

Powertrain OVERVIEW

FCA Canada: Polishing the Pentastar™; FCA US LLC Upgrades Celebrated V6

- Award-winning engine's latest iteration contributes to fuel-economy improvements of more than six per cent
- Torque increased more than 14.9 per cent at engine speeds below 3,000 rpm – where torque really counts
- Two-step variable valve lift (VVL), which benefits fuel economy and Pentastar's class-leading refinement
- Cooled exhaust-gas recirculation (EGR) delivers greater efficiency and enables knock-free operation at higher, real-world loads
- Upgraded variable-valve timing (VVT) system
- Other significant enhancements:
 - New intake manifold, longer runners enable torque boost
 - Increased compression ratio – now 11.3:1
 - High-tumble intake ports and shrouded combustion chambers
 - Eight-hole fuel injectors with optimized atomization
 - Multiple friction-reduction features
- Redesigned components reduce overall engine weight – despite added content
- More than 7.6 million customer-equivalent test km accumulated during development
- Debuts in the 2016 Jeep® Grand Cherokee, the world's most-awarded SUV
- Additional FCA US powertrain breakthroughs for model-year 2016:
 - Unique FCA US rear-axle disconnect system migrates to 2016 Fiat 500X delivering segment-first capability, efficiency

Already unique among V6 engines for its refinement, power, efficiency and adaptability, the formidable 3.6-litre Pentastar™ is remade for model-year 2016.

Depending on the application, the redesigned V6 delivers fuel-economy improvements of more than six per cent while increasing torque more than 14.9 per cent. This occurs at engine speeds below 3,000 rpm, where elevated torque has its most profound impact on the driving experience.

Enhancements such as two-step variable valve lift (VVL), cooled exhaust-gas recirculation (EGR) and innovative weight-reduction strategies boost the engine's efficiency and performance, all while preserving the smoothness that remains a hallmark of the Pentastar brand.

"With more than five million Pentastars on the road, we have clearly struck a chord in the marketplace," says Bob Lee, FCA North America Vice President — Engine, Powertrain and Electrified Propulsion and Systems Engineering. "Such success brings enormous responsibility. Accordingly, we focused our efforts on improving efficiency and providing greater customer satisfaction in a package that delivers superior value."

Features

Increased fuel-efficiency was a key impetus in the development of the redesigned 3.6-litre Pentastar V6 engine. FCA US LLC powertrain engineers evaluated multiple technologies, accumulating more than 7.6 million customer-equivalent km using computer simulation and physical tests.

Improvements were measured right down to the component level. And no improvement was too small to chase.

Ultimately, the team identified the combination of features that deliver the greatest benefits in the widest operating range.

Arguably the most compelling enhancement is two-step VVL. The system is designed to remain mostly in low-lift mode until the customer demands more power; then it responds by switching to high-lift mode for improved combustion.

The result is less overall pumping work, which on its own, accounts for a fuel-economy improvement of up to 2.7 per cent, compared with the 3.6-litre Pentastar's previous iteration, named three times to the prestigious annual list of *Ward's 10 Best Engines*.

The addition of cooled EGR firmly establishes the redesigned Pentastar among the V6 elite. In addition to the obvious emissions-reduction benefits, the system further cuts pumping losses and enables knock-free operation at higher, real-world loads.

This translates to a fuel-economy improvement, on its own, of up to 0.8 per cent.

Pumping losses are again targeted with the engine's upgraded Variable Valve Timing (VVT) system. For 2016, it moves to torque-driven cam-phasing, which reduces oil demand.

The new VVT system also increases its range of authority to 21 degrees Celsius (70 degrees Fahrenheit), from 10 degrees Celsius (50 degrees Fahrenheit). This helps mitigate knock during hot starts and expands the operating envelope of Engine Stop Start (ESS), a fuel-saving feature that is carried over from the previous-generation 3.6-litre Pentastar.

ESS is driven by a high-speed/high-durability starter that reduces crank time for quicker restarts. The system is regulated by algorithms, which act on the vehicle's powertrain and chassis components.

As a result, acceleration is always aligned with driver inputs. Passive accelerator application is met with measured throttle response; hard inputs trigger aggressive starts. And there's no waiting for either.

The same can be said for torque. More torque is delivered more quickly by recalibrating the VVT system to leverage the benefits of the new intake manifold's longer runners.

The result is a torque boost of more than 14.9 per cent, depending on the vehicle application. And this occurs between 1,000 and 3,000 rpm – engine speeds most customers see very frequently.

Says Lee: "We are particularly proud of this achievement because our engineering philosophy revolves around knowing our customers and anticipating their needs and wants. The new 3.6-litre Pentastar delivers a driving experience that is exhilarating."

