

NEWS :

Focus on condition assessment of rotating machines

ROOT CAUSE ANALYSIS OF CRACKS IN TURBINE ROTOR COMPONENTS

Improved vibration monitoring to detect crack propagation

Electrabel MCC contacted Laborelec regarding a number of cracks in one of the units of the Electrabel GDF SUEZ power plant in Schaarbeek. These cracks concerned the shaft and five blades of the last two rows. In addition, the gearbox was damaged. Laborelec identified the root cause of the blade cracks and assisted the plant in implementing an improved vibration monitoring approach.

Analyzing blade cracks

'Firstly, we conducted a metallurgic investigation of the entire cracked blades and the crack surfaces in particular,' reports Dieter Billet. 'We also executed a modal analysis to determine the most important resonance frequencies. We then analyzed operating parameters and the unit's history to help us identify the root cause of the crack. The crack surface showed no corrosion or other abnormalities that would explain the occurrence of the crack.' Additional in-depth analysis of past reports indicated that a grid incident occurred in 2008. Because of a faulty switch manoeuvre, synchronization with the grid was temporarily lost, causing a considerable shock to the turbine shaft and blades. 'Adding up all the gathered information, we were able to establish that this incident caused the initial cracks in the blades,' says Billet.

More sensitive vibration monitoring

'Small shaft surface cracks are normally machined off in order to avoid further crack propagation. In this case, the size of the crack was such that it could not be machined off,' explains Billet. 'We therefore recommended the use of a more sensitive vibration monitoring system to detect any critical crack propagation well in advance. Vibration sensor signals are now introduced into a Laborelec Vibration Monitoring System (LVMS). This means that continuous monitoring can be carried out remotely from Laborelec and that specific vibration pattern evolutions can be identified more quickly and easily.'

Monitoring system upgraded

As a result of damage found on the gearbox, Laborelec proposed a monitoring upgrade that was both economically and technically acceptable. A minor extension of the existing vibration sensors on this component allows for an improved monitoring strategy through a follow-up of filtered vibration amplitudes in the existing plant information system and a more detailed offline vibration measurement program.

Dieter Billet

MASTERING EACH CONDITION ASSESSMENT TECHNIQUE

There are various ways to assess the condition of rotating machinery. Analyses of the lubrication oil bath, monitoring machine vibrations, and measuring electrical discharges in the insulation of electrical machines can each help determine the state of the equipment. Laborelec has mastered each of these techniques. This expertise enables us to identify and anticipate various problems, as you will read in this edition of Laborelec News.

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Steam turbine rotor during an inspection of one of the cracks.

In short

- Laborelec analyzed several turbine blade and shaft cracks at the Schaarbeek Power Plant
- Our experts established that the blade cracks were caused by a grid incident
- They recommended that the plant should upgrade to an improved vibration monitoring system

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OFFLINE AND ONLINE AGEING MEASUREMENTS OF TURBO-GENERATOR WINDINGS

Many GDF SUEZ turbo-generators are 30 to 40 years old. How long can they continue to operate safely? Along with offline measurements, Laborelec now also offers the online assessment of the ageing of stator windings. The first sensors have already been installed.

Laborelec has the equipment and expertise to perform offline measurements of partial discharges in the stator insulation of small to large turbo-generators (see also Laborelec News 114). 'Our in-house tools enable multiphase measurements during a machine stoppage,' says Jeroen Van Cotthem.

Full online measurement service

In order to minimize maintenance downtime, Laborelec has complemented its service offering with online measurements. The installation of the online measurement tool starts with finding the best location for the sensors and connection boxes. 'We take pictures and establish the precise dimensions of the inside of the generator's terminal box. Computer simulations then identify the best location for the sensors. Once the plant validates our design, we carry out the installation,' states Van Cotthem. 'When everything is in place, we are able to conduct measurements at various loads and temperatures.'

GENERATOR STATOR CONDITION ASSESSMENT

Laborelec determines cause of insulation wear

Electrabel MCC asked Laborelec to investigate two electrical earthing faults in the generator stators of one of its Belgian power plants. Our experts performed a full condition assessment of the insulation in the stator windings.

Partial discharge tests and material investigations

Laborelec carried out partial discharge measurements on the plant's two generators. 'These measurements revealed the presence of discharges at the interface between the primary insulation and the conductors,' says Jean-Michel Meunier. 'This is dangerous for this type of multiple turn winding. In air cooled machines, in particular, partial discharges at the interface between the primary insulation and the conductors generate nitric acid, which attacks the conductor insulations. This in turn can cause short circuits between conductors. In this case, the winding and its primary insulation heat up locally. As a result, the dielectric properties of the primary insulation are altered, which can eventually result in a dielectric breakdown of the generator bar.'

'We therefore carried out material analyses in laboratory on a stator bar of one of the power plant's generators. These analyses confirmed the presence of nitric acid, which may have caused a short-circuit between conductors.'

First sensors installed

This past year, Laborelec has implemented its online measurement tools in two Belgian power plant units. Before the end of the year, three additional Belgian units and two units abroad will be equipped with online measurement tools. 'There are several machines of the same type among them. This enables us to compare measurement results and identify common issues and best practices,' concludes Van Cotthem.

Jeroen Van Cotthem



Laborelec simulates the specifics of the turbo-generator to determine the best location for online sensors.

