Co-Optimization of
Fuels & Engines

Potential Drivers of Soot Emissions from Alternative Fuels

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Advanced Engine Development

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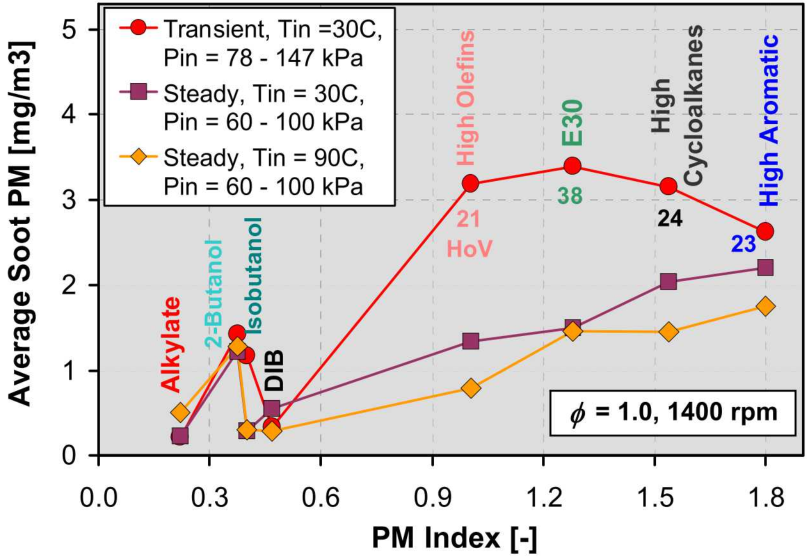
Fuel Compositional Impacts on PM

- Varying exhaust particulate matter (PM) observed for operation with fuels palette under stoichiometric, knock-limited conditions
- Efficacy of Particulate Matter Index (PMI) varies with operating conditions
- What processes are driving differences in PM under tested conditions?



$$PMI = \sum_{i=1}^{n} I_{[443K]} = \sum_{i=1}^{n} \left(\frac{DBE_i + 1}{VP\,(443K)_i} \times Wt_i \right)$$

Spray Chamber Highlights Fuel Differences

	Iso-butanol blend	*Diisobutylene blend*	*High Olefins*	*Alkylate*
#	1	3	4	6
RON	98.1	98.3	98.3	98.0
MON	88.0	88.5	87.9	96.7
Octane Sensitivity	10.1	9.8	10.4	1.3
AKI (R+M)/2	93.1	93.4	93.1	97.3
T10 [°C]	-	-	77	93
T50 [°C]	-	-	104	100
T90 [°C]	-	-	136	106
TF [°C]	-	-	198	161
Aromatics [Vol. %]	19.0	20.1	13.4	0.7
Alkanes [Vol. %]	53.1	56.3	56.4	98.8
Cycloalkanes [Vol. %]	0.0	0.0	2.9	0.0
Olefins [Vol. %]	3.8	23.6	26.5	0.1
Oxygenates [Vol. %]	24.1	0.0	0.0	0.0
Net Heat of Combustion [MJ/kg]	40.6	43.5	44.1	44.5
Stoichiometric Air to Fuel Ratio [-]	13.8	14.7	14.8	15.1
Heat of Vaporization [kJ/kg]	412	337	333	308
Heat of Vaporization Per Mass of Stoichiometric Charge [kJ/kg]	27.9	21.5	21.1	19.1
Particulate Matter Index	0.40	0.47	1.00	0.22
Average Molecular Formula	C: 6.299 H: 12.744 O: 0.326	C: 7.519 H: 14.420	C: 7.13 H: 14.23	C: 7.76 H: 17.45

Constant-volume chamber experiments

8-hole, 60° injector

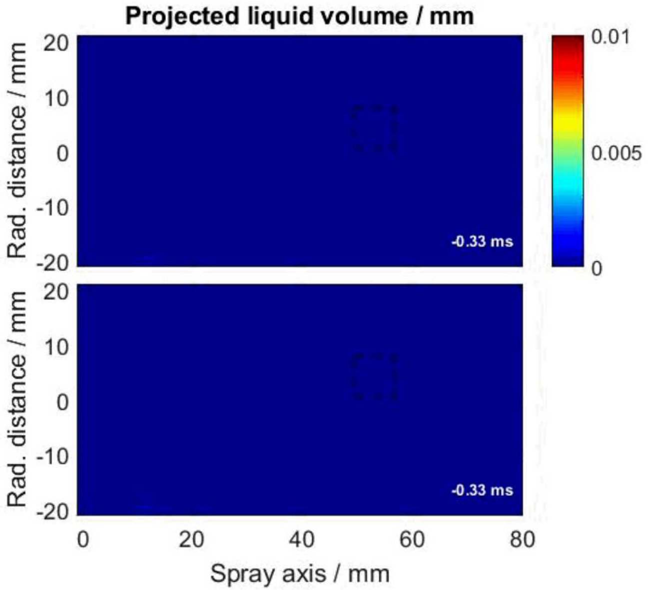
T_{inj} = 75° C

P_{inj} = 120 - 170 bar

t_{inj} = 0.6 – 1.0 ms

Pgas = 1 bar

Tgas = 70 - 150° C



P_{inj} = 120 bar; t_{inj} = 0.6 ms; Tgas = 150° C

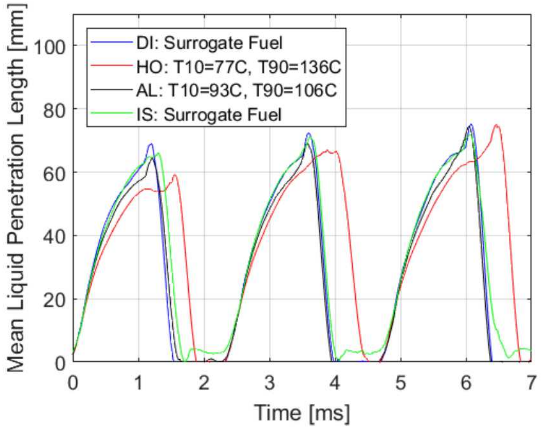
Impacts of Fuel Distillation Curve on Sprays

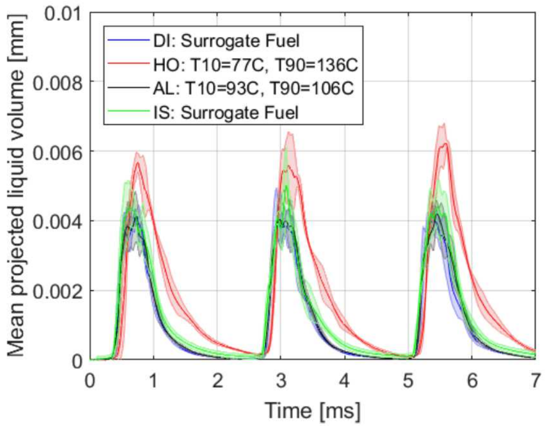
Full-boiling range gasoline yields differences relative to abbreviated boiling range fuels:

- Shorter liquid-penetration length
- Increased liquid persistence after end of injection

Do these differences in spray behavior cause observed differences in engine-out PM?

Ongoing optical engine experiments will shed additional light





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Co-Optimization of Fuels & Engines

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