Effect of Jatropha based Biodiesel, on engine hardware reliability, emission and performance

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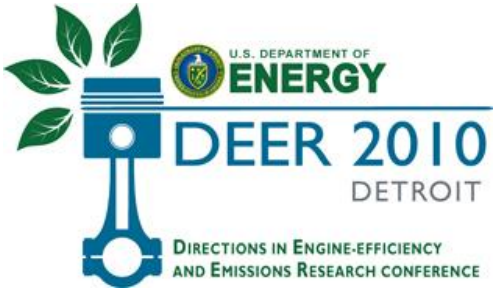


Project Summary

Cooperation among:
- GM Powertrain Europe
- GM India
- India's Central Salt & Marine Chemicals Research Institute (CSMCRI)

Jatropha Plantation

Jatropha Seeds

Biodiesel

Jatropha is a drought-resistant, non-edible plant that can be grown on marginal land

6 Opel Corsa equipped with GM 1,3L Euro4 diesel engine and Under Floor DPF

Driving Cycle Main Characteristics

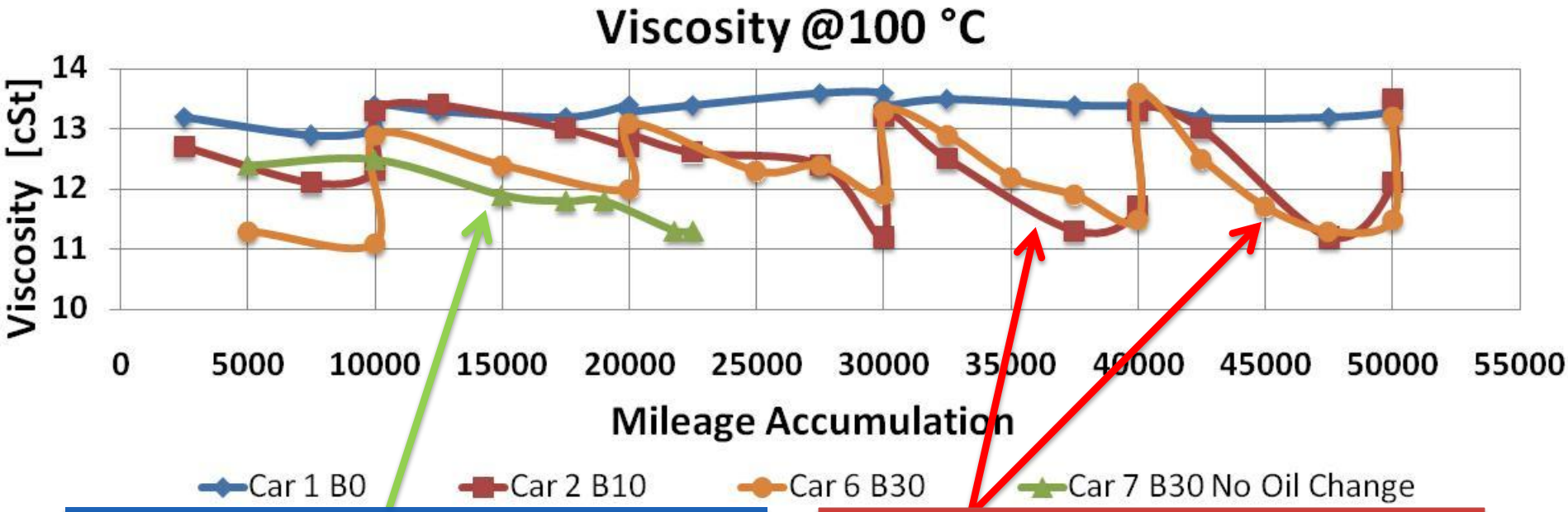
Target Mileage	Car	Cycle	Mileage per Day	Total Mileage per Day	Days per Week
40000 [km]	All Cars	City	50 [km]	250 [km]	6
		Highway	180 [km]		
		Hill	20 [km]		
10000 [km]	All Cars	City	50 [km]	250 [km]	2
		Highway	180 [km]		
		Hill	20 [km]		

Average vehicle speed during City Cycle	33 [km/h]
Average vehicle speed during Highway Cycle	80 [km/h]

Fuel and oil samples were collected every 2500 [km]

Emission and Performance tests were performed at 25k and 50k [km]

Oil samples analysis results



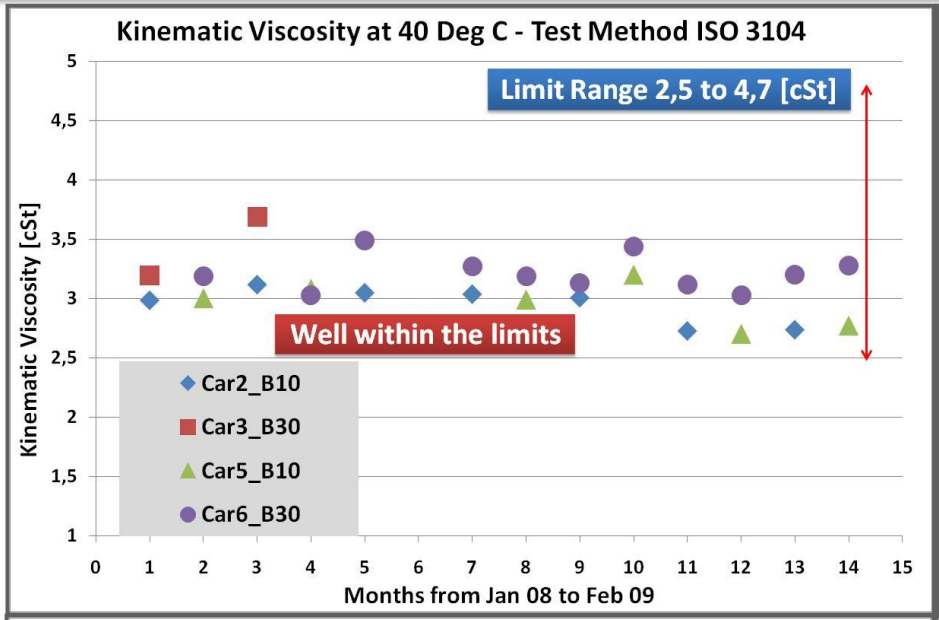
Abnormal viscosity decrease for B30 fueled car with oil change interval of 25k km

