Impact of Fuel Properties on Light-Duty Engine Performance and Emissions

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- Fuel Specifications
- Combustion Behavior with Varying Cetane
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Project Goal

Evaluate the impact of 7 different fuel blends on the emissions and performance of a 2.5 l light-duty HSDI diesel engine:

- Wide range of fuels were subject to the investigation ranging from CN = 26 to CN = 76 (including biodiesel)
- Determine the emissions characteristic of each fuel as function of combustion parameters (PI, MI, EGR, Boost, Rail Pressure, …)
- Determine the full load performance of the fuels using identical operating parameters

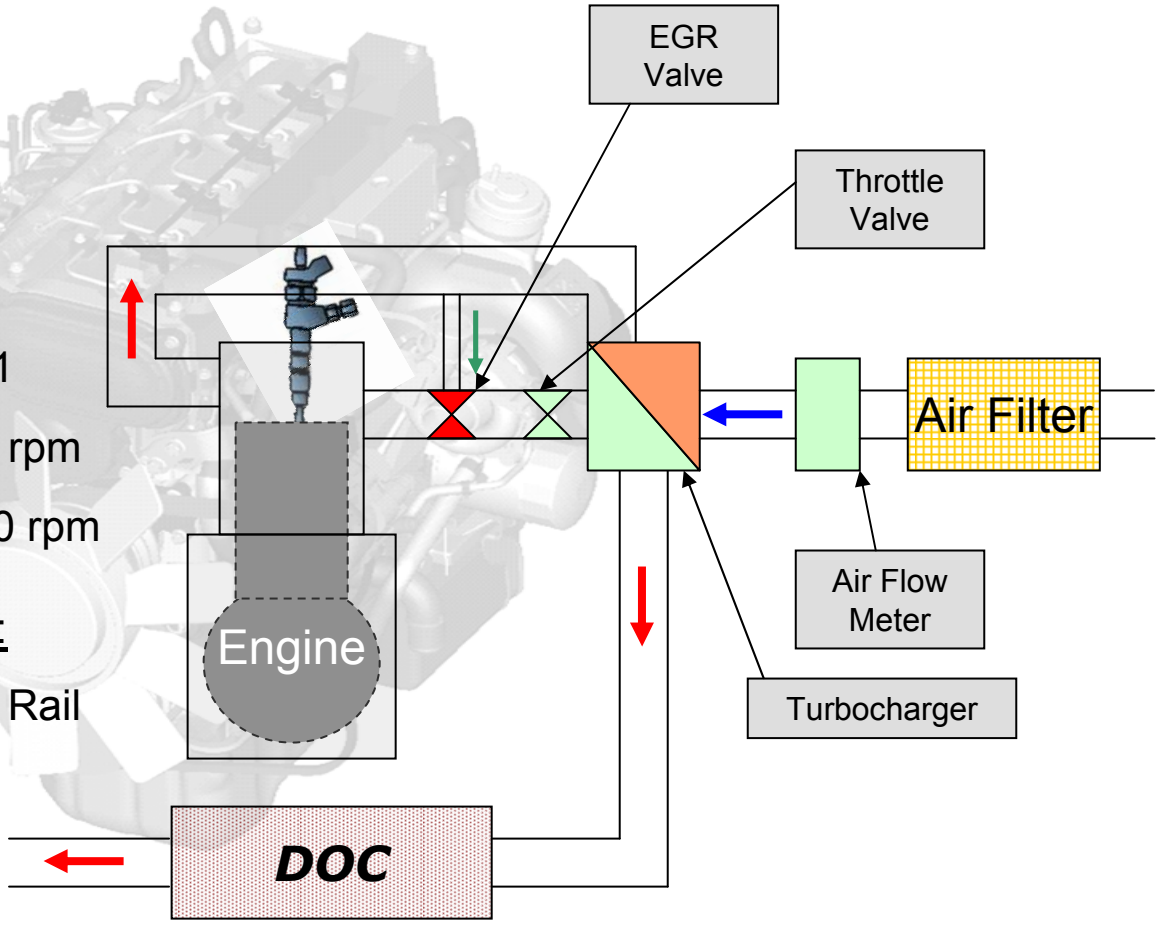
Hardware Specifications

Engine Specifications:

- 2.5 L 4 Cyl DI
- Bore = 93 mm
- Stroke = 92 mm
- Displacement = 2493 cc
- Compression Ratio = 18:1
- Power = 105 kW @ 3200 rpm
- Torque = 330 Nm @ 2000 rpm

Injection/Control System:

Bosch 2nd Gen. Common Rail
1600 bar peak pressure
Bosch EDC16



Fuel Specifications

	Cetane Number	Carbon	Oxygen	Hydrogen	Fuel Density at 293 K	Net Heating Value
	[-]	wt%	wt%	wt%	kg/m3	MJ/kg
ECD Ultra Low Sulfur	53.2	86.19	0.00	13.56	829.8	43.62
HF0695	32.4	87.14	0.00	12.86	841.1	42.76
MIX sample NAPTHA	26.0	86.25	0.00	13.75	768.2	43.61
T23	75.8	85.56	0.00	14.44	788.0	43.66
B-100 - Biodiesel	52.0	76.84	11.38	11.78	880.1	37.41
B-20 - Biodiesel	43.1	84.95	2.37	12.68	852.9	41.48
B-5 - Biodiesel	42.4	86.48	0.61	12.91	847.9	42.43

