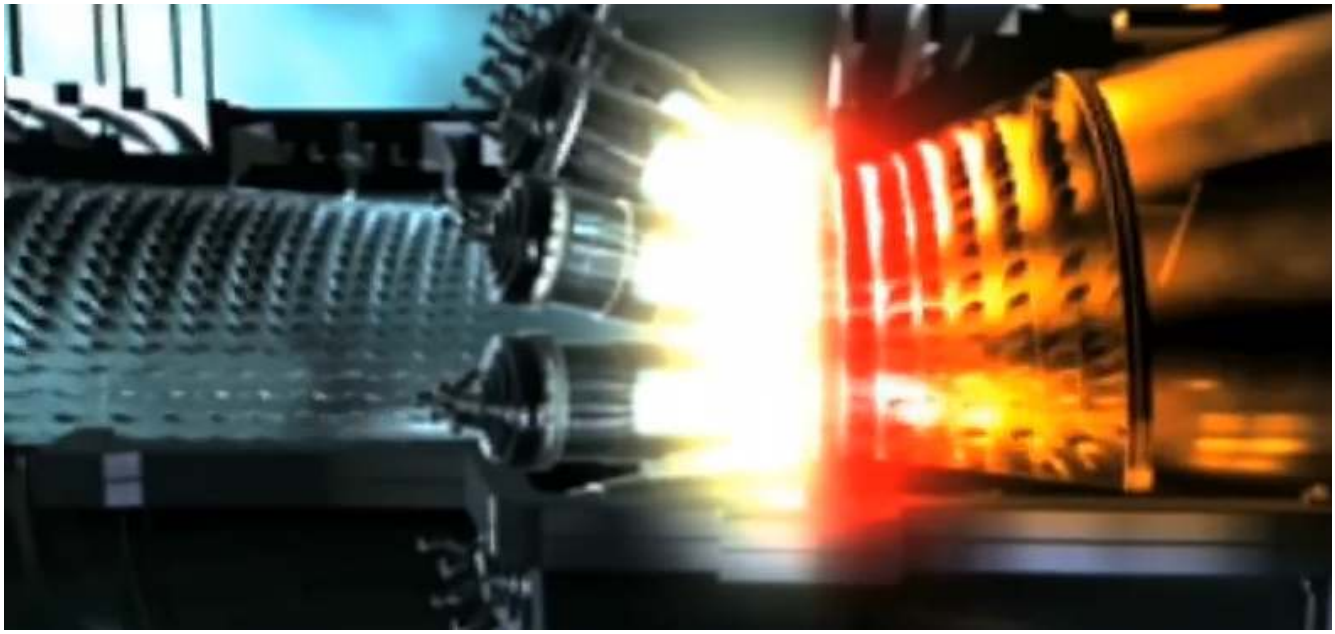
DAVIDSON®
INSTRUMENTS



Combustion Dynamics Monitoring using Temperature-Tolerant Fiber Optic Transducers

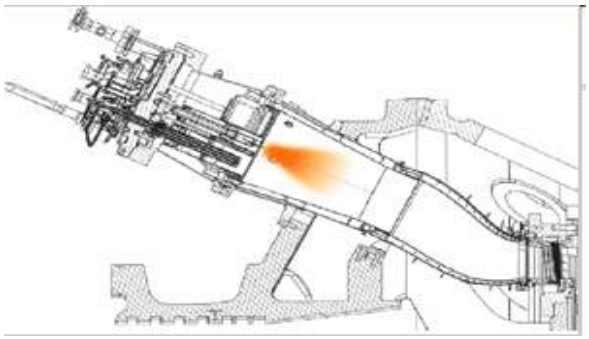
With over 1,000,000 hours of time in service, Davidson's patented temperature-tolerant dynamics instrumentation is the best way to measure combustion dynamics in GE, Mitsubishi, and Siemens frame engines. The sensors can tolerate 1200°F continuously and are based on rugged and reliable interferometric sensing technology. Davidson's system provides the earliest warnings of lean blowout and screech conditions and allows gas turbine operators to manage power generation across the load range at lower risk and with greater confidence than is possible with conventional instrumentation.

Davidson's CDMS transducers have been designed to be mounted directly on the turbine casing of GE Frame 7/9 engines and inside the Siemens 501 engines without the need for any modifications to the engines. A system can be installed by two men in three days during almost any outage.