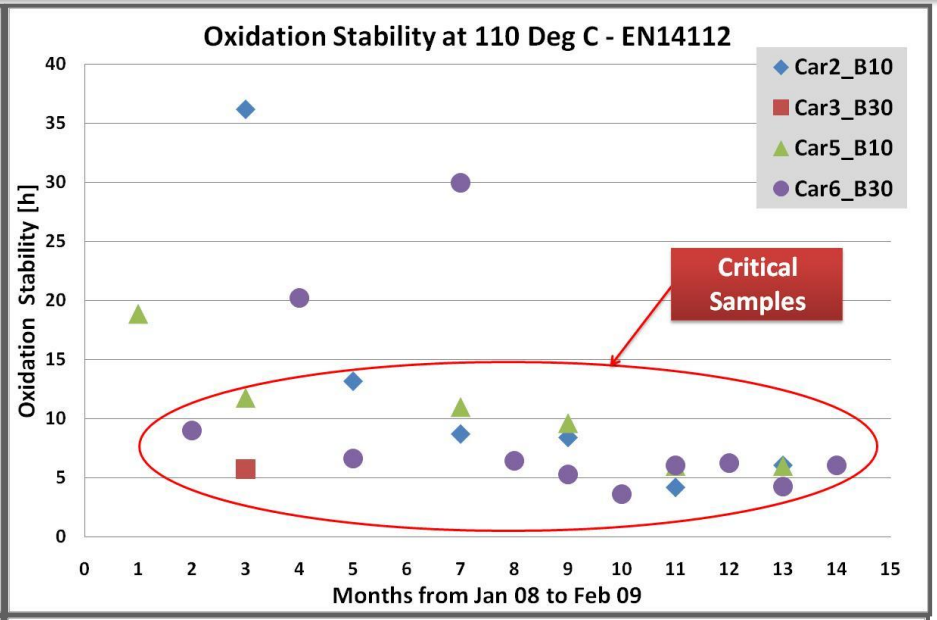
The viscosity trend for B30 car is very strong. The oil viscosity of this cars tend to decrease quickly but, even extending the oil change interval (up to 25k km), it remains within the acceptable limits in absolute values

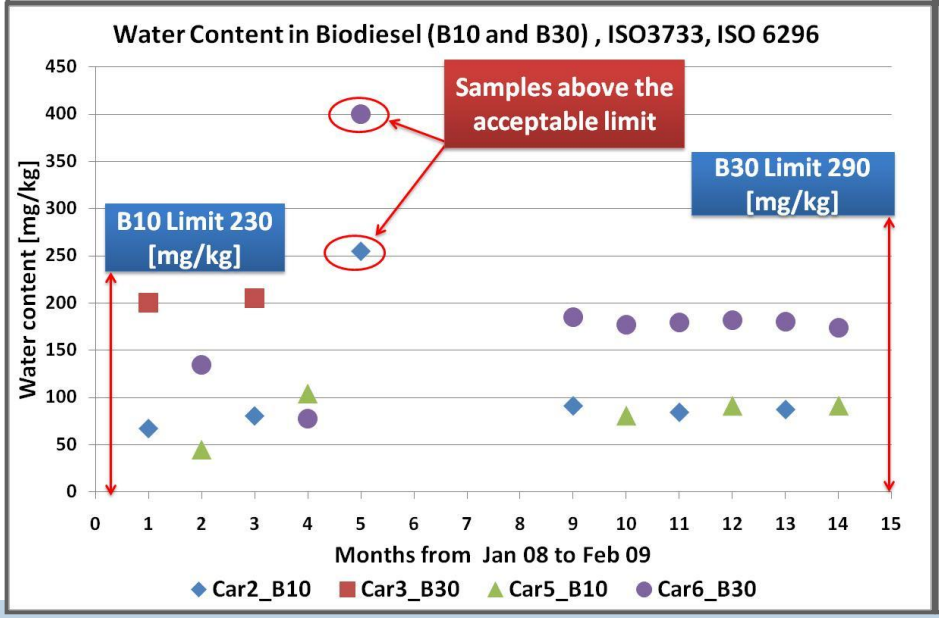
Abnormal viscosity decrease for B10 and B30

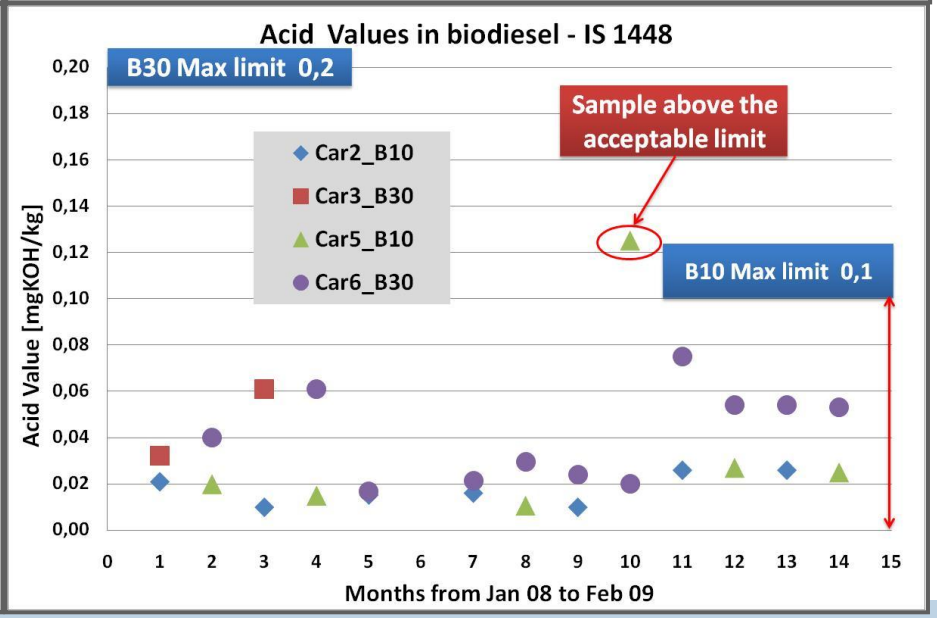
The viscosity trend for B10 and B30 cars is very strong. In particular the oil viscosity of those cars tend to decrease quickly although it remains within the acceptable limits in absolute values because the oil change interval was set to 10000km in accord with Indian service recommendation