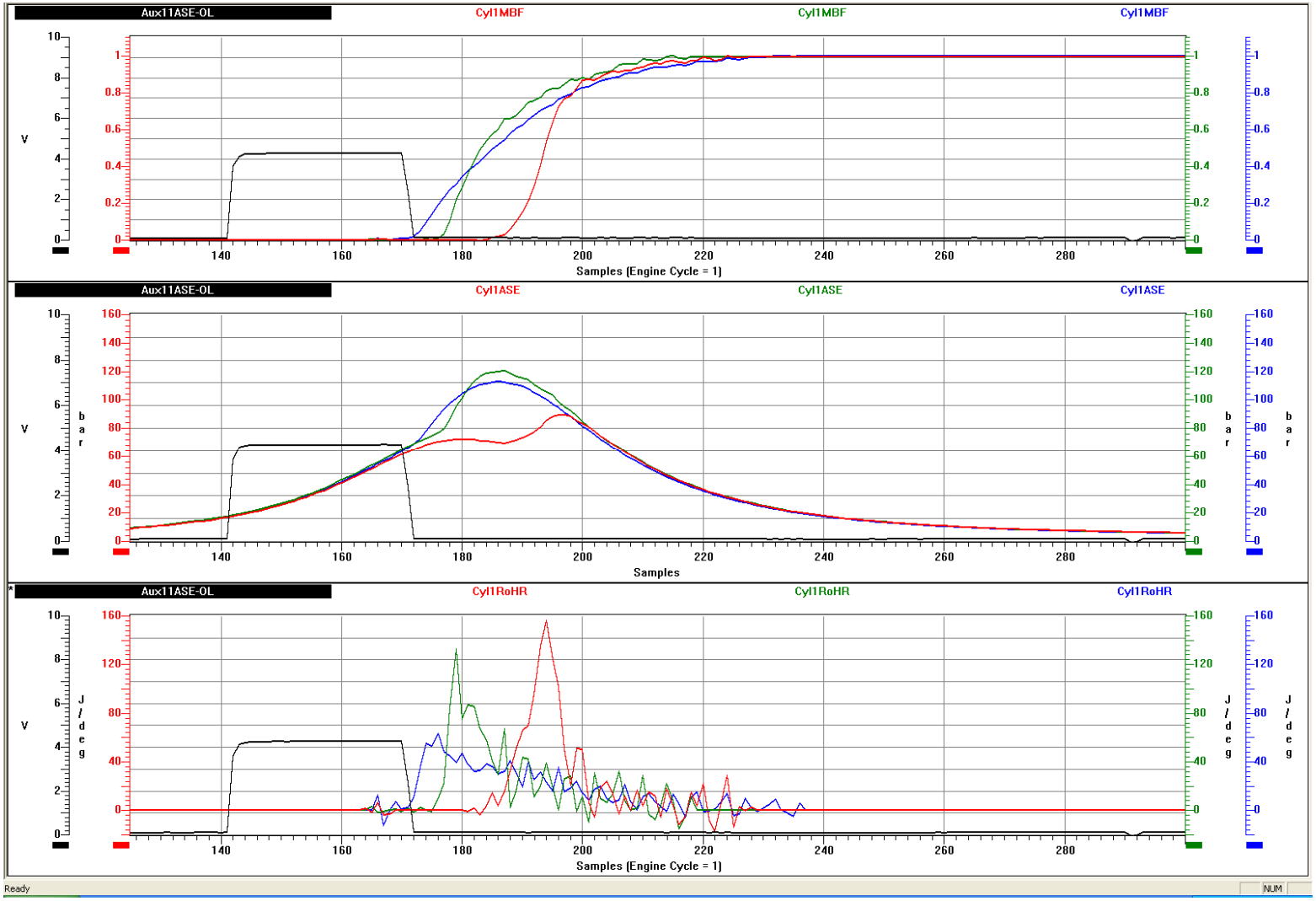
Combustion Behavior

Blue=76 Cetane Green = 44 Cetane Red=26 Cetane

Mass Burn Fraction

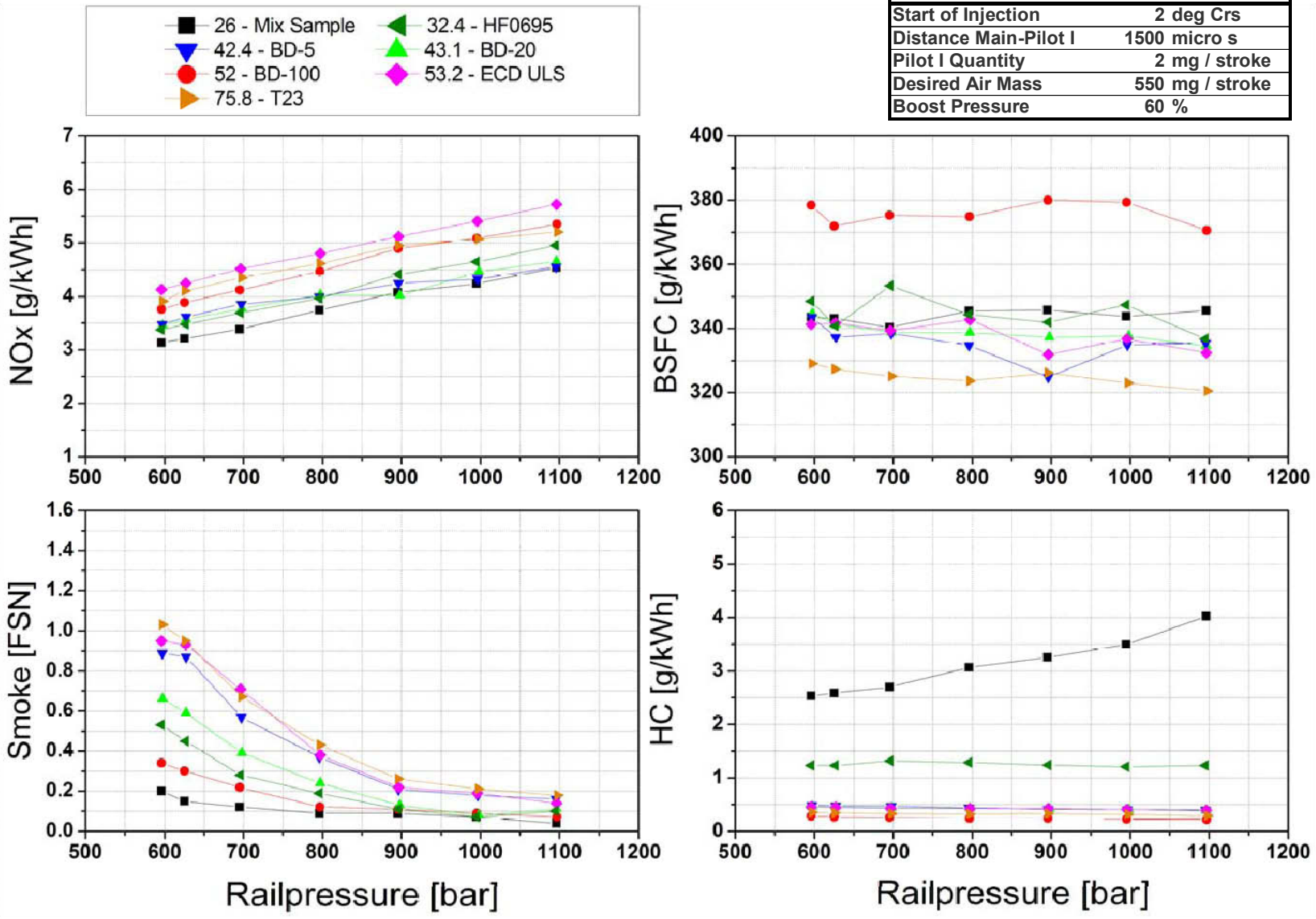
Cylinder Pressure

Heat Release Rate



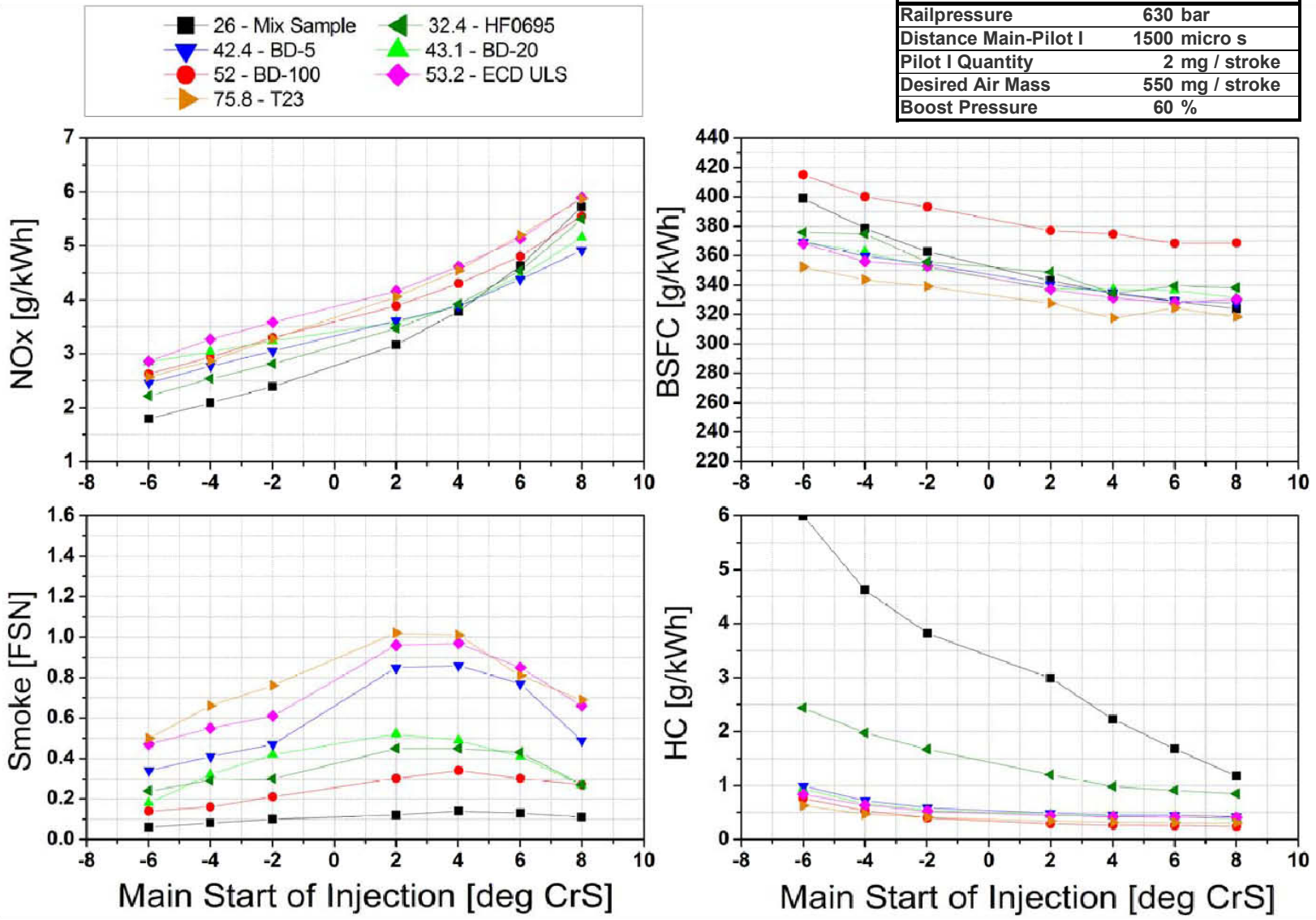
Test Results – 2000 rpm 2 bar BMEP

Base Settings	
Start of Injection	2 deg Crs
Distance Main-Pilot I	1500 micro s
Pilot I Quantity	2 mg / stroke
Desired Air Mass	550 mg / stroke
Boost Pressure	60 %



Test Results – 2000 rpm 2 bar BMEP

Base Settings	
Railpressure	630 bar
Distance Main-Pilot I	1500 micro s
Pilot I Quantity	2 mg / stroke
Desired Air Mass	550 mg / stroke
Boost Pressure	60 %



