The Effect of Fuel Cetane Quality on Light-Duty Diesel Performance
CRC Project No. AVFL-11

AVFL Committee Summary

This study was conducted as a screening analysis to determine if cetane number could have an impact on the performance of advanced light-duty diesel vehicles. Diesel engines are being considered for expanded use in U.S. light-duty vehicles to improve fuel efficiency. Currently, there are only a few diesel models in the U.S. fleet. However, light-duty diesel engine technology has been steadily progressing in Europe, with improved performance and lower emissions compared to older diesel technology. European diesel fuel typically has higher cetane number than the diesel fuel pool in the U.S.

The study was conducted using four vehicles meeting Euro-3 or 4 emissions standards representing advanced engine and control technologies that may be used in the future U.S. fleet. The committee recognized that the European test vehicles were not designed for U.S. emissions standards, fuels or climactic conditions and that additional work using U.S. vehicles could be needed in the future.

Eight test fuels were blended with cetane number ranging from 41 to 58 that broadly covers the U.S. and European cetane range. The fuel set contained independent variation in natural and additized cetane. Aromatics and density were well matched across the fuel set, but there was variability in viscosity and some spread in boiling range among the test fuels.

Testing covered a range of vehicle performance attributes where cetane impacts had been found in the past: start time, idle quality, cold-start driveability, noise, vibration and smoke. Testing was conducted at three ambient temperatures, -10°C, 0°C and +10°C. A climate-controlled chassis dynamometer was used. Driveability testing followed European procedures. The driveability rating was supplemented with measurements of engine noise and vibration during cold idle after start up and tailpipe smoke opacity throughout the test. No other tailpipe emissions were evaluated.

Fleet-average trends are summarized below. On the whole, the performance of the vehicles tested was very good. All vehicles started readily at all conditions and suffered few driveability faults. Based on these results, modern diesel engines with common rail appear to be less sensitive to cetane than older vehicles with mechanical fuel injection over the range of temperatures studied. Some adverse effects of low cetane were detected: time for engine speed rise, idle quality, cold driveability, and cold-start smoke. In general, it would be difficult for consumers to perceive these impacts. As expected, the largest beneficial effects of higher cetane occurred at -10°C. Cetane impacts were

very small at 0°C and +10°C. Surprisingly higher cetane had adverse effects on some performance attributes: fleet-average noise and vibration at 0°C and smoke after the vehicle was partially warmed-up at all test temperatures. As expected, there were also differences among vehicles in response to temperature and cetane variation.

Further work that included lower test temperatures and a larger fleet would be required to identify the temperature and cetane number range that would constitute the limits of acceptable operation for these vehicles. The committee recommends that further testing of cetane number impacts on performance be postponed until a representative number of U.S. light-duty diesel models that meet Tier 2 standards are available.

Summary of Fleet Average Trends With Increasing Cetane Number (Confidence Level)

Variable	-10°C	0°C	+10°C
Time to 2000 RPM	Positive (99%)	None	None
Measured Idle Quality	Positive (99%)	Positive (99%)	None
Smoke 0-10 Seconds	Positive (99%)	Positive (NS)	None
Smoke 90-327 Seconds	Negative (95%)	Negative (99%)	Negative (99%)
Sound Pressure Level	None	Negative (99%)	None
Vibration	None	Negative (95%)	None
Driveability Demerits	Positive (NS)	None	None
Idle Quality Demerits	Positive (95%)	None	None

NS - Not statistically significant at 95% confidence level.