Fuel samples analysis results

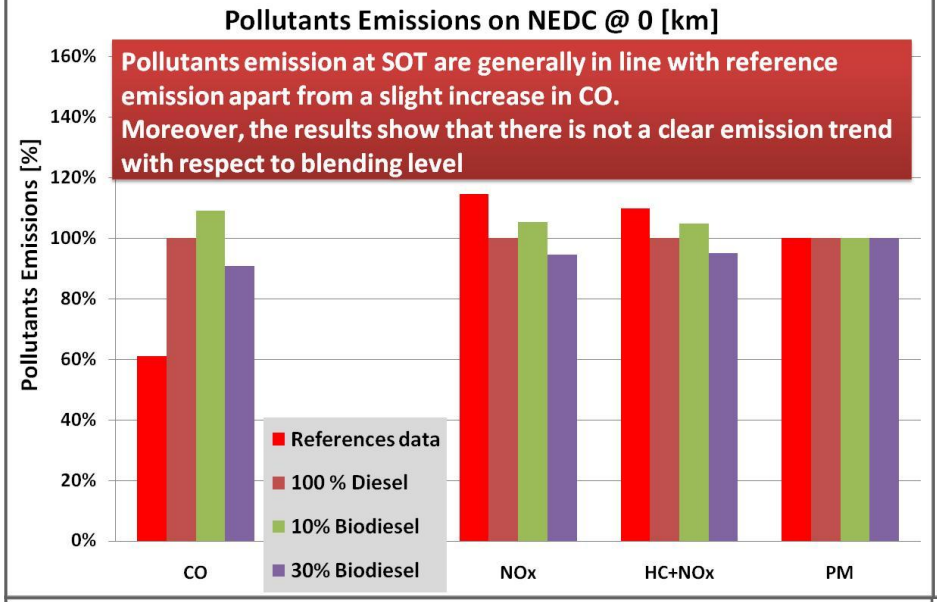


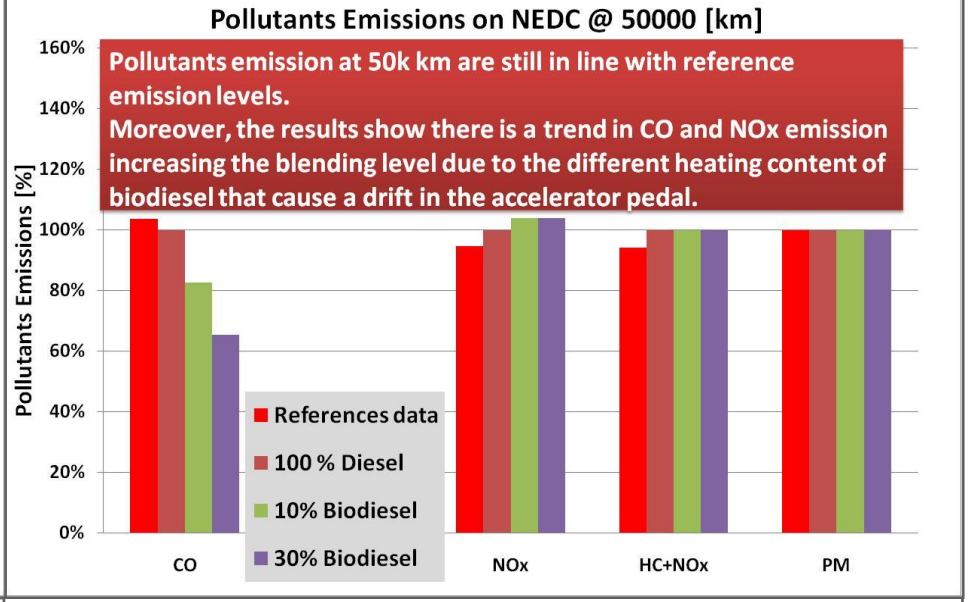


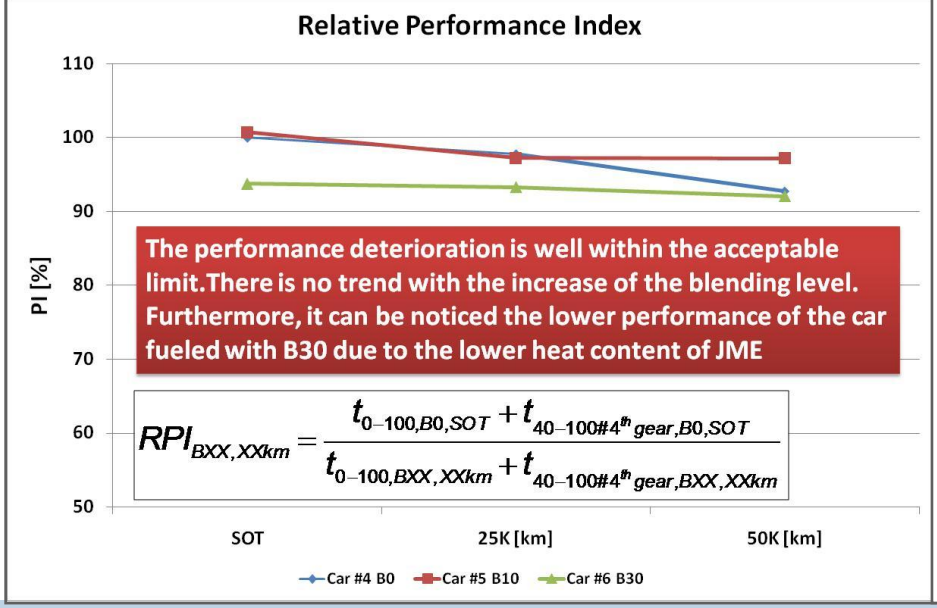


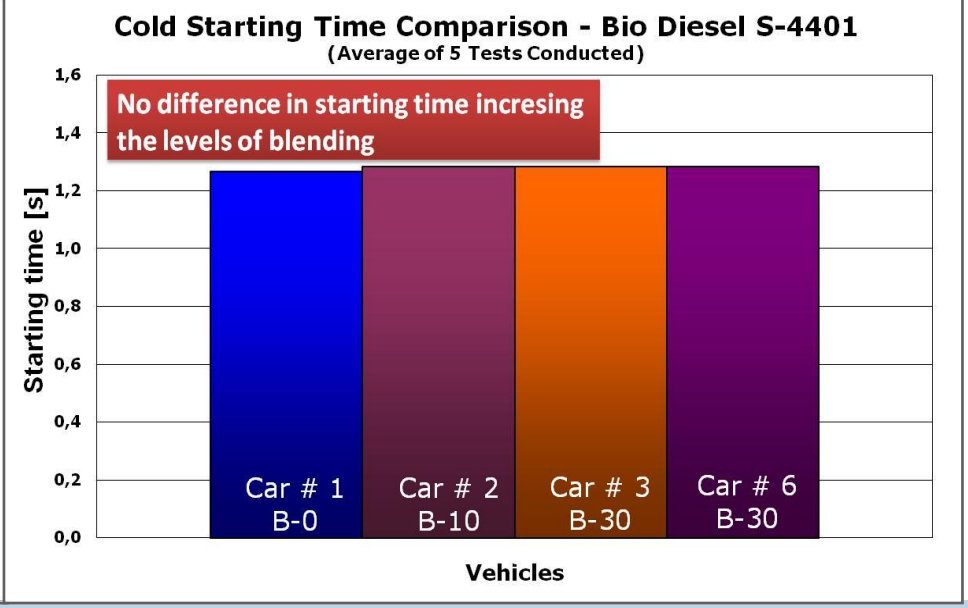


NEDC Emission Records









Teardown results