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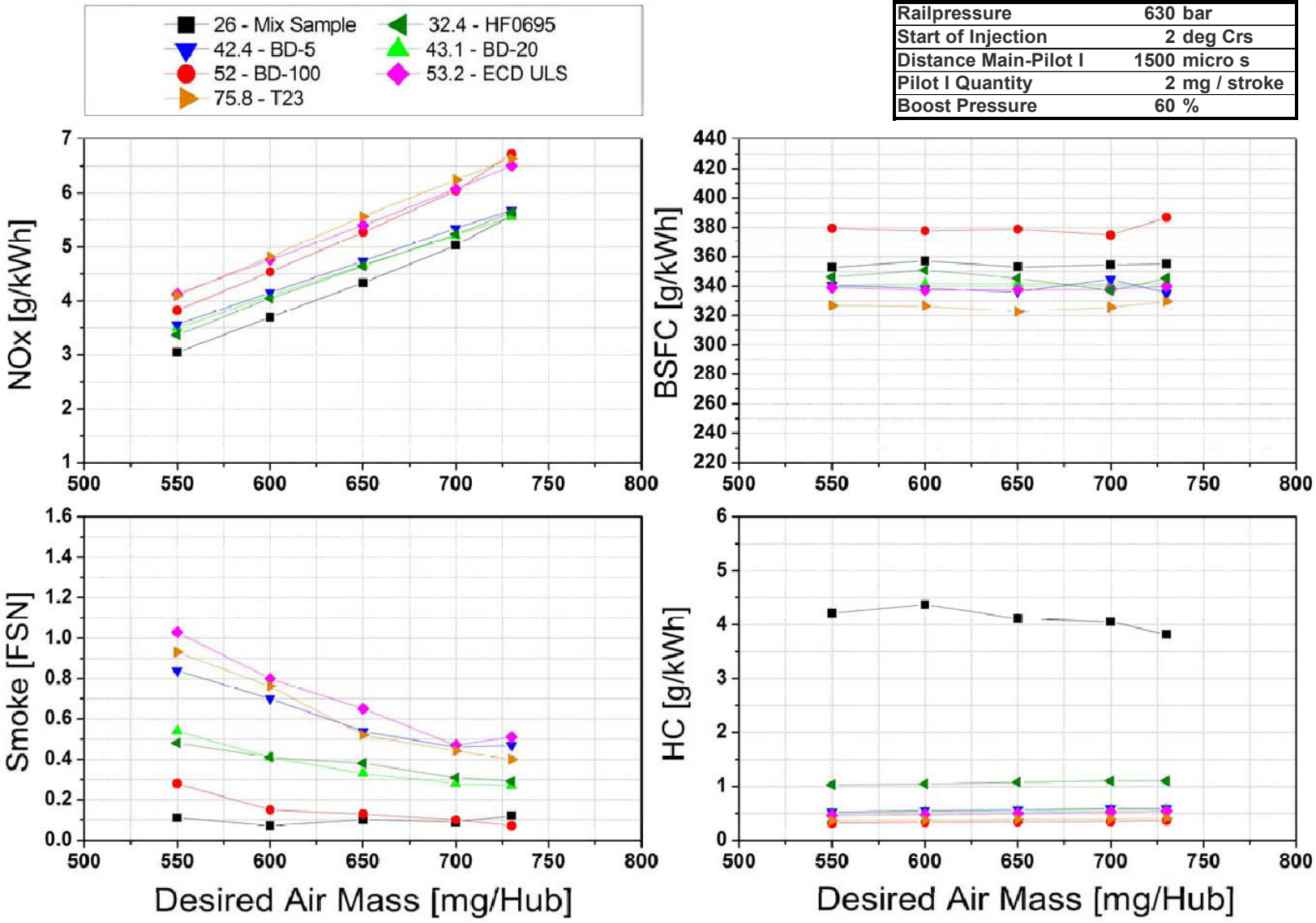
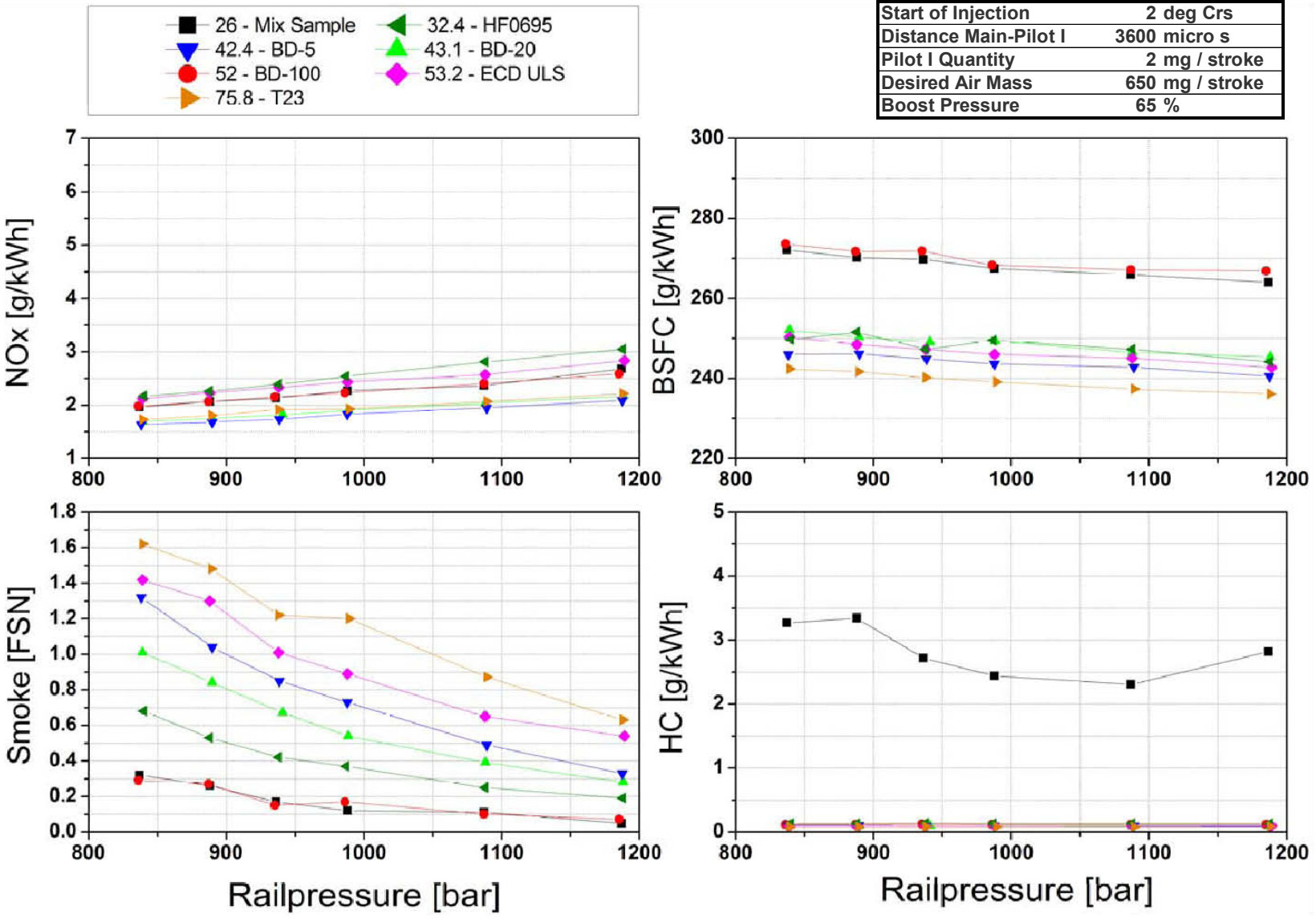


Test Results – 2000 rpm 6 bar BMEP

Base Settings	
Start of Injection	2 deg Crs
Distance Main-Pilot I	3600 micro s
Pilot I Quantity	2 mg / stroke
Desired Air Mass	650 mg / stroke
Boost Pressure	65 %



