant on where to carry out inspections. In this way, the cause of the problem was detected before any damage occurred.

SmartSignal is a tool that detects abnormal behaviour by comparing actual data with expected values. The SmartSignal data for the gas turbine showed a significant wheel space temperature increase from 420 to 460 °C, indicating a probable malfunction in the cooling circuit. Such an event must immediately be investigated. It causes an increase in the temperature of the stator blades, which, in turn, can accelerate the blade ageing process.

Valve had remained closed after offline wash

'We instantly informed the plant operators of the problem and advised them to verify that the compressor air bleed piping was not blocked and that all valves were in the correct position,' recalls Sébastien Gregoire. During their inspections, the operators discovered a closed valve on the compressor bleed piping that should have been open. 'The valve had been closed for an offline compressor wash before the start of the unit in order to prevent cleaning products from entering the piping. After the wash, the valve had not been reopened correctly.'

Based on Laborelec's advice, the operators were able to effectively address the issue and prevent potential damage.

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Remote monitoring identified a potentially dangerous temperature increase which led to the remedial action avoiding damage to the stator blades.

Practice-oriented training on gas turbine materials

On June 8 and 9, there will be a two-day training course at Laborelec headquarters on materials technology for gas turbine applications. 'The course is very practice-oriented,' Evy De Bruycker explains. 'First, we give the attendees a broad overview of superalloy materials and coatings, production and application techniques, and technical properties. Then, through a series of well-documented cases, we present a wide range of practical issues. What are the typical failure and degradation mechanisms? How can we assess the remaining life of blades, and how can they be reconditioned? What should we look for when inspecting the quality of incoming material?'

This training course is aimed at maintenance technicians and managers alike. On demand, the course can be given on-site as well.

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