B0 | B10 | B30



Throttle Body



EGR Ejector

Teardown results

B0 | B10 | B30



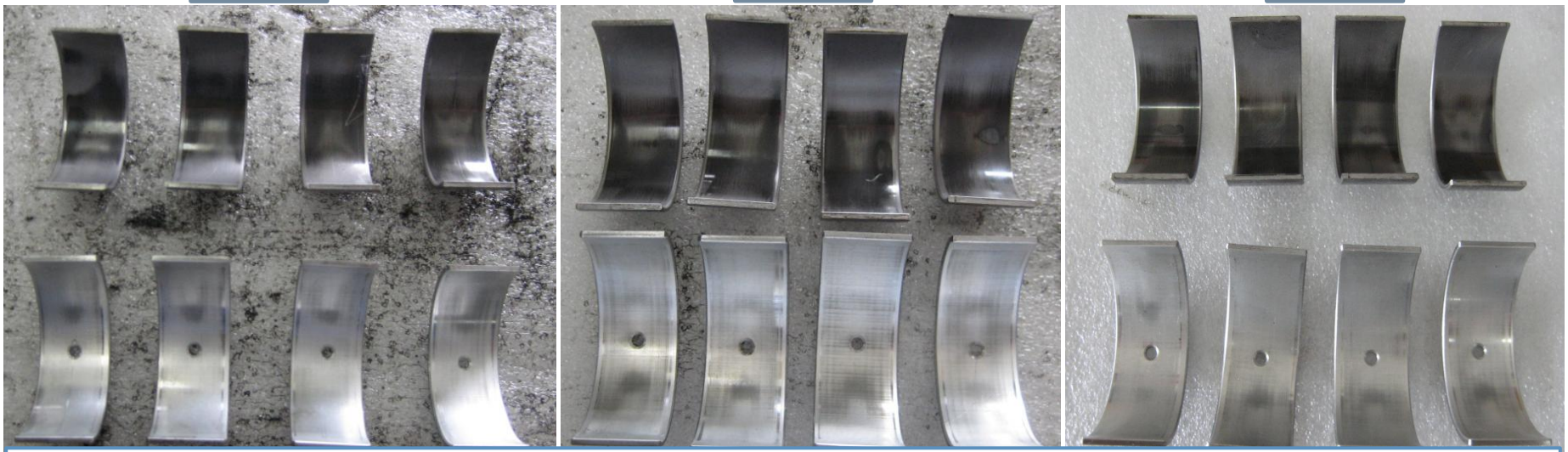
Pistons



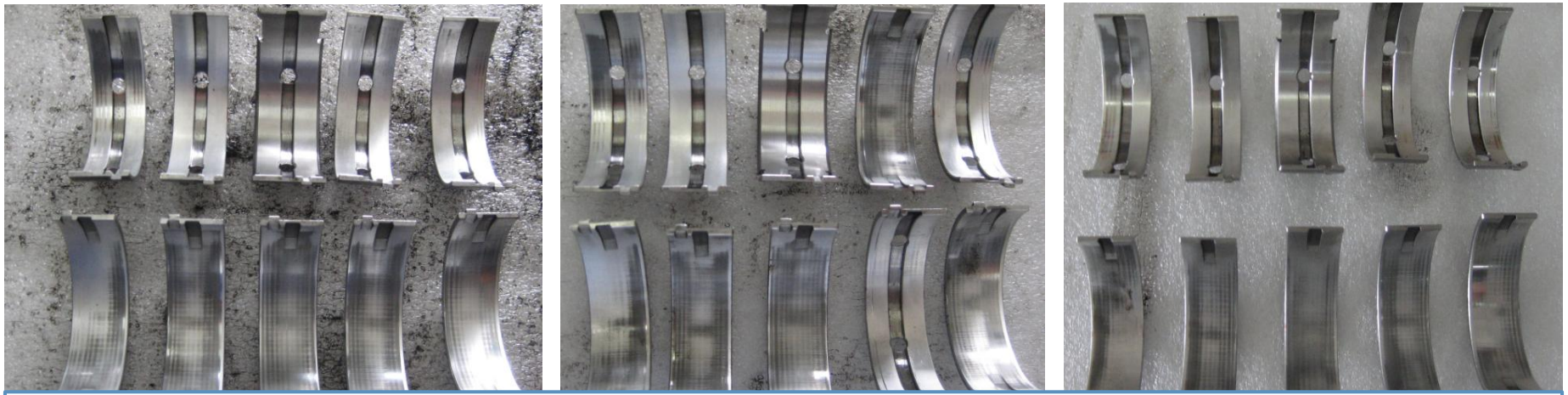
Intake valves

Teardown results

B0 | B10 | B30



Crankshaft Bearings