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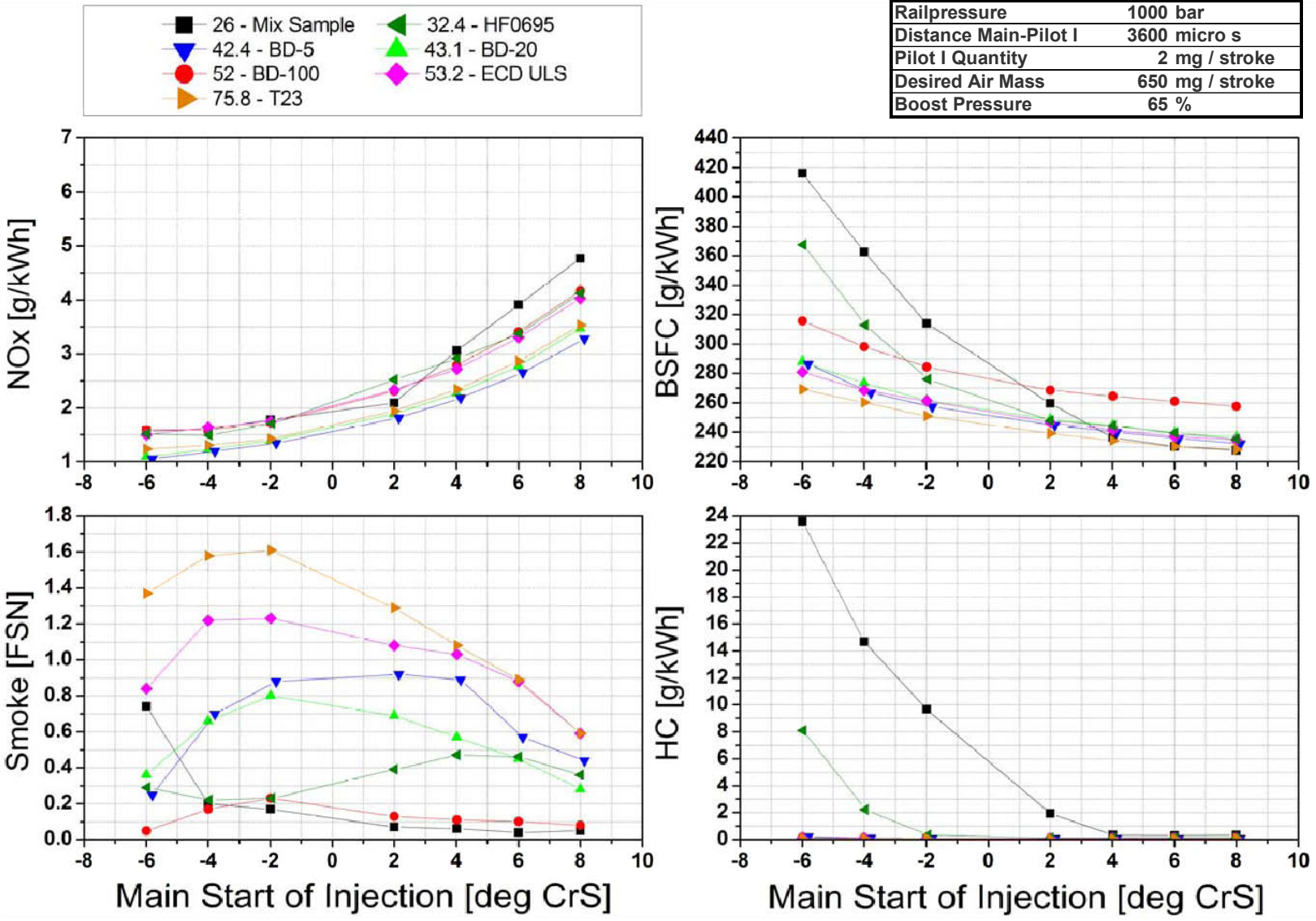

