COMBUSTION MEASUREMENT TECHNOLOGIES

FLAME KERNEL VELOCITY EVALUATION
COMBUSTION STABILITY UNDER FLOW AND EGR INFLUENCE

Reduce Cyclic Combustion Fluctuations: Flow and EGR Influence on Flame Kernel Formation
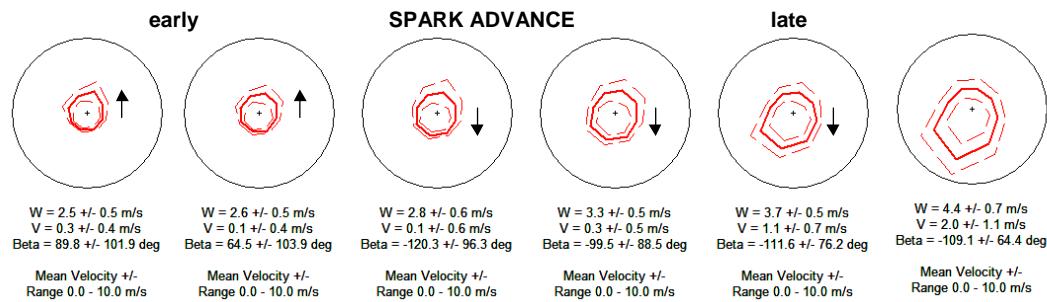
Task / Challenge

Higher than usual IMEP fluctuations in low and part load, insufficient transient response, cylinder to cylinder variations

Possible Root Cause

Flame kernel formation requires a well defined flow field (turbulence and net convective flow) to result in reproducible flame propagation and combustion. Flow field fluctuations, especially in medium and low load can result in poor flame kernel formation and in increased IMEP variations.

Test Procedure
Measurement and evaluation of flame kernel growth (how fast and in which direction) under influence of spark timing, air and EGR variation.

early		SPARK ADVANCE		late	
W = 2.5 +/- 0.5 m/s V = 0.3 +/- 0.4 m/s Beta = 89.8 +/- 101.9 deg	W = 2.6 +/- 0.5 m/s V = 0.1 +/- 0.4 m/s Beta = 64.5 +/- 103.9 deg	W = 2.8 +/- 0.6 m/s V = 0.1 +/- 0.6 m/s Beta = -120.3 +/- 96.3 deg	W = 3.3 +/- 0.5 m/s V = 0.3 +/- 0.5 m/s Beta = -99.5 +/- 88.5 deg	W = 3.7 +/- 0.5 m/s V = 1.1 +/- 0.7 m/s Beta = -111.6 +/- 76.2 deg	W = 4.4 +/- 0.7 m/s V = 2.0 +/- 1.1 m/s Beta = -109.1 +/- 64.4 deg
Mean Velocity +/- Range 0.0 - 10.0 m/s	Mean Velocity +/- Range 0.0 - 10.0 m/s	Mean Velocity +/- Range 0.0 - 10.0 m/s	Mean Velocity +/- Range 0.0 - 10.0 m/s	Mean Velocity +/- Range 0.0 - 10.0 m/s	Mean Velocity +/- Range 0.0 - 10.0 m/s

The example shows the response of flame kernel growth (mean +/- standard deviation) to a spark timing sweep.

Action: Measurement of flame kernel formation by means of VisioFlame sensor. Test variations to generate speed – load – spark timing maps

Data: Flame kernel data for tested variants

Result: Identification of operating areas with good and poor flame kernel stability.

Benefit: Understanding of necessary actions on in-cylinder flow

EGR Influence

Residual gas near the spark plug can have similar influence on flame kernel growth as the flow field. Whenever appropriate, flame kernel measurements under variation of EGR levels should be included in VisioFlame measurements.

Action: Measurement of flame kernel formation by means of VisioFlame sensors. EGR variation tests

Data: Flame kernel data for tested variants

Result: Identification of operating areas with good and poor flame kernel stability

Benefit: Understanding of necessary actions on EGR calibration

Benefit in Engine Development Process
- have direct data on the influence of flow field / EGR on flame kernel growth
- understand action of (tumble) airflow on flame propagation
- understand effect of valve timing on flame kernel
- see influence of spark electrode position on flame propagation
- evaluate necessity and chances for modifications

Technical Data

- VisioFlame spark plug sensor together with 8 channel optical signal recorder
- VisioFlame signal evaluation software license
- spark plug sensor applicable in any type of engine, NA or TC
- synchronized operation with indicating system
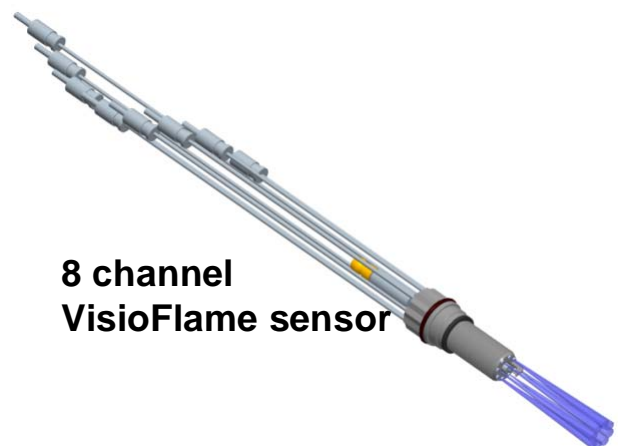
8 channel VisioFlame sensor

System requirements

- sparkplug sensor with 8 fiber optic channels
- fiber optic cables connecting sensor to VisioFEM
- Two VisioFEM gasoline signal converters, cascaded for 8 channel operation, analog voltage out
- Indimodul signal recorder, 8 analog voltage input channels
- IndiCom / CONCERTO user interface with VisioFlame Kernel evaluation license
- PC or laptop with IndiCom / CONCERTO license