Connecting Rod Bearings

Teardown results

B0 | B10 | B30

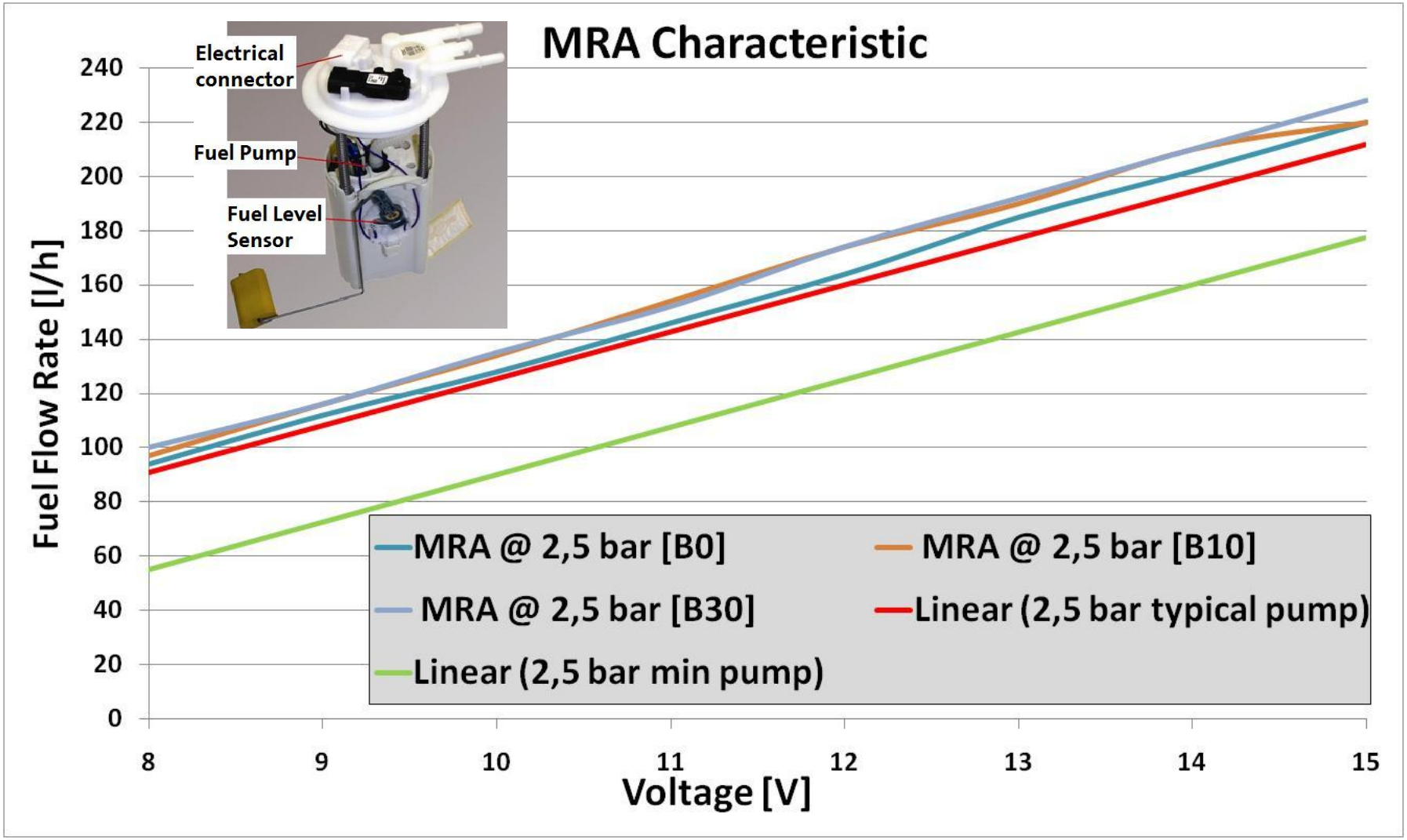


Injectors



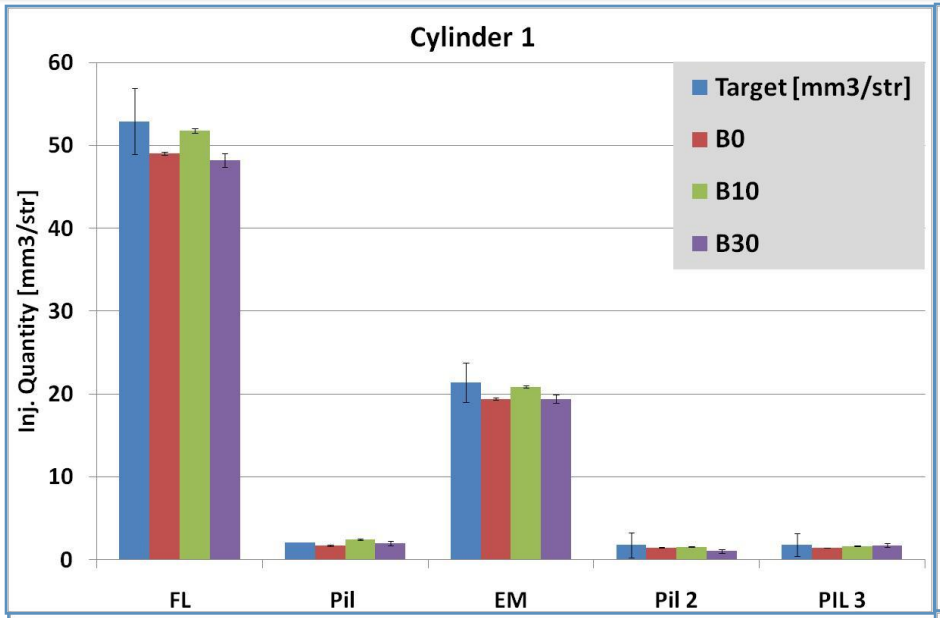
Oil Pump Rotor

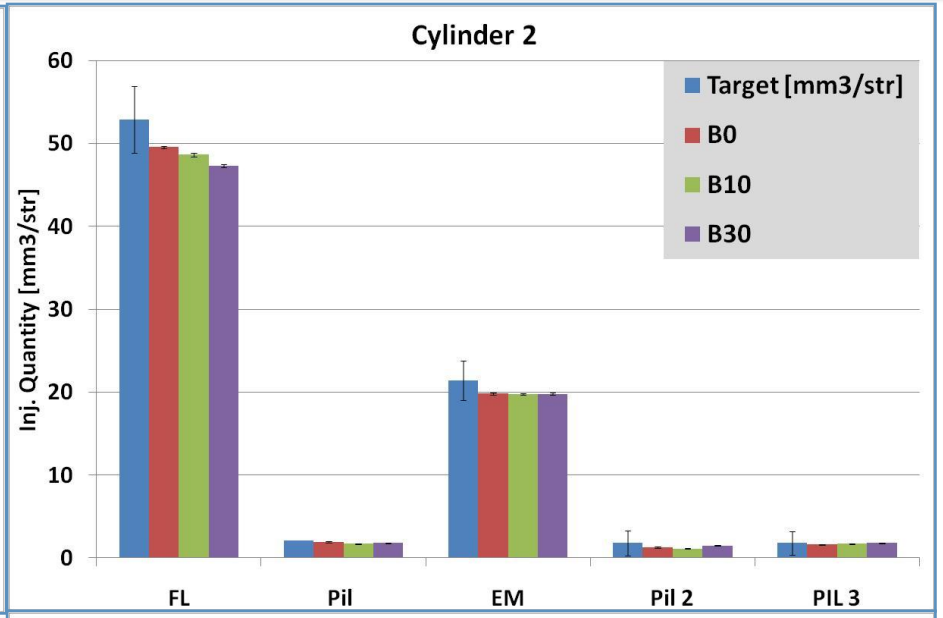
Technical report on MRA (Module Reservoir Assembly)

