

Achieving CAFE 2025 Standards with the Achates Power Opposed-Piston, Light-Duty Diesel Engine

SAE Technical Paper 2014-01-1187



Challenge

Emissions and fuel efficiency regulations in the U.S., and around the world, demand that vehicle manufacturers make significant changes to engine technology. For example, by 2025, Corporate Average Fuel Economy (CAFE) standards will mandate a 54.5 MPG (without credits) fleet average for both cars and light trucks. Add to that the passage of Tier 3 (LEV III) emissions standards, which are being introduced in phases and will ultimately require fleet average emissions levels of 0.030 g/mi NMOG+NO_x for all light-duty vehicles (below 8,500 lbs. GVW) by 2025.

Solution

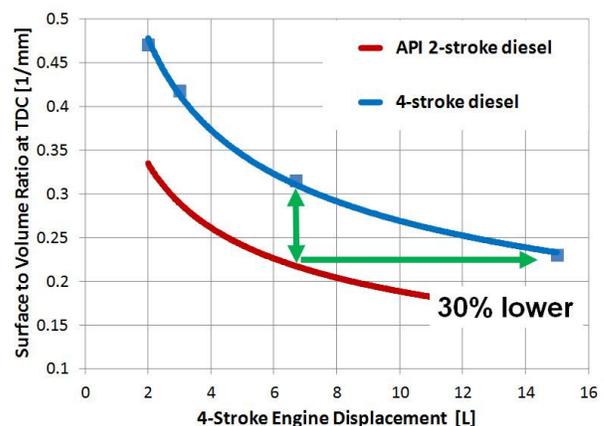
Technologies applied to today's conventional engines have produced incremental improvements in fuel efficiency and emissions. However, even these solutions are hindered by the inherent limits of the four-stroke powertrain and each comes at a significant cost. The best way to achieve CAFE and Tier3/LEV III standards requires new, game-changing technologies like the Achates Power opposed-piston engine.

Among the Achates Power engine's many architectural advantages are:

- Reduced heat losses
- Leaner combustion
- Faster and earlier combustion at the same pressure rise rate

Results

The Achates Power opposed-piston engine—when configured to meet the requirements of a next-generation light-truck application—is able to achieve all of the critical attributes while delivering a very significant improvement in fuel economy.



In fact, the Achates Power technology provides an even greater fuel economy advantage in a light-duty application than in a heavy-duty application. The lower the speed and load operating modes (characteristic of light-duty applications) and the lower the engine-out NOx (required to achieve Tier 3 emissions standards), the greater the fuel efficiency advantage delivered by the engine.

Not only does the Achates Power engine configured for this work achieve a 30% fuel economy improvement over a benchmark engine—funded by the U.S. Department of Energy (DOE)—but it also achieves the engine-out emissions targets necessary to meet Tier 3/LEV III with the appropriate aftertreatment. In addition, the technology has excellent exhaust temperature management capabilities to manage catalyst warm-up requirements. The Achates Power engine enables some of the largest and heaviest vehicles that are subject to CAFE to comply with the final 2025 regulation levels without hybridization or vehicle improvements. Furthermore, the Achates Power light-duty engine exhibits excellent vibration characteristics and packages in a typical full-size, light-duty truck for simple and transparent integration in standard vehicles.

Achates Power Engine vs. DOE-Funded Benchmark Engine

- Engine-out emissions targets that **meet fully phased-in Tier 3/LEV III standards**
- **30% more fuel efficient *without* hybridization and other vehicle improvements**
- Excellent catalyst light-off capabilities
- Excellent vibration
- Seamless integration into existing vehicles

LA4 Cycle (Engine-out Emissions)

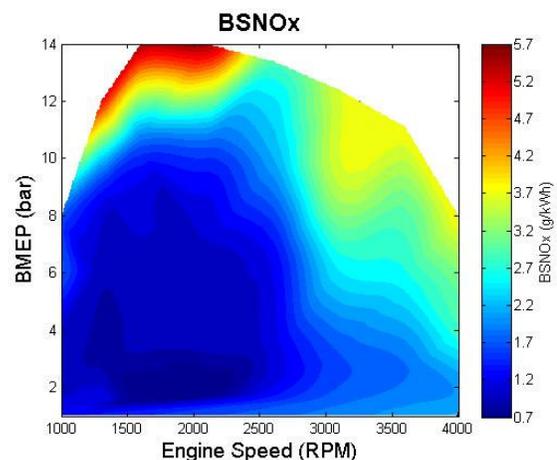
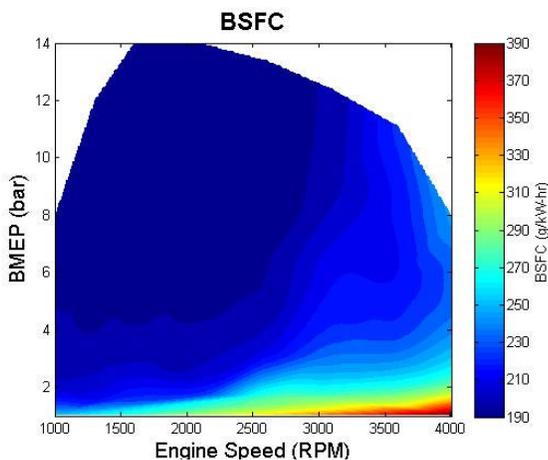
| Parameter | Fuel Economy | NOx | PM | HC |
|------------------|--------------|------------|------------|------------|
| Unit | MPG | g/mile | g/mile | g/mile |
| ATLAS | 26.7 | 0.82 | 0.13 | - |
| Achates | 34.1 | 0.47 | 0.03* | 0.12 (THC) |
| % Improv. | 28% | 42% | 74% | - |

*Achates Power engine only measuring soot with AVL415S, not the total PM.

Highway Fuel Economy Cycle (Engine-out Emissions)

| Parameter | Fuel Economy | NOx | PM | HC |
|------------------|--------------|------------|------------|-------------|
| Unit | MPG | g/mile | g/mile | g/mile |
| ATLAS | 34.4 | 0.94 | 0.09 | 0.10 (NMHC) |
| Achates | 45.7 | 0.34 | 0.04* | 0.12 (THC) |
| % Improv. | 33% | 63% | 55% | -16% |

*Achates Power engine only measuring soot with AVL415S, not the total PM.



For more information, visit www.sae.org to download the technical paper, 2014-01-1187, or contact: Laurence Fromm at fromm@achatespower.com or +1 858.535.9920, ext. 210.