Design of a Novel Gasoline Particulate Filter Aging Method

Stefan Sterlepper, Johannes Claßen, Prof. Dr. Stefan Pischinger: Institute for Combustion Engines VKA, RWTH Aachen University
Jim Cox, Dr. Michael Görgen, Helmut Lehn, Dr. Johannes Scharf: FEV Europe GmbH
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Motivation

95 % of current calibration projects at ***FEV*** with GPF

75 % of current GPFs are coated (for EU/CN)

75 % of GPFs are in close-coupled position

- Driving style
- Driving profile
- Ambient conditions
- Oil specifications

Low soot loads | Hot exhaust conditions | Interactions with coating

Backpressure impacts

Legend:

- Market study (FEV-internal) → Trend 2018+
- Impacts during component lifetime
- Diesel experience not applicable

Conclusion

- A market study (FEV-internal) shows a high **variety** of gasoline particulate filters (GPF) swiftly entering new vehicles
- There is not “one representative ash” (neither for Gasoline nor for Diesel)
- Ash for accelerated aging has to be oil-derived
- An appropriate accelerated aging method needs high **flexibility**

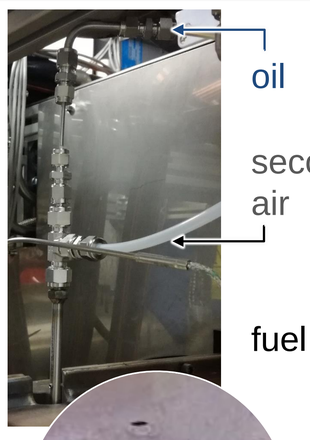
System choice

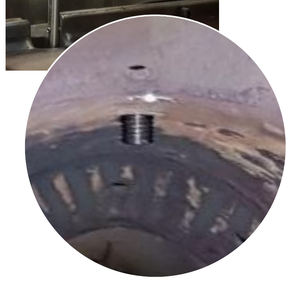
	Vehicle	Engine + modified oil control rings	Engine + fuel doping	Burner + fuel doping	Burner + oil injection
Likelihood to find this ash in vehicles	++	+	−	To be investigated	To be investigated
Acceleration potential / oil volume flow variability	−	+	+	+	++
Ash formation adjustability	−	−	−	−	+
Reproducibility of subsequent agings	−	o	o	o	To be proven

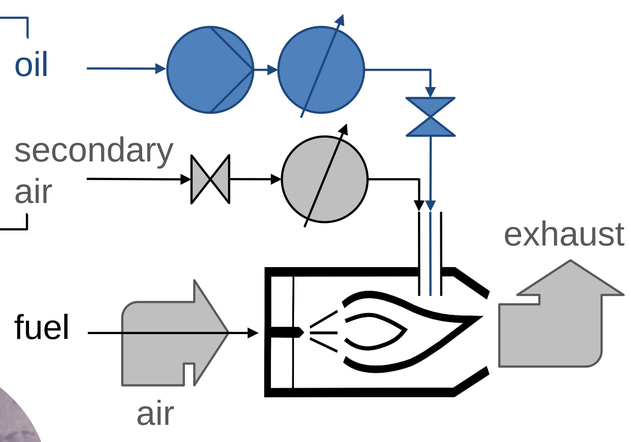
Chosen approaches

- The burner test bench with dedicated oil injection uniquely allows to **influence the ash formation**
- Burner with fuel doping and oil injection investigated for GPF aging