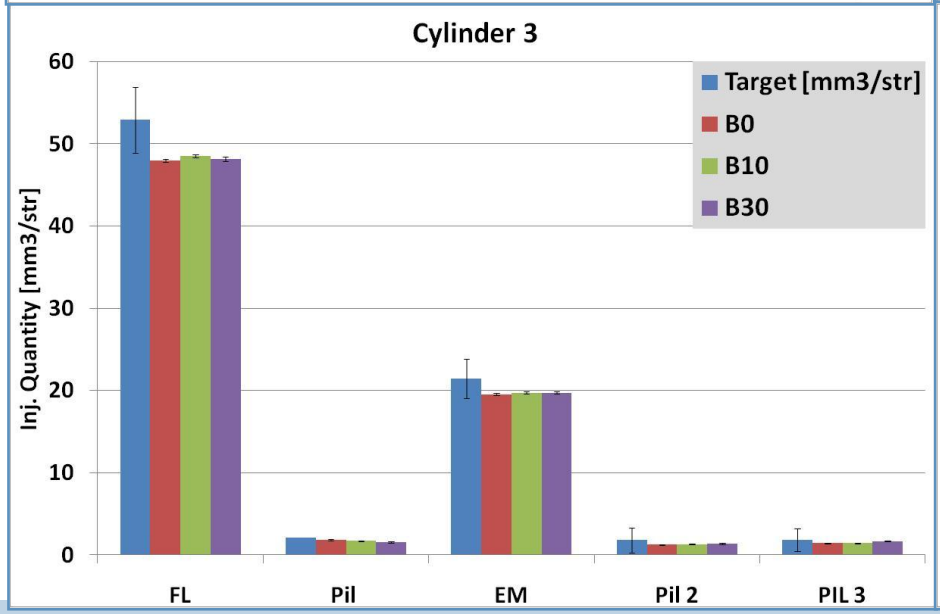


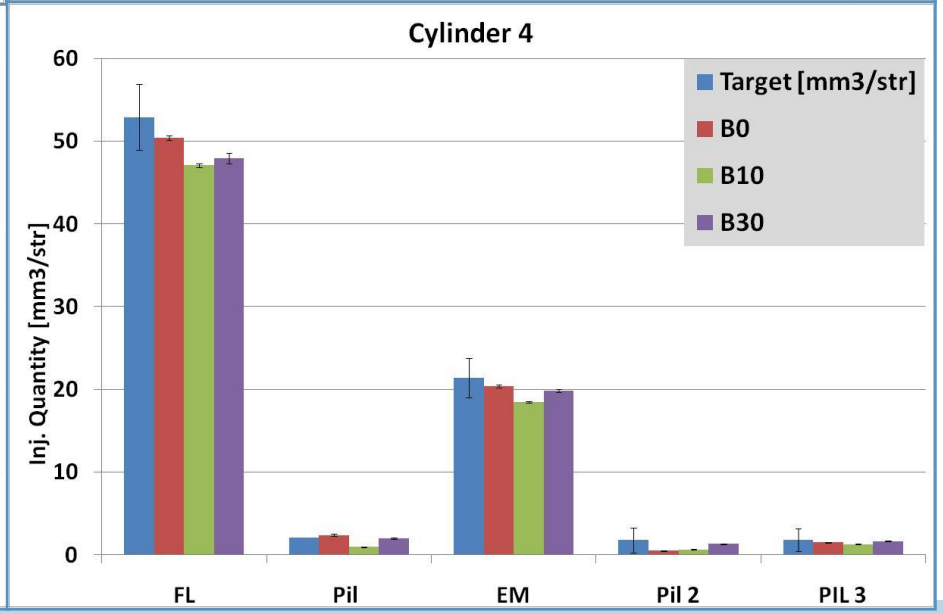
There is no Performance degradation in B0/B10/B30 MRAs

Technical report on B0,B10 and B30 FIS - Bosch CRI2.2+

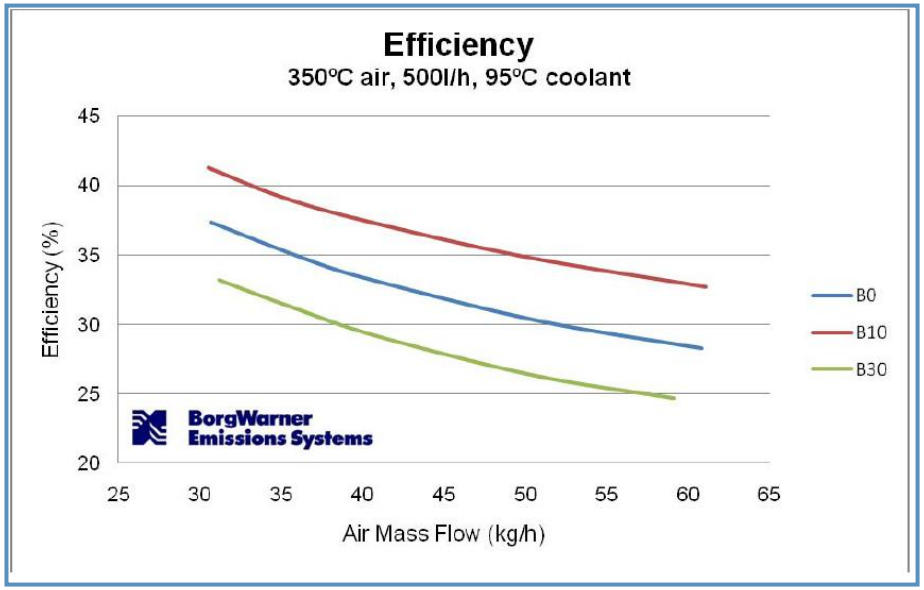








Technical report on EGR Cooler – BorgWarner



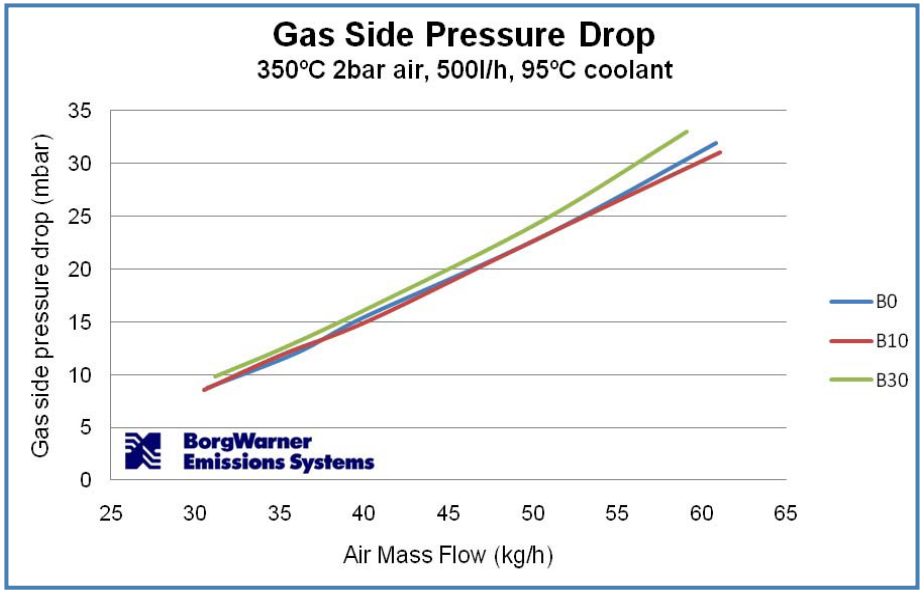
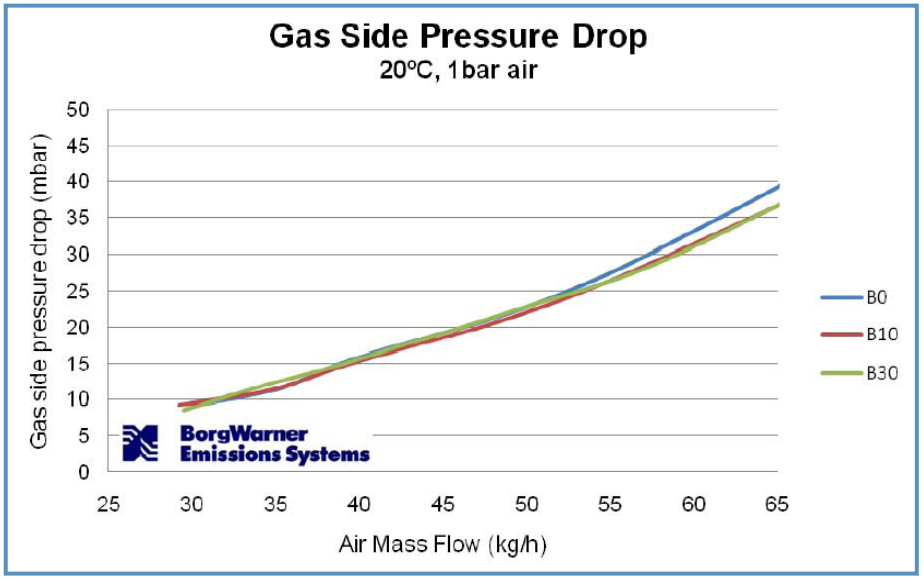


Image 10: B0 EGR Cooler Internal Aspect

Image 11: B10 EGR Cooler Internal Aspect

Image 12: B30 EGR Cooler Internal Aspect



Technical report on Turbo Charger - BW

B0

B30

B30 TC shows increased corrosion at the VGT mechanism.

Technical report on Turbo Charger - BW

It can be clearly seen the prints from vane lever on deposits

B30

B30

Deposit build up to 0.5mm.

Increased corrosion probably due to low oxidation stability of biodiesel that in turn leads to higher acidity and corrosion capability.