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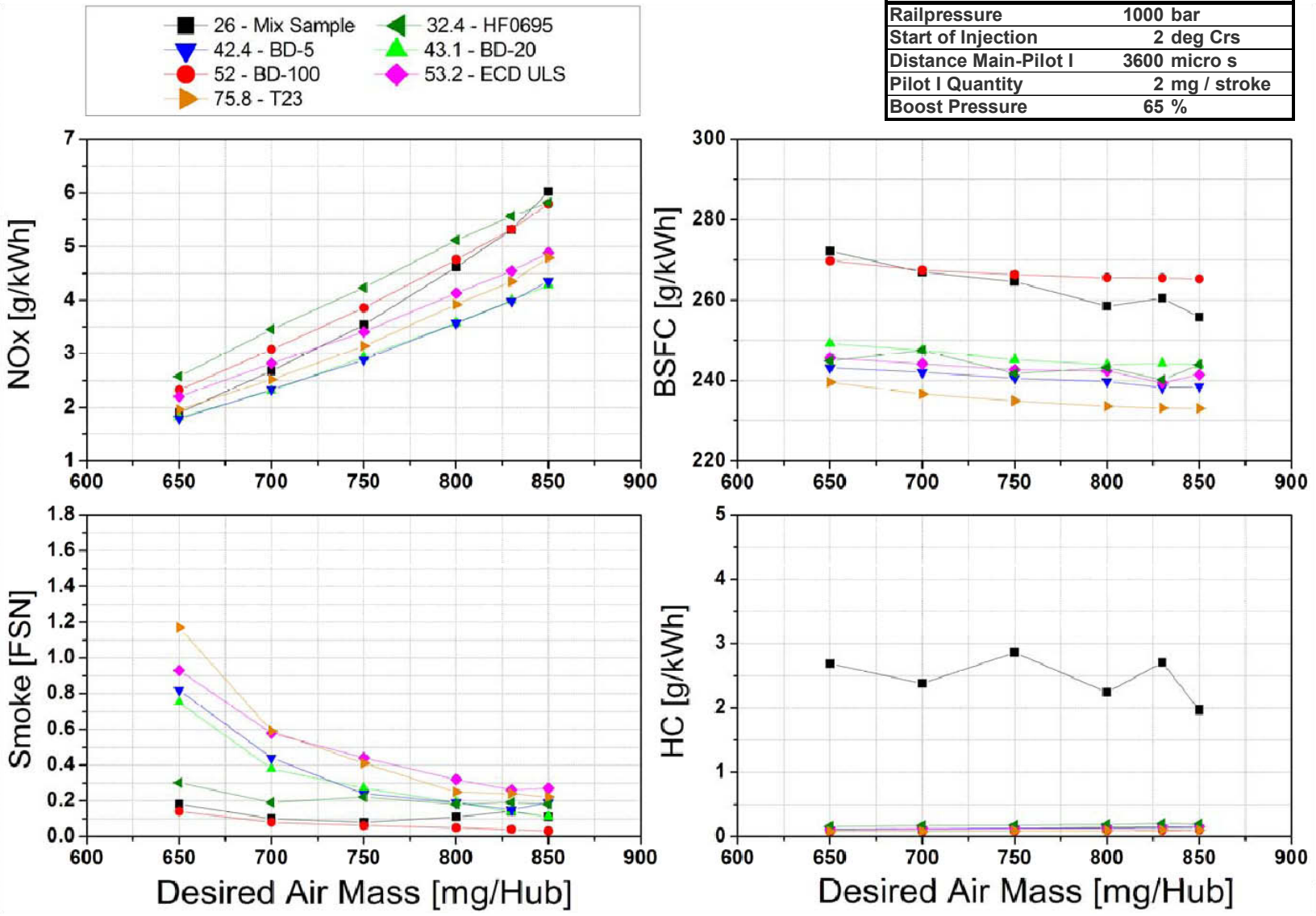
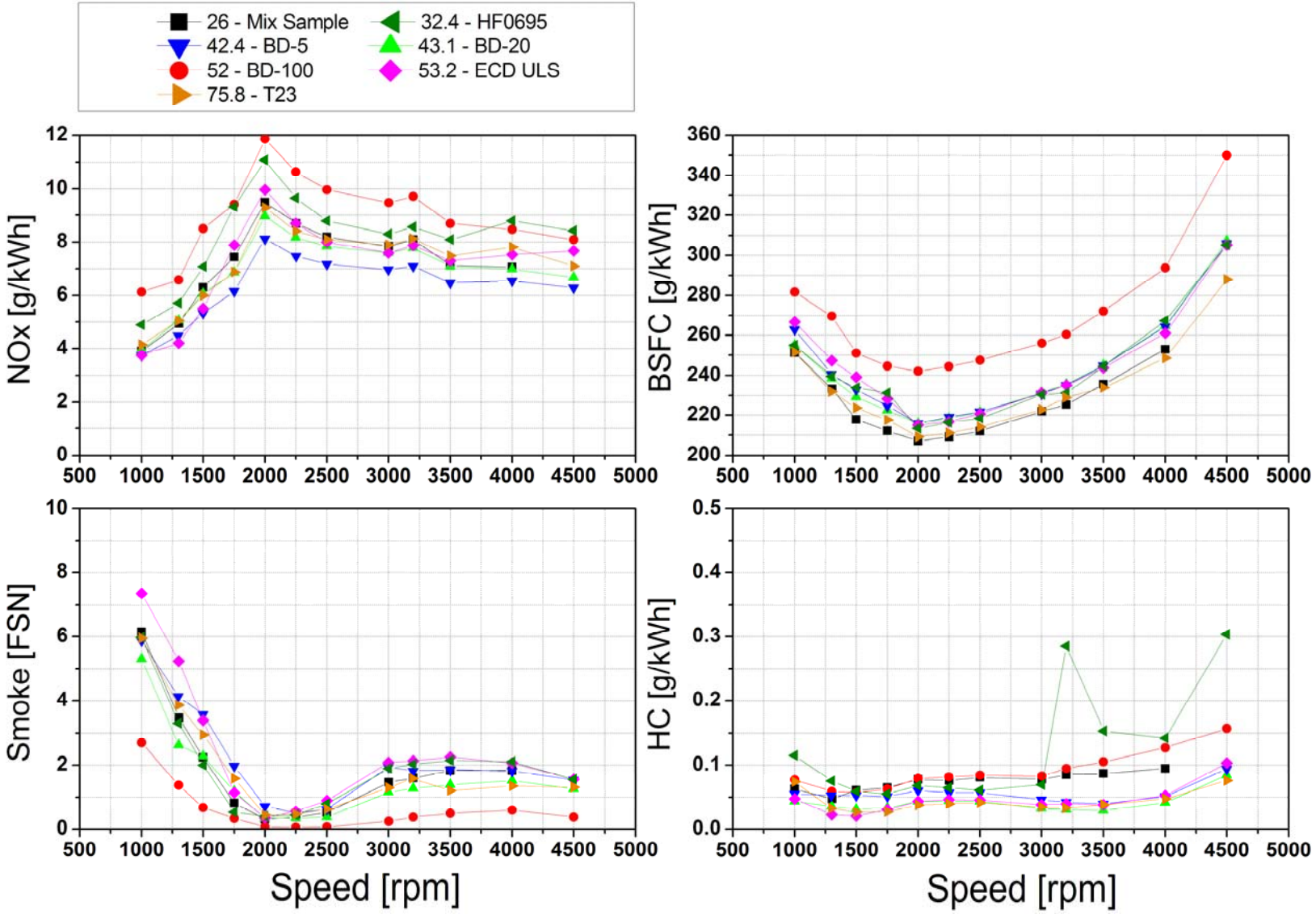
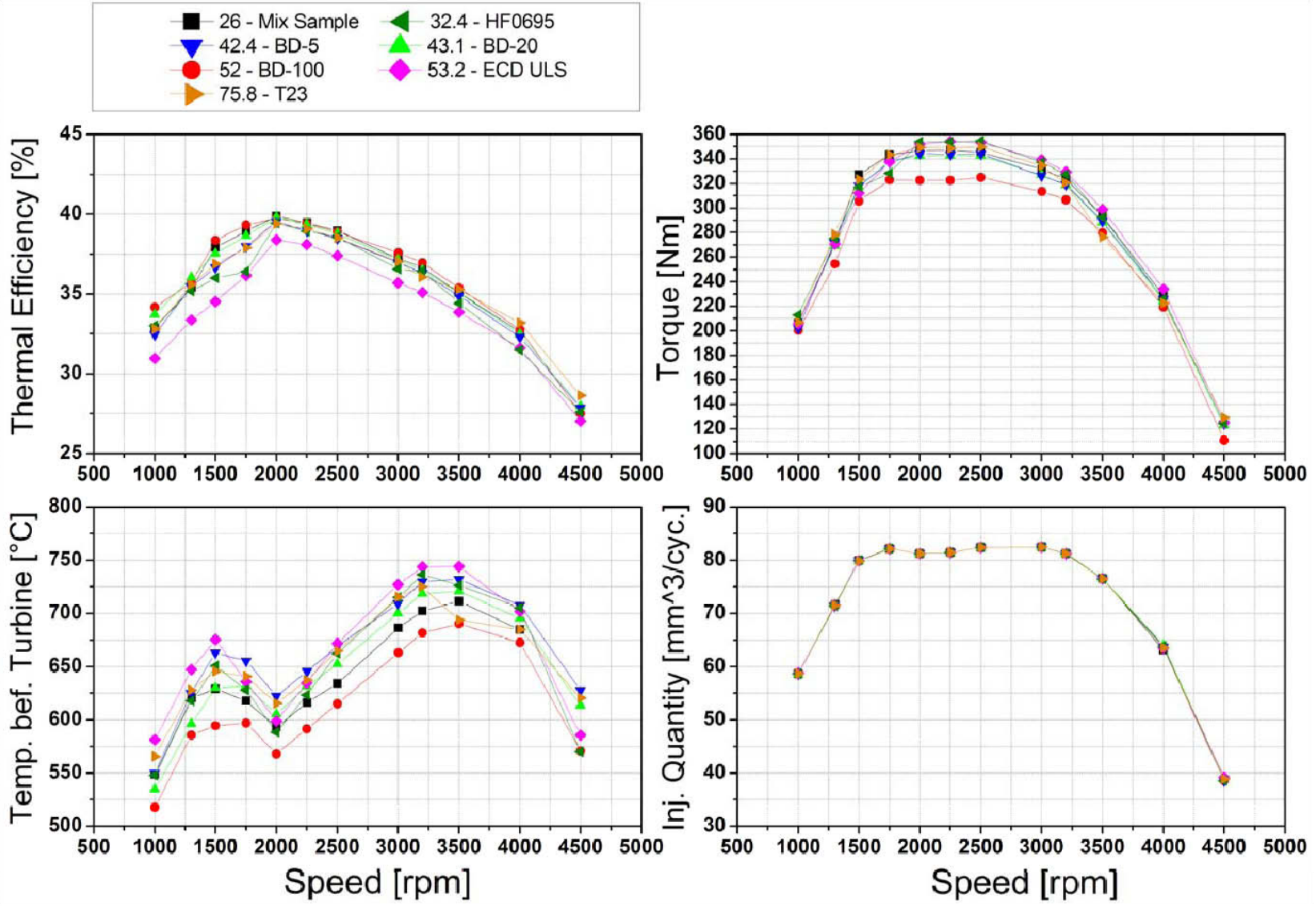


Test Results – Full Load



Test Results – Full Load



Summary and Conclusion

- High cetane fuel (76) exhibits best fuel consumption but suffers from high smoke level resulting from a short mixing time
- Extreme low cetane fuel (26) suffers from poor fuel consumption and high HC emissions due to late combustion
- Higher loads and optimized timing make low cetane fuels more attractive from a smoke and fuel consumption perspective
- While NOx is elevated, oxygen content of biodiesel fuels (B20, B100) has a significant impact on smoke level
- Low heating value and high density of B100 greatly effects fuel consumption throughout the load range
- Performance trends vary significantly with the engine operation and combustion system making it difficult to identify ideal fuel properties