Commissioning tests on new units

The power plant decided to replace two of its stators. Laborelec attended the electrical commissioning tests of the new units at the factory of the original manufacturer. Our experts also carried out extensive additional measurements on the old stators to assess which one was in the best condition to be kept in storage as an emergency back-up unit.

Jean-Michel Meunier



Our experts carried out partial discharge tests to identify the precise type of insulation wear.

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GROWING INTERNATIONAL APPRECIATION FOR OIL ANALYSES AND VIBRATION SERVICES

Laborelec's condition assessment services for rotating machines are rapidly expanding far beyond Belgian borders. The fact that these services do not always require on-site presence is a bonus, although local support remains crucial.

The transfer of data can be accomplished in various ways. Vibration data can be sent via e-mail, oil samples are mailed by postal services. However, guaranteeing quality service at long distance requires local support.

Local support remains crucial

In order to make a precise analysis, our experts require various types of historical information. 'Did the machine experience operational problems in the past that could have influenced its mechanical behaviour? Have there already been oil issues? Was debris found in the oil bath that could indicate vibration-inflicted damage? Exchanging such additional information is crucial for a correct interpretation of our analyses,' elaborates Laborelec's Vibration Technology Manager Koenraad De Bauw.

In the case of oil analyses, local support is even more crucial. Laborelec oil expert Koen Balman explains: 'Sampling is one of the first and most important steps of any good oil analysis. If we cannot take the samples ourselves, we have to rely on local staff. Because it is so important, it is necessary for us to visit the site before the beginning of our collaboration so that we can gather elementary information about the lubrication system. Our visit is also an ideal occasion to build a relationship and train the local staff to properly take and prepare oil samples.'

Koen Balman, Koenraad De Bauw



Condition assessment services do not always require on-site presence of our experts, but local support is indispensable.

Increased internationalization enhances comparability

Approximately fifty power generating units outside of Belgium are currently connected to Laborelec's Vibration Monitoring System (LVMS). Half of them are followed locally; the other half is followed at Laborelec headquarters. Consequently, our experts can centralize detailed vibration data from various types of machines or from different plants using the same type of machine. This makes it possible to compare vibration data and identify common issues quickly. Laborelec Vibration Technology Manager Koenraad De Bauw illustrates with an example: 'We are monitoring the vibration behaviour of four identical GT26 technology single shafts. Each of them is showing deviations near the clutch, indicating a general issue for that particular model of machine. This is important information in our discussions with the original equipment manufacturer.'



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BASIC ELEMENTS FOR OPTIMAL LUBRICATION OIL MANAGEMENT

Over the years, Laborelec has built invaluable oil management experience. This is now valorized in a structured lubrication oil audit. Based on an on-site screening, they give power plants advice to optimize their lubrication oil management by implementing best practices.

Good management of lubrication oils starts with good **storage**. Oil barrels are sometimes stacked inappropriately and randomly, without any indication of which ones are the oldest. Our experts advise customers on how to improve their storage techniques and apply the First In First Out rule.

Oil sampling is also a major concern. Good oil analysis requires proper oil sampling. Therefore, our experts assist in finding the best sampling points. 'We suggest locations where the oil is very turbulent, preferably in a return pipe. This allows us to collect samples with the most representative levels of wear debris and contaminants,' notes Laborelec oil expert Koen Balman. 'We take these rules into account when we work out a new oil sampling procedure for our clients.'

QUICKLY LOCATING AND RESOLVING OIL CONTAMINATION

Low antioxidant levels made it necessary to replace the 23,000 litre lubrication oil bath of the Zandvliet Power steam and gas turbine. However, once replaced, the oil started to turn cloudy and the level began to rise. The expertise of Laborelec and local staff enabled to find the root cause and solve the problem within the week.

Resolving air contamination

Laborelec joined the local staff in their search for potential root causes of the problem. 'After shutting down the purifier, the level of the oil bath immediately started decreasing. Closer investigation revealed that the purifier's suction pump was injecting air into the oil bath,' explains Laborelec oil expert Koen Balman. 'After the pump was repaired, the purifier was restarted. The oil level remained normal and the oil's cloudiness disappeared.'

Tackling water infiltration

The Laborelec Oil Laboratory followed the water concentration of the oil bath regularly. And, although the purifier was filtering out thirty litres of water per day, the water concentration still remained too high. This indicated a second problem: water infiltration. The local staff decided to investigate various possible root causes such as a leak in the oil's cooling system or the migration of hydrogen vapour from the alternator. Their in-depth analyses revealed a sealing steam problem.

A third point of interest is **contamination control**. 'The air breathers on top of the oil reservoir not only have to prevent infiltration of dirt particles, they also have to be moisture proof,' explains Balman. 'If this is not the case, we urge the customer to replace their breathers immediately. Furthermore, when adding new oil it is important to use a filter cart.'

Taking these steps into account will help optimize lubrication oil management. In addition, it creates a firm basis for establishing an appropriate condition monitoring program for rotating machines.

Koen Balman



Good oil analysis requires proper oil sampling. Locations where the oil is very turbulent such as in a return pipe are excellent for collecting samples.

'The steam turbine's sealing steam was not properly adjusted, allowing steam to penetrate into the oil bath,' states Balman. 'After re-adjusting the sealing steam system, everything returned to normal.'

Koen Balman



Laborelec's state-of-the-art oil laboratory enables the rapid identification of possible lubrication oil contaminants.

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