Technical report on Turbo Charger - BW

B0

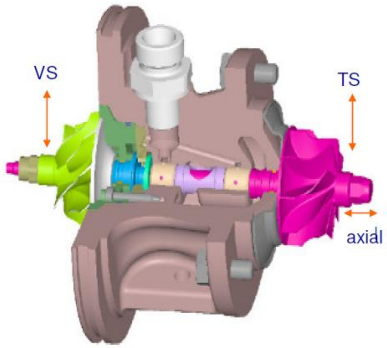
CS

TS

B30

CS

TS



Clearance check core

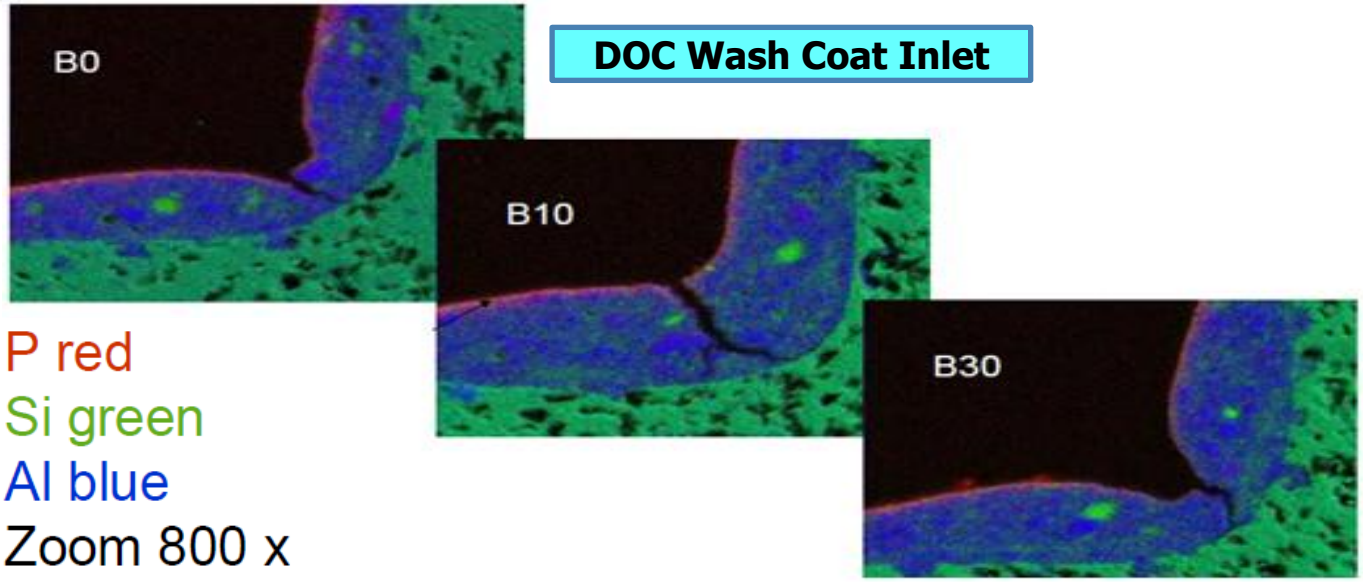
radial
CS = 0.34 mm
TS = 0.33 mm
Axial = 0.07 mm
remark: normal plays

Slightly higher wear for B30 TC (2-3 µm vs. 1-2 µm for B0)

Untypical jelly build up on thrust bearing for B30 TC

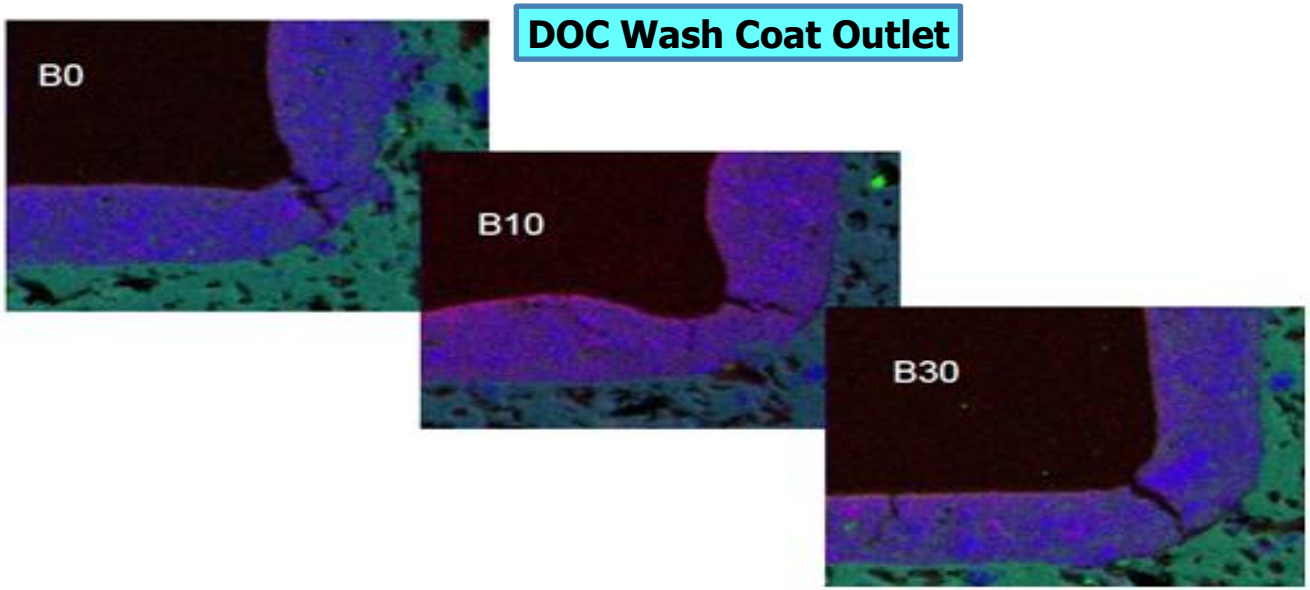
Technical report - Diesel Oxidation Catalyst – BASF

