MISTRAS
A World of NDT Solutions
Products & Systems Division

PHYSICAL ACOUSTICS CORPORATION

PRODUCT BULLETIN

Designed with Acoustic Emission Technology to provide early warning and detection of cracking events and help prevent future failures of combustion turbines.

ACTMS: Acoustic Combustion Turbine Monitoring System

ACTMS TECHNOLOGY

The Acoustic Combustion Turbine Monitoring System (ACTMS) is designed to detect cracking in mid-compressor stator vanes of natural gas/oil fired combustion turbines using an online Acoustic Emission (AE) system. ACTMS, using noninvasive sensor mounts, shows AE is capable of detecting and identifying crack activity in the presence of normal turbine operational noise.

Mid-compressor vane cracking is an industry recognized problem wherein at its later stages, blade liberation can cause total catastrophic loss of the compressor. The losses from these failures are between $7 and $10 million per incident, not including the revenue loss from the 55 day average, forced repair outage.

BACKGROUND

A combustion turbine is a rotary engine that extracts energy from a flow of combustion gas or oil. It has an upstream, axial flow compressor coupled to a downstream turbine, with a combustion chamber in-between.

Axial-flow compressors are dynamic rotating compressors that use arrays of fan-like aerofoils to progressively compress the incoming air for combustion. The arrays of aerofoils are set in rows, usually as pairs: one rotating and one stationary. The rotating aerofoils, also known as blades or rotors, accelerate the fluid. The stationary aerofoils, also known as a stators or vanes, decelerate and redirect the flow direction of the fluid, preparing it for the rotor blades of the next stage. Both the blades and vanes decrease in size with the circumference of the turbine of the available volume for a given volume of air, thus, increasing pressure and density.

Cracking in the stator blades can occur as a result of the force from airflow, pressure and vibration. The cracking typically appears mid-blade, about half way between the root, where the blade is connected to the case and the tip, the end closest to the shaft of the rotor. In later stages of cracking, the blade can separate and be pulled through the compressor, toward the combustor and turbine impacting other stators and blades and tearing them off in the process. The photo above shows the rotor of a compressor after a blade liberation event.

These failures, most common in the S3 to S5 region, are known as mid-compressor failures. The root cause of the failure is not fully understood, but may be attributed to manufacturing defects, operational issues, foreign object damage (FOD) or vane attachment wear. Other unsubstantiated causes may be operational stress, harmonics and resonance or corrosion pitting. In any case, the failures occur at an average of one per year across the installed base of GE 7FA turbines and have been seen in the Frame-9 turbines.

Benefits

- Global, on-line monitoring for the detection and early warning of vane cracking.
- Extends intervals between inspections
- Less down time for inspections and verification of potential failures
- Graphical filters and rate alarm minimize false positives to increase credibility in alarm outputs
- Non intrusive sensor mounting will not cause OEM warranty concerns

ACCORDING TO INSURANCE STATISTICS, LOSSES FROM INCIDENTS REQUIRING A COMPRESSOR REBUILD HAVE TOTALED OVER A QUARTER BILLION DOLLARS WITH AN AVERAGE OF $7 TO $10 MILLION DOLLARS PER EVENT.

ACTMS: Acoustic Combustion Turbine Monitoring System

ACOUSTIC EMISSION MONITORING SYSTEM

The MISTRAS Acoustic Combustion Turbine Monitoring System is designed with Acoustic Emission technology to detect and provide early warning of cracking events and help to prevent future failures.

Traditionally, detection of potential failures are performed on a periodic basis, during outage, and using traditional inspection techniques. Visual and borescope or UT inspection of the blades requires extensive downtime and trained personnel to make determinations on potential areas of concern. Adding to the challenges in inspection are the limited inspection access to installed vanes, vane geometry, orientation of flaws and consistency of inspection procedures.

Acoustic Emission is a global, in-service monitoring technique that provides real-time protection of active flaws. AE is detection of waves generated by the rapid release of the stressed energy from localized sources within a material. AE can also be regarded as a stress wave generated by stress energy release of cracks or micro impacts of cracks, pits, scratches and scars from a material or structure under stress. Cracking the stator blades releases waves of this nature and is detectable by AE sensors, monitoring systems and software.

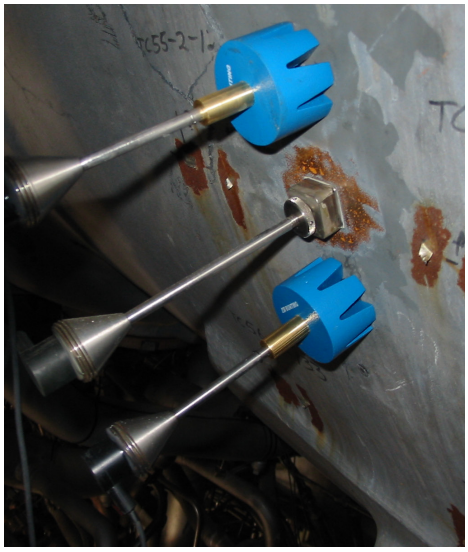
The ACTMS uses non-intrusive sensors, mounted on the case of the turbine by magnets or waveguides that transfer the cracking energy to the sensor while dissipating heat. The sensors are selected to detect cracking while overcoming the high background noise of the operating turbine. Typical GE, 7FA installations require 12 sensors in a conical array to detect cracking in stator rows 0 through 5, the arrangement for maximum coverage of the documented failure area.

The sensors are wired to a monitoring system, mounted outside the turbine enclosure. The monitoring system evaluates the signals from the sensors in real-time and determines which are cracking and which are operational artifacts.

Acoustic Emission, when employed with multiple sensors, is capable of not only detecting active flaws but locating their position in three dimensions. Using this location capability, the ACTMS software graphs the position of each cracking event and uses the graphical filter alarms to determine when multiple events are within a localized area, indicating activity within a single blade or section of blades. Alarms are then generated based on localized activity within a given period of time (rate) to overcome individual transient signals and false alarms.

Monitoring systems are connected to the plant operating network to alert operators and engineers to problems for follow-up inspections and remedial action. Alarm discrimination and outputs can be connected directly to the turbine SCADA system for warning and trip function.

For more information:
Please call 1-609-716-4000 or visit us on the web at www.mistrasgroup.com.

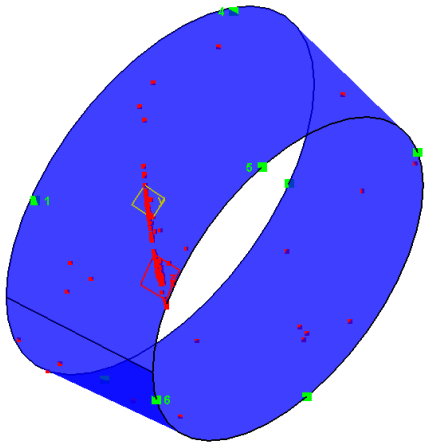


Sensors detecting cracking while overcoming high background noise of the operating turbine.

ACTMS System

The Acoustic Combustion Turbine Monitoring System includes all of the hardware and software for installation and integration on your turbine. Configurations are available in Class 1, Division 1 Intrinsically Safe and Non-intrinsically Safe designs.

- 12-Channel Computer Hardware
- Preamplifiers
- Preamplifier Junction Box
- Sensors
- Waveguides, threaded or magnet mount
- Software with crack detection and alarm output
- Cables
- Installation and Operation Manuals



Warning and trip alarm discrimination and outputs of turbine SCADA system.

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