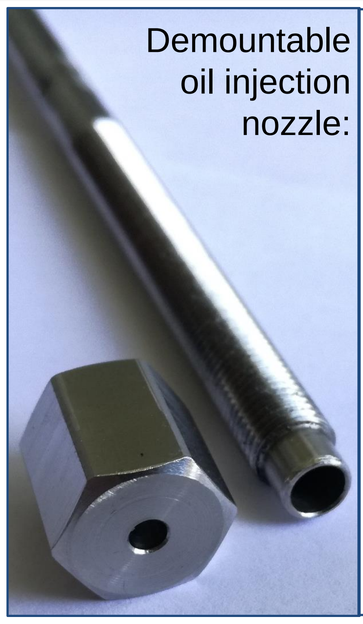
System definition

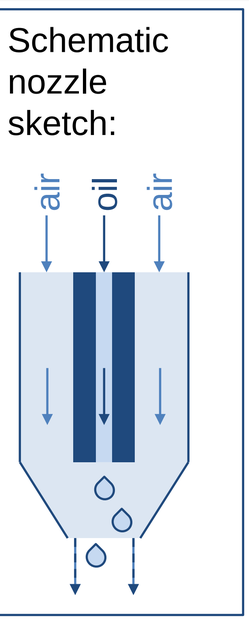




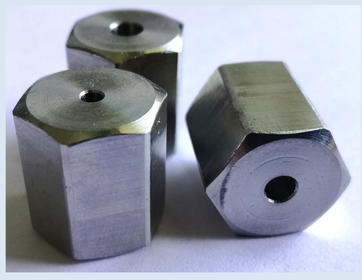


Oil-air-feed screwed through burner wall into combustion chamber



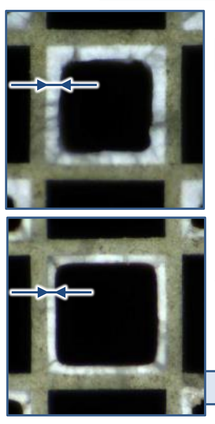


- A oil feed design, which is independent from the fuel and (primary) air feed, enables flexible **control of the ash content** in the exhaust gas
- Secondary air control and different nozzle designs enable **adjustment of the oil spray pattern**



Rapid ash loading results

	m_{ash}	$dp_{ash(300)}$
Fuel doping	12.2 g	~22.4 mbar
Oil injection	9.2 g	4.2 - 9.0 mbar
Vehicle reference [1)]	12.9 g	~ 6.5 mbar

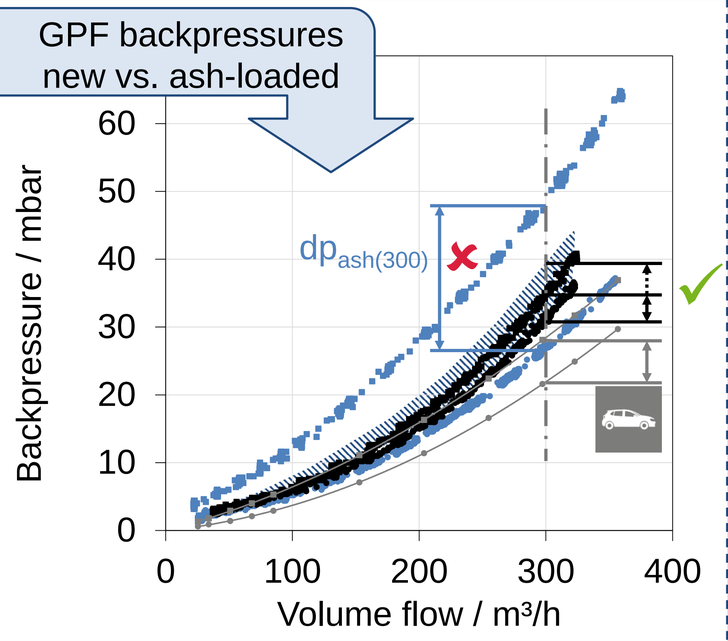


1)

Comparison of 2 agings: exhaust mass flow * 3 & final ash load ≈ const. →wall ash thickness ↘

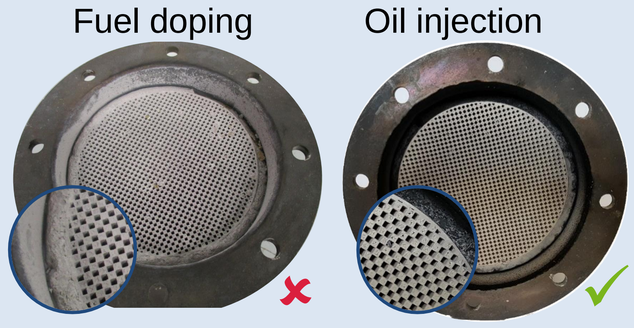
Exhaust mass flow variations enable **shaping the wall-to-plug-ash ratio**

GPF backpressures new vs. ash-loaded



- The oil-injection-GPF does not show the (unrealistic) thick white ash layer known from fuel doping for rapid ash loading

Fuel doping | Oil injection



- Backpressure results **indicate a high comparability** of burner- and vehicle-generated ash loadings

Outlook

Next steps, starting in 07/2018

dp Backpressure stability in dynamic RDE cycles → Detailed ash laboratory analysis → Combination of ash loading and thermal aging

- Proof of the burner method’s capability to **adjust the ash production** to multiple vehicle-representative ashes
- Fundamental GPF aging research

Institute for Combustion Engines
RWTH Aachen University
Forckenbeckstraße 4
52074 Aachen
www.vka.rwth-aachen.de

Contact:
Stefan Sterlepper
Sterlepper_s@vka.rwth-aachen.de

FEV Europe GmbH
Neuenhofstraße 181
52078 Aachen
www.fev.com

1) Vehicle reference and SEM pictures by Corning. The authors thank Corning for the valuable contribution.