

Visualization of soot formation in a DISI engine for different fuel injection strategies and in cold start conditions with the aid of endoscopic color imaging

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Full cycle analysis: Spray, Ignition and Combustion, applied on a 6-cylinder GDI engine

Motivation:

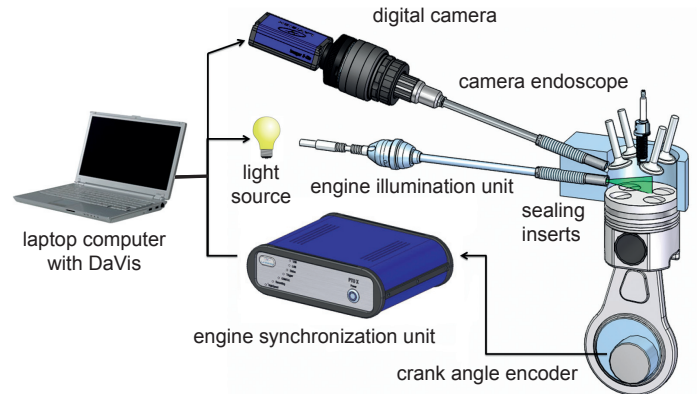
- in cylinder visualization of soot formation under transient operation
- interaction of spray and combustion within individual cycles with the aid of high-speed crank angle resolved image recording
- intuitive soot visualization with colour imaging

Engine-in-the-Loop

test bed setup:
 Coupling of a GDI 6-cylinder in-line engine with a 3D vehicle model for virtual test drive

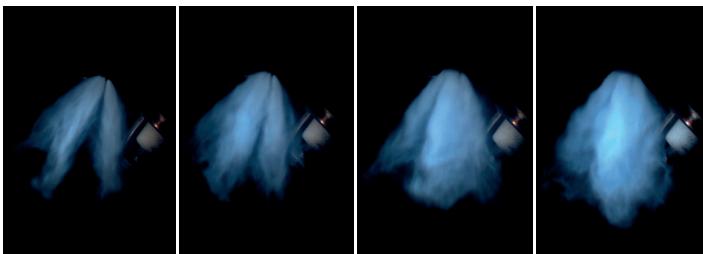


Endoscopic Imaging: Setup EngineMaster *inspex*



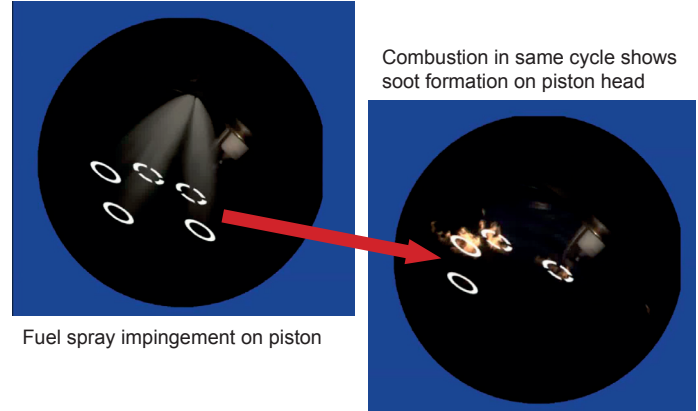
Spray analysis: Variation of start of injection (SOI)

Images at SOI +6°CA



Early SOI → Standard SOI

Soot formation as a direct result of piston wetting during fuel injection at early SOI



Fuel spray impingement on piston

Combustion in same cycle shows soot formation on piston head

Contribution of individual combustion cycles to cold-start soot emissions

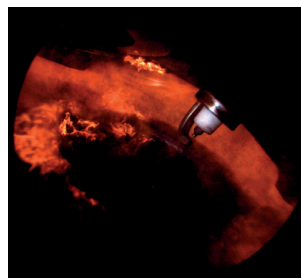
Fired cycle #1



Pool fire on cold piston

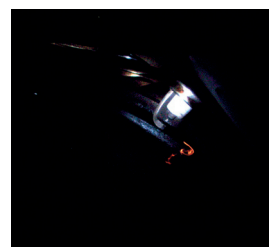
Crank angle locked recording at 25°CA aTDC

#2



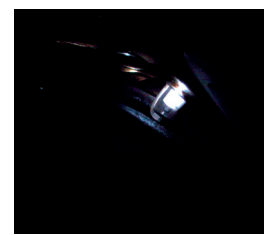
Soot formation near cold walls

#3



Residual diffusion flames

#4



Clean combustion

References:

- [1] Disch, C., Kubach, H., Pfeil, J., Koch, T., Spicher, U., Thiele, O., Donn, C., Schyr, C., "Cycle-resolved combustion diagnostics of a direct injection gasoline engine in transient operation," 11th International Symposium on Combustion Diagnostics, 2014
- [2] Disch, C., Pfeil, J., Kubach, H., Koch, T., Spicher, U., Thiele, O., "Experimentelle Untersuchungen zur Entwicklung des kurbelwinkel aufgelösten Brennraumluftverhältnisses im Transientbetrieb eines Ottomotors mit Direkteinspritzung", published in Ladungswechsel im Verbrennungsmotor, 7.MTZ-Fachtagung, 2014
- [3] Disch, C., Pfeil, J., Kubach, H., Koch, T., Spicher, U., Thiele, O., "Experimental Investigations of a DISI Engine in Transient Operation with Regard to Particle and Gaseous Engine-out Emissions", JSAE 201509125, 2015.

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