New engine design adjusts compression to meet driving conditions

OAAT ACCOMPLISHMENTS

Variable Compression Ratio (VCR) Engine

Challenge

Conventional gasoline engines operate at a fixed compression ratio, which is set low enough to prevent premature ignition of the fuel, or "knock," at high power levels under fast acceleration, high speeds, or heavy loads. Most of the time, however, gasoline engines operate at relatively low power levels under slow acceleration, lower speed, or light loads. If the compression ratio were increased at low-power operation, gasoline engines could achieve higher fuel efficiency.

Technology Description

A variable compression ratio (VCR) engine is able to operate at different compression ratios, depending on the particular vehicle performance needs. The VCR engine is optimized for the full range of driving conditions, such as acceleration, speed, and load. At low power levels, the VCR engine operates at high compression to capture fuel efficiency benefits, while at high power levels, it operates at low compression levels to prevent knock.

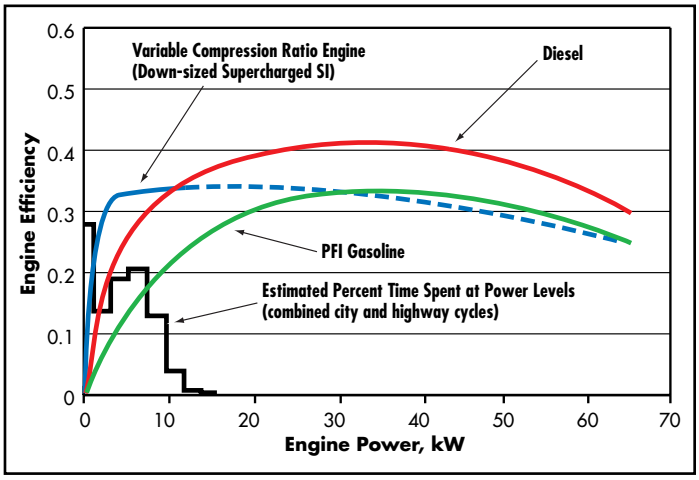
To further improve fuel economy, the VCR engine is small, with about one-third the displacement volume of a conventional gasoline engine. A supercharger boosts engine peak power when needed for occasional hard acceleration or hill climbing.

Accomplishments

Computer modeling showed that the projected efficiencies for the VCR engine should meet the propulsion system requirements needed to reach the goal of 80 miles per gallon set by the Partnership for a New Generation of Vehicles (PNGV).

AVL Powertrain conducted dynamometer tests on an engine in which the compression ratios were varied. Findings from these tests include the following:

- The test results validated the efficiencies predicted by the computer model.
- The test engine exhibited a very favorable burn rate and coefficient of variance, which allow the application of lean-burn technology that will further improve efficiency.
- A preliminary evaluation of hydrocarbon and nitrogen oxide emission levels yielded results that were favorable and consistent with expectations for a gasoline engine of similar power output.



VCR engine promises high efficiency at low engine power levels.

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Benefits

At the low power levels (0-20 kW), typical of most vehicle operating conditions, the VCR engine could achieve efficiency comparable to that of a diesel engine – about 25% higher than that of a conventional gasoline engine (see graph on page 1).

At the same time, because it is a gasoline engine, the VCR engine should be able to achieve federal Tier 2 and California LEV 2 emission standards.

Future Activities

- Develop an optimized cylinder head for the VCR engine that is capable of realizing the full potential of this technology.
- Conduct an optimization assessment and determine the best engine configuration and develop optimized components for a second-generation engine.
- Develop a second-generation engine by using assessment results and optimized components.

Partners in Success

- Argonne National Laboratory
- AVL Powertrain Inc.
- Computer Systems Management Inc.
- Envera LLC
- Ricardo Inc.

Dynamometer tests of the VCR engine concept validated computer modeling results.