DOC Wash Coat Inlet



P red
Si green
Al blue
Zoom 800 x

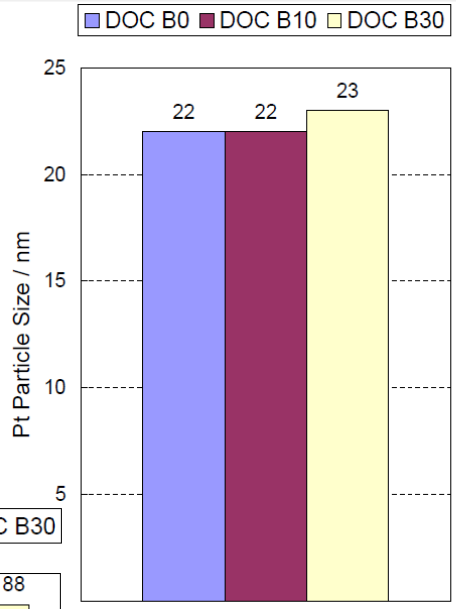
DOC Wash Coat Outlet

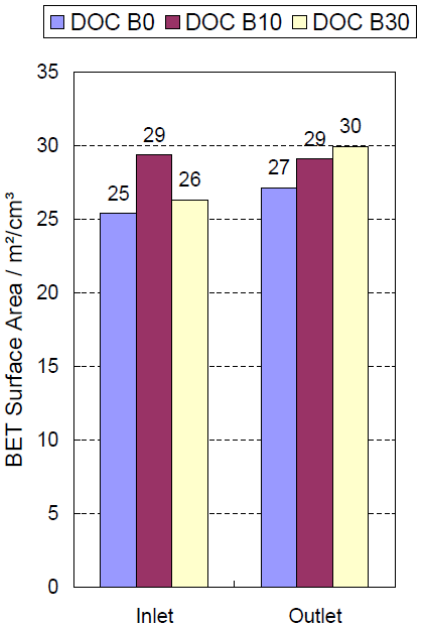


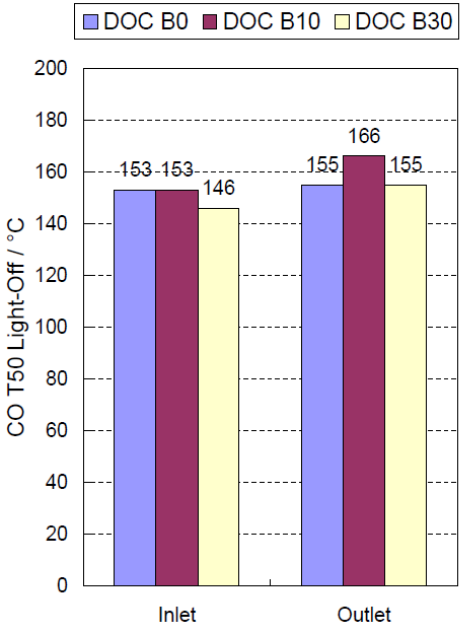
There is no significance difference in B0/B10/B30 DOC

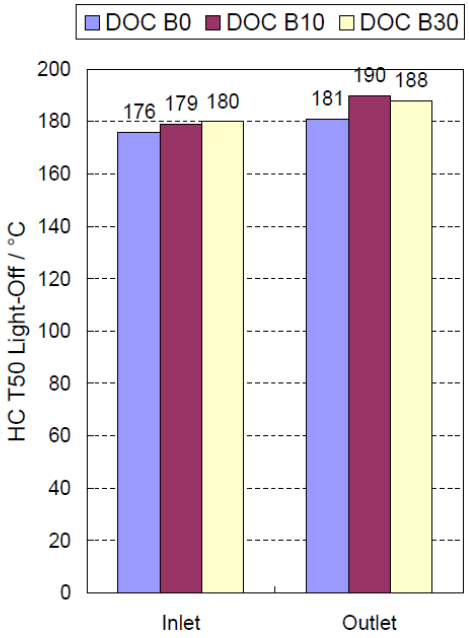
Technical report - Diesel Oxidation Catalyst – BASF

NO significant trend in DOC in Pt particles size and washcoat active surface area as well as HC and CO light off temperature increasing the level of blending









Conclusion

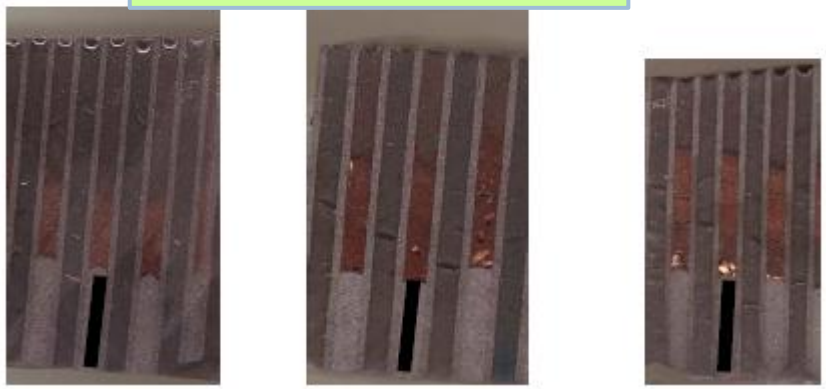
- There seems to be no influence of the Biodiesel level on catalyst poisoning and Catalyst performance under the test conditions.

Technical report Diesel Particulate Filter – BASF

Original DPF Code

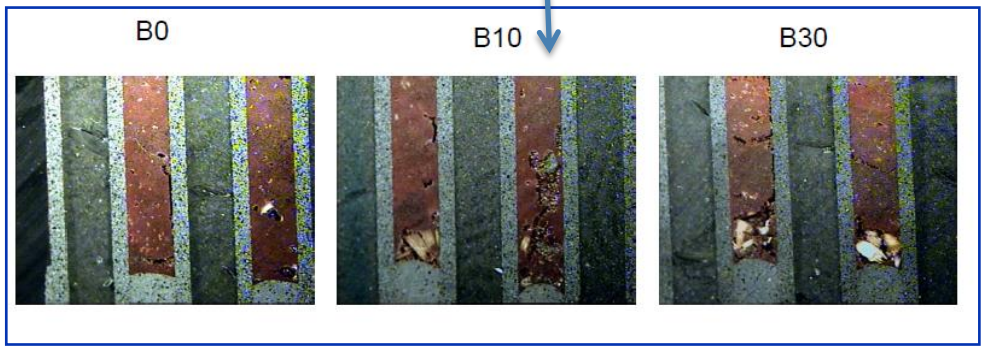
B0 B10 B30

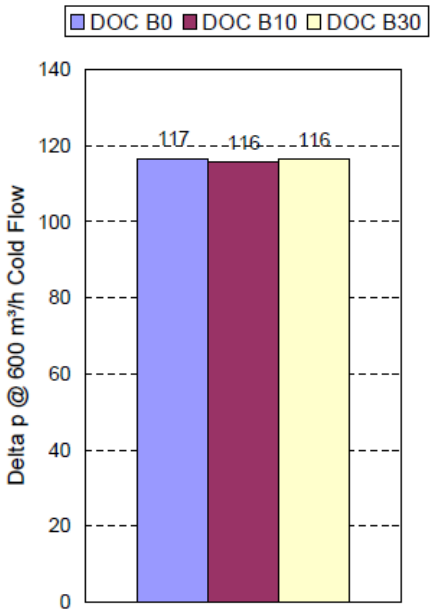
After being fixed in epoxy resin and cut into slice



Slightly more ash stored in B10 and B30

Pictures of DPF Rear core after fixed in epoxy resin and cut into slice – Same ash Morphology for all samples





Conclusion

- There might be a small influence on the amount of stored ash if the amount of biofuels is increased from 0% to 10% (no difference b/w 10 to 30%)

Conclusions:

No major failures encountered during testing related to biodiesel usage.

Nevertheless:

- Oil Dilution
- Injectors
- EGR Cooler
- Turbocharger
- DPF

showed to be critical items with respect to biodiesel usage.

Therefore, those components need further investigations as we go towards higher acceptable levels of Biodiesel content in fuel

Thank You

For Your Attention

Questions?...