Speaking points of Panel 2 - Turbocharging and Mild Hybrids
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Recognition of organizers, participants, and attendees

Introduction of myself

Panel Introduction

The automotive industry has a strong history of using innovation to develop solutions in response to demands from customers and regulatory bodies. In the late 1700s, transportation was revolutionized with the steam-powered automobiles as the industrial revolution was underway. Electrically-powered vehicles competed with steam-powered vehicles throughout the 1800s and into the early 1900s until the internal combustion engine was refined through innovation, persistence, and perspiration to become the dominant automobile power plant. While early inventors faced challenges due to limited knowledge or availability of materials, they did conduct ground breaking work that paved the way for today's modern internal combustion engine and automobiles. The works and experiments of Nikolaus Otto, Rudolf Diesel, Gottlieb Daimler, Karl Benz, Nikola Tesla, Thomas Edison and many others continue to serve as references for today's advancements in engine efficiency and energy storage.

Many of us were taught the "rule of thirds" regarding engine efficiency – one third of the fuel's energy does work while two thirds of the fuel's energy is lost as heat to the exhaust and ambient surroundings. However, research activities in our industry over the past few years…even decades…has largely focused on debunking the "rule of thirds" to get a more efficient and cleaner engine/vehicle for the consumer while meeting increasingly stringent requirements for criteria pollutants. Passenger cars are aiming towards new fuel economy standards in 2025 while the SuperTruck program sponsored by the US Department of Energy has demonstrated heavy-duty long-haul diesel trucks with fuel economy values of 10.7[1] to 12.2[2] mpg.

Innovative Technologies

In this afternoon's session we will discuss "Turbocharging and Mild Hybrids." These principles are leading to mainstream efficiency-gaining technologies in the passenger car market. In the recently released Draft Technical Assessment Report of the Midterm Evaluation of Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards for Model Years 2022-2025, the US Environmental Protection Agency, the California Air Resources Board, and the National Highway Traffic Safety Administration stated that "turbocharged engines have also seen a swift increase in market share[3]," along with an increase in production of gasoline direct-injection engines. These findings are quite different compared to more traditional vehicle-level fuel economy improvements including hybridization and weight reduction. Historically, turbochargers and superchargers have predominantly been used in diesel (compression-ignition) engines and the

[1] Koeberlein, D., Cummins SuperTruck Program, DOE Annual Merit Review, June 2015.
[2] http://freightlinersupertruck.com/#main, Daimler Trucks North America LLC, August 2016.
[3] Draft Technical Assessment Report…, EPA-420-D-16-900, July 2016.

performance market for increased efficiency and power, but are now being more widely used in gasoline (spark-ignition) passenger cars and trucks. Single turbochargers are being used as well as series arrangements for precise air-path control using fixed or variable geometry hardware configurations. They are being supplemented with electric air pumps, or e-boosting technology, to improve driveability and performance for powertrain optimization. Sales penetration of the aforementioned hybrid vehicles peaked in the 2010 model year at just under 4% and have since slowed due to lower fuel prices, electric vehicles, and more efficient conventional drivelines. These hybrid vehicles brought the Atkinson cycle into mainstream production to use its efficiency benefits, and now with turbocharging and variable valve systems, Miller cycle engines are also being introduced to the market. But some vehicle manufacturers are introducing mild hybridization rather than full hybridization using innovative energy storage and energy assist methods in the vehicle. However, even mild hybridization may require higher operating voltages, such as 48V, and higher battery capacity rather than the conventional 12V system for passenger vehicles. With the introduction of these engine and powertrain configurations, customers have more options today from which to choose to make informed choices that can maximize the return on their vehicle investment.

To put these innovations into perspective, the US Department of Energy through www.fueleconomy.gov shows that consumers have an increasingly greater number of efficient vehicle options today for purchase than from years past. A simple search of "family sedans" with a combined fuel economy rating of greater than 30 mpg shows 26 vehicles available in model year 2016 compared to just 13 in model year 2012. These vehicle configurations are comprised of hybrids (including plug-in hybrids), diesel engines, naturally-aspirated gasoline engines, and turbocharged gasoline engines. Of significance is the fact that the number of hybrid options remains relatively unchanged while the number of non-hybrid solutions continues rise year over year. Expanding on turbocharged engines in mainstream production, Ford introduced the downsized, turbocharged, gasoline engine, commonly known as EcoBoost®, in 2009 in limited capacity. EcoBoost® engines offer higher power and improved fuel economy compared to conventional gasoline engines. In the 2016 model year, this technology is available in all of their conventional cars, sport utility vehicles, and light-duty trucks. Similarly, General Motors is now offering turbocharged engines in their ECOTEC® line for compact vehicles to downsized, turbocharged engines in the performance Chevrolet Camaro. FCA has recently introduced the MultiAir® downsized, turbocharged engine with improved torque response and fuel efficiency. These examples are just three examples of many innovative solutions that vehicle manufacturers have recently developed in response to increasingly demanding customer and regulatory standards.

Conclusion

Today's engineering challenges in the transportation industry are best addressed at the system level. We can no longer address the engine, transmission, or body alone to realize the best efficiency improvements. Current state-of-the-art products in the transportation segment attempt to fine-tune each sub-system in order to optimize the system as a whole in regard to emissions compliance, performance, driveability, and ultimately, customer acceptance. Innovative solutions continue to be developed by academia, national laboratories, suppliers, and manufacturers that change the way we think about our vehicles and their impact on our environment.

Our speakers in today's panel will describe some of their innovative solutions in greater detail.

Introduction of speakers