Rotating Detonation Engines  Internal Combustion Engines  Gas Turbines

Laser-Absorption-Spectroscopy Techniques

Scanned-Wavelength Direct Absorption

\[ I(t) \text{ (Absorbing Gas)} \]

\[ T, P, X, \text{ and } U \text{ information in shift and width of lineshape} \]

\[ A = \int \alpha(v) dv = S(T, P, X) \]

Scanned-Wavelength-Modulation Spectroscopy (WMS)

Adantages of WMS

- Independent of \( I(t) \) & emission
- Well suited for environments with low optical throughput
- Well suited for high-P gases
- Noise rejection @ high-f
- Frequency multiplexing
- Applicable to most tunable lasers

Temperature Measurements Behind Ignition Blast

\[ 25 \text{ kHz bandwidth} \]

\[ T \text{, } 0.02 \text{ cm to } 10 \text{ cm} \]

Temperature & \( \text{H}_2\text{O} \) Measurements During Quasi-Steady Burner Operation

\[ 3.5 \text{ kHz} \]

\[ T \text{, } 0.05 \text{ cm to } 5 \text{ cm} \]

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Results

Experimental Setup for Measurements in Burner

- Ignition Blast
- Steady Operation
- Top View of Burner

Temperature Measurements Behind Ignition Blast

- SE-LAS sensor provides temperature measurements at 50 kHz with accuracy and precision equal to LOS sensor despite losing 99% of incident laser light

Temperature & \( \text{H}_2\text{O} \) Measurements During Quasi-Steady Burner Operation

- SE-LAS sensor provides high-fidelity measurements of scanned-WMS-2f/1 spectra, temperature, and \( \text{H}_2\text{O} \) mole fraction
- Accuracy and precision of SE-LAS sensor validated against LOS sensor at wall (i.e., sensor housing) temperatures up to 575 K
- No degradation in sensor performance was observed over 12 minute fired test