Function

The redesigned 3.6-litre Pentastar V6 engine benefits from numerous upgrades which better harness the combustion event. The upshot is improved efficiency.

Most notably, the engine's compression ratio jumps to 11.3:1 from 10.2:1, compared with the engine's previous iteration.

High-tumble intake ports combine with shrouded valves to take advantage of the engine's new fuel injectors. Featuring eight holes each, twice the number in the previous iteration's injectors, they offer optimized atomization and targeting.

Factor in the effect of 100-millijoule high-energy ignition coils with platinum sparkplugs and the above combustion enhancements account for a 1.5-per cent improvement in fuel economy.

Multiple friction-reduction strategies contribute to an additional one-per cent fuel-economy hike, compared with the engine's previous iteration.

Particularly notable is the use of HG-R1 on the timing drive guide-faces. The new Pentastar is the first production engine to feature this low-friction material.

Also contributing to friction reduction are new valve springs, low-tension piston rings and piston pins which feature diamond-like carbon coating.

Form

Just as refinement is a defining trait of the Pentastar V6 engine family, so is component design. Its integrated exhaust manifold contributes to packaging efficiencies that enable plug-and-play-type integration across a formidable range of vehicle segments and drivetrain configurations.

The new 3.6-litre Pentastar debuts on the 2016 Jeep® Grand Cherokee, the world's most-awarded SUV. The new intake manifold improves airflow, which benefits volumetric efficiency and enables a boost of up to 295 horsepower (hp), from 290 hp.

For model-year 2016, FCA US powertrain engineers were challenged by the potential negative effects of incremental weight wrought by the engine's new feature content. However, clever component redesign produced an engine that weighs as little as 148 kg (326 lb.), depending on the application.

That's two kg (four lb.) less than the previous 3.6-litre Pentastar, despite the addition of new content weighing six kg (13 lb.).

A thin-wall strategy was used to reduce the nominal thickness of certain die-cast components – without compromising the noise, vibration and harshness (NVH) characteristics for which Pentastar engines are known.

Windage-tray weight was slashed by 19 per cent and front-cover weight was cut by five per cent. Two-piece oil pans were eliminated, with the exception of Trail Rated vehicles.

The engine's crankshaft also went on a diet. Its main bearings and pins were trimmed, which contributed to an overall block-assembly weight reduction of six pounds. This generates additional friction-reduction.

“Our customers have made clear their profound appreciation for the 3.6-litre Pentastar,” Lee says. “We feel the upgraded Pentastar will evoke similarly strong emotions.”

Finale

Model-year 2016 brings to FCA US showrooms a crossover that offers a drivetrain with capability no other vehicle in its class can claim. The all-new Fiat 500X features rear-axle disconnect technology that is unique to the FCA US stable of front-wheel-drive-based vehicles.

It disconnects and reconnects the rear axle – automatically and seamlessly – as needed and at any speed.

When driving conditions warrant only front-wheel-drive, the rear axle disconnects at both the PTU and rear-drive module, which improves fuel economy by reducing the parasitic loss, which occurs with conventional systems.

For model-year 2016, FCA US engines – except for the 8.4-litre V10 that powers the Dodge SRT Viper – will be E15-compatible in anticipation of the fuel's proliferation.

About FCA North America Powertrain

Rejuvenated when the Company was established in 2009, FCA US powertrain organization has intensified its efforts to develop engines that deliver superior performance, improved fuel economy, reliability and driving enjoyment. Since 2009, nearly half of the Company's total manufacturing outlay (more than \$2 billion USD) has been invested in powertrain projects.

About FCA Canada

Founded as the Chrysler Corporation in 1925, FCA Canada Inc. is based in Windsor, Ontario, and celebrates its 90th anniversary in 2015. FCA Canada Inc. is a wholly owned subsidiary of FCA US LLC, a member of the Fiat Chrysler Automobiles N.V. (FCA) family of companies. FCA Canada has approximately 440 dealers and markets Chrysler, Jeep, Dodge, Ram and FIAT brands as well as the SRT performance vehicle designation. The company also distributes the Alfa Romeo 4C model and Mopar products. In addition to its assembly facilities, which produce the Chrysler Town & Country, Dodge Grand Caravan (Windsor), Chrysler 300, Dodge Charger and Dodge Challenger (Brampton), FCA Canada operates an aluminum casting plant in Etobicoke, a research and development center in Windsor, and has sales offices and parts distribution centers throughout the country.

FCA, the seventh-largest automaker in the world based on total annual vehicle sales, is an international automotive group. FCA is listed on the New York Stock Exchange under the symbol "FCAU" and on the Mercato Telematico Azionario under the symbol "FCA."

