COMBUSTION MEASUREMENT TECHNOLOGIES

DIESEL ENGINES
THERMOVISION FLAME IMAGE EVALUATION

Task / challenge

The Soot – NO\textsubscript{x} trade off in diesel combustion is decided by fuel injection, air and EGR management and combustion chamber geometry. How the flame succeeds or fails in burning at desired temperature and with best utilisation of the available air is of central concern to combustion development. New options for injection systems, actuators and combustion chamber design create the growing need to directly see, measure and compare flame data.

Inspecting flames in diesel engines

Endoscopic flame imaging techniques are well established, see AVL FS MIC D 01. Transferring flame photographs into numerical data for variants comparison is achieved with "Thermovision" software modules.
Two Color Method flame image evaluation

Flame brightness and spectral ratio of flame radiation are evaluated to yield flame temperature and concentration of radiating soot particles. This well established „Two Color Method“ is applied for every color pixel of the image field.

Data reduction: Areas of interest

For all practical engineering purposes, the heterogeneity of a flame is best matched by defining areas of interest for image data reduction. This is done with rectangular sectors as shown in the photograph, or with arbitrary area definitions.

Examples on soot formation – oxidation

Raising EGR levels at otherwise constant conditions yields higher soot emissions. How does soot concentration in the flame respond to such variations: soot formation at an EGR level of 15% stays unaffected, oxidation, however, is significantly impaired. This gives more soot particles the chance to escape unburnt and thus contribute to engine out emissions.

Nozzle opening pressure:

Less obvious than the EGR result is the influence of raising nozzle opening pressure (NOP). The more forceful start of injection first increases soot formation, but then yields faster soot burn off.

Action: Diesel flame imaging with calibrated endoscope and camera. 
Data: Crank angle sequences of diesel flame distribution in combustion chamber. „Thermovision“ data reduction for areas of interest
Result: Flame temperature (not shown here) and soot concentration traces for user selected areas of interest of the combustion chamber

FS MIC D 02
Benefits

- Compare emissions relevant flame data within precisely selected areas of interest
- Understand variants influence on basis of flame data
- Understand local effects inside the combustion chamber
- Optimise diesel combustion system under direct knowledge of flame effects
- Have faster understanding of new combustion system features

Technical Details

- VisioScope for endoscopic flame imaging, see AVL FS MIC D 01
- Thermovision software licence for evaluation of calibrated color flame images with „Two Color Method”
- User defined area-of-interest definition
- User defined crank angle window definition
- Automatic data evaluation for selected area of interest and crank angle windows

Project packages

- Preparation of endoscope access in cylinder head
- Measurement and evaluation services
- Measurement packages: per week
- VisioScope and Thermovision training and commissioning