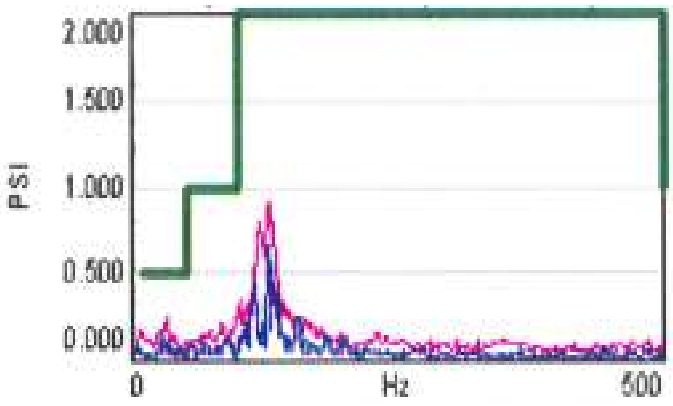
In the GE engines, the transducer projects through the casing and the sensor is positioned flush with the inside of the combustion liner. The transducer has a flexible tip to prevent damage due to thermal offset of the holes in the casing and the liner. In the Siemens engine, the flexible transducer probe is installed in the acoustic wave-guide located along side the combustion basket and positions the sensor flush with the inside of the combustion liner. By locating the sensor so close to the combustion liner, Davidson is able to measure combustion dynamics with greater fidelity and less distortion than other sensors.

Combustion Dynamics Monitoring

Stable combustion in large frame gas turbines is necessary for long term engine reliability and availability. Abnormal combustion dynamics are caused by combustion instabilities and are exhibited as pressure fluctuations or oscillations in the combustion zone of a gas turbine. Combustion dynamics are measured as the amplitude and acoustic frequency of the pressure oscillations.



Cross-Section of Gas Turbine Combustor



Combustion Dynamics Acoustic Spectral Analysis

Fractured Transition Piece Resulting from Abnormal Combustion Dynamics

Sudden changes in load, ambient temperature, humidity, and the Wobbe index of natural gas can cause combustion instabilities and lead to a number of problems including: auto-ignition, flashback, combustor blowout, abnormal combustion dynamics, and non-compliant emissions. High amplitude pressure oscillations or combustion instabilities at the resonant frequencies of critical engine parts can degrade hot section components, i.e., liners, transition pieces, and crossfire tubes, and ultimately destroy an engine.

Monitoring combustion dynamics continuously provides excellent engine health diagnostics, early detection of combustion instabilities, and can prevent serious damage to the hot flow path components in the engines.

Reliable continuous combustion dynamics monitoring can be integrated with advanced automated tuning and control systems and used to tune an engine to maintain emissions compliance consistent with optimization of engine output and maximizing the life of the engine. The signals can be monitored remotely via the internet allowing experts to provide engine diagnostics using predictive maintenance and other special diagnostic algorithms.

Why Use Davidson Fiber Optic Transducers

Davidson Transducers Can Take the Heat

Davidson's fiber optic transducers eliminate the need for and problems associated with acoustic wave-guides, purging systems, piezo-electric transducers, tuned cables, and charge amplifiers.

Davidson's sensors are positioned at the combustion liner because they can tolerate 1200°F. Direct measurement at the liner provides the highest fidelity and lowest distortion of the signals. Temperature tolerance enables the highest reliability and stability combustion dynamics measurements in gas turbines.

Davidson 7FA Transducer

The pressure sensing diaphragms inside the Davidson transducers are made of a high strength superalloy and are not subject to the need for periodic calibration when operating at 800° F because the mechanical properties of the superalloy are stable at these temperatures. Davidson transducers do not rely on piezoelectric crystals which degrade over time at elevated temperatures.

Unlike piezoelectric transducers, Davidson transducers are unaffected by vibrations and thermal transients. Since there are no active electronics associated with the sensing mechanism, there are no frequency dependent phase delays.

Davidson's instrumentation has integral health monitoring algorithm that stops reporting if the signal quality from a transducer is compromised. This enables the instrumentation to be integrated with advanced automated tuning and control systems.

The instrumentation can be configured for analog or digital output and is compatible with conventional spectrum analyzers and CDMS monitoring software. The output of the system can be displayed on a monitor showing separate alarm thresholds for cold tones, hot tones, and screech tones.

Davidson Fiber Optic Measurement Instrumentation

Davidson is committed to manufacturing products of the highest quality and reliability for the most demanding industrial applications.

Fiber optic sensors offer the following benefits over conventional electronic sensors:

- **Tolerant to High Temperatures and Corrosive Environments**
- **Safe in Class 1, Division I Explosion Hazardous Areas**
- **Immune to Electromagnetic Interference (EMI)**

Additional benefits of Davidson's fiber optic sensing systems:

- **Low installed cost and total life cycle cost**
- **Flat Frequency response from DC to 10kHz**
- **High resolution and long term stability**
- **System diagnostics that eliminate false readings**
- **Seamless interface with analog and digital data acquisition systems**
- **No frequency dependent phase delays**

For more information about Davidson Instruments and our fiber optic sensing systems, visit our website at www.davidson-instruments.com

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